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Fuzzy modelování při hodnocení použitelnosti
informačních systémů veřejné správy

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DUMAS J. - REDISH J. A Practical Guide to Usability Testing. Aktualizované vydání. Intellect Ltd. 1999. 404 s. ISBN 1841500208.

CHANG E. - DILLON T. A usability-evaluation metric based on a soft-computing approach. Systems, Man and Cybernetics, Part A, IEEE Transactions, 2006, vol. 36, issue 2, s. 356-372.

KRUG Steven. Don't make me think. 1. vydání. New Riders Press, 2000. 195 s. ISBN 0789723107.
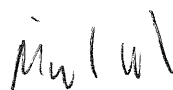
PATERNO Fabio. Model-Based Design and Evaluation of Interactive Applications. 1. vydání. Springer Verlag, 2000. 192 s. ISBN 1852331550.

RAVDEN S. - JOHNSON G. Evaluating usability of human-computer interfaces: A practical method. 1. vydání. Halsted Press, 1989. 126 s. ISBN 0-470-21496-1.

PATERNO F. - PAGANELLI L. Intelligent Analysis of User Interactions with Web Applications. International Conference on Intelligent User Interfaces, 2002, s. 111-118.

RAVDEN S. - JOHNSON G. Evaluating usability of human-computer interfaces: A practical method. 1. vydání. Halsted Press, 1989. 126 s. ISBN 0-470-21496-1.

RUBIN Jeffrey. Handbook of usability testing: How to Plan, Design, and Conduct Effective Tests. 1. vydání. Wiley, 1994. 330 s. ISBN 0471594032.

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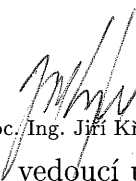Termín odevzdání diplomové práce: **1. května 2009**

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ABSTRACT

This work presents a new methodology of usability evaluation based on the principles of fuzzy theory. Unlike the other methods allows obtaining a score of usability evaluation. Although the methodology is designed to evaluate the usability of Information Systems in Public administration, it might be generally used for any kind of user interface. The criteria of evaluation are in principle based on a set of properly chosen key characteristics affecting the usability of the target user interface. The evaluation is represented by imprecise, vague linguistic expressions containing some value of quality of use. A fuzzy inference system is used to elicit the knowledge stored in the fuzzy rule base to determine the overall output. The usability score represents a meaningful and authentic value − an indicator of quality of particular Information System, a value that can be compared with the others. The proposed methodology of fuzzy usability evaluation was implemented to the application Fuzzy Usability Evaluator that has been used for evaluating usability of Web portals as an example of Information System in Public administration.

KEYWORDS

NÁZEV

Fuzzy modelování při hodnocení použitelnosti informačních systémů veřejné správy

SHRNUTÍ

Tato práce prezentuje novou metodologii pro hodnocení použitelnosti založenou na principech fuzzy teorie. Na rozdíl od ostatních metod umožňuje získat skóre hodnocení použitelnosti. Ačkoliv je metodologie určena pro hodnocení použitelnosti informačních systémů veřejné správy, může být obecně použita pro jakýkoliv druh uživatelského rozhraní. Kritéria hodnocení jsou v podstatě založena na definici množiny pečlivě vybraných klíčových charakteristik ovlivňujících použitelnost cílového uživatelského rozhraní. Hodnocení je pak reprezentováno nepřesnými, vágními lingvistickými výrazy, které obsahují nějakou hodnotu kvality užití. Fuzzy inferenční systém je použit pro odvození znalostí uložených v bázi fuzzy pravidel, které umožňují určení celkového výstupu. Skóre použitelnosti vyjadřuje smysluplnou a autentickou hodnotu – ukazatel kvality konkrétního informačního systému, hodnoty, která může být porovnána s jinými. Navržená metodologie fuzzy hodnocení použitelnosti byla implementována do aplikace Fuzzy Usability Evaluator, která byla použita pro hodnocení použitelnosti Webových portálů, jakožto příkladu informačního systému ve veřejné správě.

KLÍČOVÁ SLOVA

Použitelnost; informační systémy; veřejná správa; fuzzy logika; kvalita software; softwarové inženýrství.

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Introduction

In today's age of information usability becomes extraordinary important. Usability engineering, a discipline dealing with human-computer interaction [1], is quite new in terms of history, experience and number of trained people, yet it became very popular. The importance of usability evaluation increased rapidly in last 10 years [1], [2]. The amount of new software increases proportionally with the number of its users. Today, as never before in the past, user has large possibilities of choice [3], since various dedicated software was developed to satisfy users' special needs or meet their requirements. In contrast with the past, users are no longer pushed to use particular product, just because there does not exist any other. Hence, measuring of usability had been underestimated. Why should be measured something that cannot be compared to anything else similar? However, the usability was always here. It did not suddenly show up.

Nowadays, the usability has its fundamental role in software engineering [1]. It may reveal qualities as well as lack of functionality, which usually arises during the design phase of a product [1]. Nevertheless, usability is not only limited to testing the quality of use of software products. It might evaluate the ease of use of product manuals, cars, home electronic devices as well as the usability of Web sites or cell phones [4].

1. State of the art of usability measurement

The history shows us that there was not always an accent on users' comfort [1]. One could say that users were slaves to the machines, which, instead of performing tasks efficiently and not standing in users' way to get their work done without too much effort, made it even more difficult.

When this changed, the designers, programmers and vendors started to use very often the term "user friendly" system [1], [5]. This term is not appropriate, since users do not need machines to be friendly to them. They just need machines not to stand in their way when they try to get their work done. The term also implies that users' needs can be described along a single dimension that systems are more or less friendly. In reality, different users have different needs, and a system that is "friendly" to one may not feel the same to another [1].

Due to these facts, user interface professionals have tended to use other terms in recent years. The field is known under names like computer-human interaction (CHI), human-computer interaction (HCI), user-centered design (UCD), human factors (HF), etc. [1]. These different fields contributed in creation of widely accepted definition of term usability [5], [6] or [7].

1.1 Usability engineering and usability evaluation

Only by defining the abstract concept of usability in terms of some precise and measurable components, we can arrive at an engineering discipline – usability engineering [8] - where usability is not just argued about, but is systematically approached, improved, evaluated and possibly measured [1]. Clarifying the measurable aspects of usability is more appropriate than aiming at a fuzzy feeling of "user friendliness" [9].

Measuring the usability aspects of the system's user interface [10] with the help of particular methodologies is called the usability evaluation [1], [11]. As stated in [12], the usability evaluation is an important interface design process, since it allows discovering the problems of the design and better understanding of the targeted users [1].

As cited by [13], a usability evaluation method refers to any method or technique performing a usability evaluation of user interface (UI) at any stage of its development [1]. Each usability evaluation method should be realized according to the [14]:

- cheaply,

- quickly,
- with useful results.

According to the definition found in his book, [1] recommends to measure usability by having a representative number of test users, who perform a set of tasks on tested system. He also found out that usability is measured relative to certain users and certain tasks. Same system might be measured with different usability characteristics if used by different users for different tasks.

Literature however does not discuss how to obtain a usability score by using some of the methods of usability evaluation. Obtaining score of usability evaluation results from a need to have [15]:

- an objective indicator of quality of use,
- a value that can be compared to the other similar values,
- a mechanism that provides clear information for consumers (clients, users, non-experts) as well as advanced feedback for expert users (evaluators, administrators, supervisors, designers, project managers, executive).

1.2 Current methods of usability evaluation

According to the [1], [8], [14] the usability evaluation methods are divided into several groups, most commonly into:

- expert-based evaluations (inspection methods),
- user-centered evaluations (usability testing methods).

These methods differ depending on the source of the evaluation. This source can be usability experts or users. A person using a usability evaluation method to evaluate usability is called an evaluator. It might be a person with expert knowledge (e.g., Web designer, Web administrator, IT specialist, economist, project manager, etc.) as well as a person who is in charge on supervising the usability evaluation process. A person using a usability inspection method is often called an inspector [16].

Usability evaluation typically only covers a subset of the possible actions users might take. For these reasons, [1] or [11] recommend to use several evaluation methods. Table 1 lists most common usability evaluation methods and summarizes their possibilities and suitability for obtaining a score of usability evaluation. These methods are broadly discussed in the literature cited above.

Table 1: Overview of current usability evaluation methods, source: [1]

Method group	Method name	Description	Advantages	Disadvantages
Expert-based evaluations	Guideline review	Expert checks guideline conformance	Cheap and quick. Suitable for detecting problems in usability.	Focus only on the conformance to some usability guidelines.
	Cognitive walkthrough	Expert simulates user's problem solving	Relatively cheap. Very useful for detecting the problematic tasks and difficulties in learning the system.	Expert cannot simulate behavior of every user, therefore cannot predict all possible states. Not useful for measurement.
	Pluralistic walkthrough	Multiple people conduct cognitive walkthrough	Useful results. Very suitable for testing the system and detecting possible problems.	Quite expensive, might not be quick. Not suitable for obtaining a measure.
	Heuristic evaluation	Expert(s) identifies(y) heuristic violations	Relatively cheap and quick. Reveals problems, gives recommendations and might be possibly measured.	Measure based on the judgment of group of experts according to the conformity to the set of criteria. Measure may not represent users' opinions.
User-centered evaluations	Thinking-aloud protocol	User talks during the test	Users evaluate by using their natural language, large spectrum of information is obtained. Very suitable for detecting the usability problems.	Very difficult to analyze and quantify, make conclusions. Might be very expensive and time-consuming.
	Performance measurement	Tester or software records usage data during the test	Precise in terms of obtaining exact biometric, physical or other measures.	Suitable for detecting usability problems. User language is not examined. Very expensive.
	Remote testing	Tester and user are not co-located during the test	Relatively cheap and quick. Large number of users can be tested. Might be statistically analyzed and measured.	Results might be full of ambiguities. Measure is based on scaling and approximation might not be always precise.

The fundamental goal of all inspection methods is to find usability problems in an existing interface design and then use these problems to make recommendations

for improving the usability of an interface [1]. The evaluator examines the usability aspects of a UI design with a respect to its conformance to a set of guidelines that can range from highly specific recommendations to broad principles [12]. Guidelines list well-known principles for UI design, which should be followed in the development project [1]. Wide variety of usability guidelines have been established by different authors and can be found in [2], [6], [10], [17], [18], [19], [20], [21], [22], [23].

Commonly used inspection techniques are heuristic evaluation [1]. In heuristic evaluation, one or more evaluators independently evaluate an interface using a list of heuristics [1]. After evaluating the interface, the evaluators aggregate their findings and associate severity ratings with each potential usability problem. The output of this evaluation is typically a list of possible usability problems [1]. Heuristic evaluation is the most informal inspection method [14], mainly because it relies on a small set of usability criteria. Since heuristic evaluation is very cheap, fast and easy-to-use [14], it is considered as the most widely used inspection method [8].

As for the user-centered evaluations, [1] considers testing with real users as the most fundamental usability evaluation method and in some sense irreplaceable, since it provides direct information about how people use products and what their exact problems are with the concrete interface being tested.

During usability testing, participants use the system to complete a specified set of tasks while the evaluator or specialized software records the results of the participants' work. The evaluator then uses these results to derive usability measures, such as the number of errors and task completion time [1], [10].

1.3 Problem definition

Although usability studies are widespread, the issue of obtaining usability score that would directly express the evaluation of some UI remains an unexplored area of interest. There is not any clear consensus how to measure usability obtaining a significant score taking also in mind that users' language is full of vague expressions, ambiguities and uncertainty [24].

Current methods of usability evaluation do not provide such measure, although some conceptions were already presented, for instance in [25]. Another problem of these methods is that they are usually very expensive to perform, time-consuming, unable to face

vagueness and ambiguities surrounding the evaluation process, attuned mainly to the problem detection and their result are usually very difficult to analyze. From these reasons, there is a need to develop a usability evaluation methodology that is:

- cheap and quick,
- precise and produces results that might be easily analyzed,
- obtaining single value score,
- evaluated by both users and experts,
- able to deal with the users' language which is full of vague terms,
- based on mathematical principles,
- able to be used for usability evaluation of various kind of UIs (e.g., Web sites).

The author of this work assumes that a lightweight methodology for evaluating the usability of Information Systems [26] should be developed. This methodology should meet all the requirements that were defined above. Since such methodology has not been developed yet, this work is dealing with the problem of finding principles of such methodology, its development, use, validation and its generalization for any kind of system.

Hence, the goal of this work is to create a methodology easing the users' ability to evaluate the usability by using their natural language, which is full of vague expressions [24]. The output of the model should be a single real number representing the overall score of particular evaluation defined on range from 0 to 100 points, where higher value represents better usability score. This score might be used for instance as a measure of quality or in decision making as the helpful input for comparative analysis [27].

The proposed methodology should not serve in the first place as a usability validator, detecting the deviations from usability guidelines, but rather a metric [28], giving the direct information about quality of use. As presented above, such information might have large possibilities of utilization.

The methodology will be based on a set of criteria selected thoroughly and sensitively according to the characteristics of the target environment of Public administration [29] representing the major aspects that affects the usability of Information Systems (IS). If mentioned usability guidelines (i.e., criteria) are modified according to the characteristics of particular environment the methodology is not only limited to Information Systems of Public administration [30].

Since it is not appropriate to model vagueness, uncertainty, ambiguity that are natural parts of communication, decision making and other processes, using classical binary logic [24], this work presents an approach for usability evaluation of Information Systems in Public administration (ISPAs) based on the fuzzy modeling [31], [32].

Ways of expressing and combining uncertainties according to the [24] include theory of probability, fuzzy logic, Bayes' theorem and Dempster-Shafer theory. For many scientific fields, the fuzzy logic is the only suitable apparatus, while the other theories fail, since fuzzy variables are more attuned to reality than crisp variables [33]. In fact, it is a paradox that data based on fuzzy variables provide more accurate evidence about real phenomena than those based upon crisp variables.

Each theory has its advantages, disadvantages and problems. Although, any total convincing argument cannot be presented, fuzzy theory has according to [24] as the only presented theory a clean mathematical framework provided by fuzzy sets [31]. The basic concept that makes possible to treat fuzziness in a quantitative manner is based on a membership function, where each fuzzy set is characterized by a membership function, which assigns to each object its grade of membership [32].

In order to understand the goal of this thesis, defined problem should be first decomposed. The goal is to perform a "*usability evaluation of Information Systems in Public administration based on the fuzzy approach*". Apparently, the definition of initial problem seems to be very complicated. Therefore, it would be appropriate to decompose it to atomic parts (see Table 2).

Table 2: Decomposition of the initial problem, source: own

Notation of decomposed part	Auxiliary question	Decomposed part	Field of interest	Available methods
Subject (task)	What task is about to be performed?	*"Usability evaluation"*	Usability engineering	Usability evaluation methods, questionnaires, usability testing
Object	On what object is the task going to be performed?	*"of Information Systems"*	Information Systems	Structure of the system, users of the system
Environment	In what environment is the task going to be performed?	*"in Public administration"*	Public administration	Characteristics of the environment, members and relationships of the system, processes, output, feedback
Apparatus	By the help of which apparatus is the task going to be performed?	*"based on the fuzzy approach"*	Fuzzy sets and systems	Operations with fuzzy sets, fuzzy numbers, fuzzification, defuzzification, Mamdani style inference, rule base

According to the presented decomposition, the decomposed parts should be first explored and comprehended individually, afterwards synthesized and solved as a complex problematic.

2. Establishment and development of the methodology

Which single real number represents expression "to be fast?" Different people have different answer and opinion. As a result of this question, highly imprecise answers would appear, yet expressed with a number.

What would be the answer if the question was "How easily comprehensible is the coffee's machine user interface?" It is apparently possible to state the answer as a single number that is a member of some artificial scale, say from 0 to 100. Would this number have a significant level of accuracy or would it be just a feeling about some state of variable?

In the case of such a question, it would be more appropriate to answer such as "very well" or "quite easily." These evaluations are in principle vague, imprecise because they do not stand for any single value that would be commonly accepted. Hence, another question arises – what number or set of numbers stands for "very well" or "quite easily?" the problem of evaluation seems to be even more complicated, since the complex question is evaluated by a vague expression instead of assigning some numeric value. How this can be more accurate?

As defined previously the optimal apparatus to deal with this problem is based on theory of fuzzy logic, which will allow using natural language during the evaluation. The question is how to convert these *fuzzy* evaluations to the rigorous form that might be mathematically processed and easily understood by humans. The solution how to treat uncertainty that inheres in users' evaluations, however *fuzzy*, vague, or imprecise the idea seems to be, is to express them in the form of fuzzy numbers [24]. The users, instead of stating numbers from some scale (for instance from 0 to 100 or from 1 to 7), express their evaluation propositions using their natural language. Hence, the result of answering the evaluating criteria is a set of words stating some level of preference. Since the users' evaluations do not have a form of crisp measures, these input variables are expressed as fuzzy measures [33].

The idea of establishing usability score results from the previously presented reasons. Following summary lists the principles that should be respected during the establishment of the methodology of usability evaluation based on the fuzzy approach (methodology of fuzzy usability evaluation):

- Users do not directly express the overall score by using any numerical values.

- Using their natural language, they evaluate a set of characteristic features that significantly affect usability.
- Users' mental load should be minimized so they can fully focus on the aspects of evaluation.
- Overall value is not computed as a mean of evaluated criteria.
- Usability score is a best approximation of expert knowledge stored in the special database.

2.1 Methodology of fuzzy usability evaluation

The proposed methodology of fuzzy usability evaluation combines findings of the fuzzy theory and the usability engineering. The methodology consists of the following phases:
- establishment,
- testing,
- evaluation,
- analysis and conclusions.

The procedures that need to be executed in order to get a score of usability evaluation are summarized in Table 3.

Table 3: Procedures of fuzzy usability evaluation process, source: own

Phase	Procedure	Description
Establishment	Utility of usability evaluation process	Prior to the execution of other procedures, the utility of usability evaluation need to be identified. The process must have positive impact on the target system (quality, satisfaction, loyalty, efficiency, reliability etc.)
	Object of evaluation	Group of homogenous systems that will be evaluated has to be selected. Only systems that are worthy to be tested for usability should be evaluated.
	Target group of users	The group of typical users of the evaluated systems should be easily defined. It is necessary to inquire group of users in order to obtain results. Hence, it must not be impossible or difficult to realize suitable form of usability testing.
	Criteria of evaluation	A finite number of major aspects affecting the usability of evaluated systems must be defined. It is recommended to perform thorough study of these characteristics.
	Parameters of evaluation	Every criterion of the evaluation – variable that helps to explain usability has to have defined universe of discourse, finite number of states of the linguistic variable, shape and parameters of the membership functions. The number of the output membership functions for usability, shape and other parameters of membership functions of this linguistic variable must be decided.
Testing	Empirical scale definition	It is necessary to define the empirical scale that explains how the sample of users understands the evaluation expressions. This is done by inquiring a group of testing users that evaluates the usability both by using word expressions and by numeric score of each criterion.
	Rule base definition	The evaluator may use results of testing to define the fuzzy rule base. That however depends on the level of evaluator's knowledge. Properly defined rule base is the most important factor that determines precision of the output.
Evaluation	Usability evaluation	After definition of the empirical scale and equipping the rule base with expert knowledge, regular usability evaluation may be initiated. During the evaluation, desired number of users evaluates each criterion of selected systems. The result of usability evaluation is a set of evaluated criteria in form of word evaluation.
	Score of usability evaluation	Each set of evaluations is first fuzzified, inference with the help of knowledge stored in the fuzzy rule base and afterwards defuzzified to the form of single real number. The resulting value is the score of usability evaluation and is defined on range from 0 to 100 points.
Analysis and conclusions	Analysis of results	After performing all evaluations, the results can be analyzed. One may compare results to find the best alternative or analyze how different classes of users evaluate selected systems.
	Conclusions	Depending on the purpose of the usability evaluation, the evaluator can make various kinds of conclusions that may involve other fields. The interpretation of results relies on the evaluator and desired goal of the usability evaluation process.

Some procedures of fuzzy usability evaluation process described in Table 3 specific for the environment of Public administration are broadly discussed further in this chapter.

2.2 Establishment phase

According to the proposed methodology, it must be examined whether the usability evaluation process has a utility. Afterwards, the objects to evaluate need to be chosen as well as an appropriate number of testing users and users that will evaluate the usability of selected objects of evaluation.

One of the pillars of the fuzzy usability evaluation process is the criteria definition. It is suggested to perform a vigorous analysis of the target systems' characteristics by consulting experts from given field.

At the end of the establishment phase, the problematic has to be defined also in terms of fuzzy theory, thus all necessary parameters need to be determined.

2.2.1 Utility of the usability evaluation process

The importance of usability evaluation of selected ISPAs or generally any kind of UI inheres in developing an objective measure of quality of use of these systems.

The main reasons why conduct the usability evaluation of the ISPAs are as follows:
- development of an objective measure of quality of use,
- raise of the interest and competiveness,
- growth of the attractiveness,
- new opportunities.

Specific set of utility factors needs to be however defined when performing concrete usability evaluation process.

2.2.2 Object of evaluation

As defined above, the entire problem of this work is discussed in terms of the environment of the Public administration. Constraining the problematic only to this particular environment significantly eases the complexity of the initial problem.

Since the common definition of Information System [26] does not particularly determines or mention any particular framework or interface, the one that is accessible with minimal restrictions for the users should be chosen. Such platform might be easily evaluated and sample of tested users would be highly representative. Author assumes to use the Web-based Information Systems, since the Web platform is recently the most dynamical environment for presenting any kind of information [34].

The most suitable type of Information System to perform the goal of this thesis on, will be the Web portals [35] presenting the municipalities, i.e., cities, small towns, villages, districts or any other Web sites that presents some urban area or municipal territory. The reasons leading author to choose this particular type of Information System are following:

- it has large number of users due to its accessibility,
- it is not subject to any restrictions of use,
- it is free of charge,
- to understand its content does not require any special knowledge,
- the representative group of typical users can be easily chosen,
- it is constantly available,
- testing its usability has a utility, which might result in increasing the quality, if the results of evaluating reveal any problems,
- the results of evaluation can be compared to other similar Web sites presenting the municipality.

A Web portal in terms of the Public administration (WPPA) could be perceived as a virtual environment in which citizens meet the Public administration, where portal represents one initial point, which allows access to services and information provided by Public administration [35]. The structure of WPPA is depicted in Figure 1.
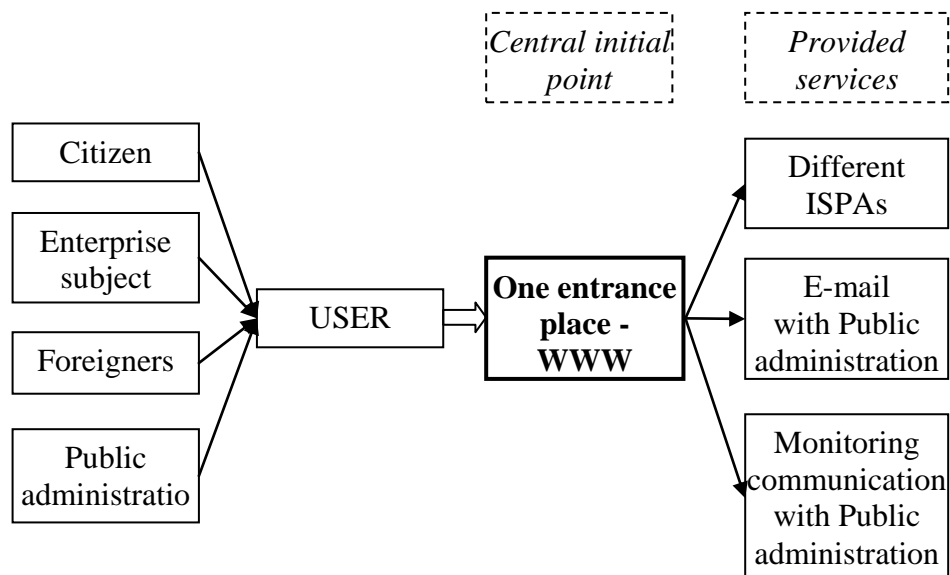
Figure 1: Web portal functioning, source: [35]

The structure of ISPA in terms of a Web portal the local authority, municipality generally consists of [36]:

- general information about the head of the local authority,
- the structure and organizational chart of the local authority and provided services,
- information about provided services and the way how to reach them (contacts, forms, documents),
- general information about the local economical activities,
- cultural and historical information about the area.

2.2.3 Users of the target system

It is necessary to know the people that are using the system. Individual user characteristics and variability in tasks are factors with the largest impact on usability, so they need to be studied carefully [1].

To become a user of WPPA, the person has to have some kind of needs in relation to Public administration. There is a high probability that the citizen will be obliged to interact with Public administration and deal with some common situation of everyday citizen's life.

Therefore, the users of WPPA are Internet users of various ages, capable to read and process information. The last attribute also requires users to be capable to control basic operations with the computer or any other kind of machine making possible to reach the Web portal of the municipality. More specifically, this group of users is described by these criteria:
- male and female individuals,
- age between 10 – 80 years,
- enough intelligence to process the information,
- ability to control basic computer operations.

According to [1], knowing the user's work experience, educational level, age, previous computer experience, allows to anticipate their learning difficulties.

In his book, [1] also suggests to study users' goals as well as their information needs. The typical tasks of the user of ISPA might be for instance following:
- to find various kind of information about the municipality,
- to know the recent information from the municipality,
- to answer questions regarding the services provided by the local authority,
- to interact with the local authority on distance, etc.

2.2.4 Criteria of evaluation

Each entity of real world has a number of key characteristics - unique descriptors that allows generalizing its complex structure. Whenever there is a reason to create a model of some system in order to simulate some state, measure quality, compare results or detect problems, it is always useful to know these characteristics.

While the quality of use of some system can be described by a relatively small set of factors that determines its overall value, systems with large number (or a number of discrete) descriptors exist [15]. Higher complexity the system has, the larger the amount of factors exists.

After studying large number of Web usability guidelines, the most important attributes that characterize a good Web site have been chosen with the respect to the particular environmental characteristics of Public administration.

A set of nine criteria that retain important characteristics of the WPPAs were chosen (see Table 4). However, many other criteria could be used, some of them more or less important. For the purposes of this work, the amount of criteria is sufficient.

Table 4: List of criteria affecting the usability of WPPA, source: own

No.	Criterion	Evaluating question
1	Accessibility	Specify how easily is the Web site's content legible (readable) and viewable for you.
2	Instant comprehension	How much do you consider the information instantly comprehensible?
3	Information retrieval	How simply (and fast) is to find some kind of information on Web site?
4	Recency	How much do you consider the information found on the Web site actual?
5	Navigation simplicity	Evaluate simplicity and level of comprehension to the Web site's navigation.
6	Design preference	How much does the graphic design of the Web site fulfill your expectations or meet your preferences?
7	Orientation	How good is the knowledge of your current location through the Web site at any moment during the browsing?
8	Amount of graphics	Qualify your level of satisfaction with the amount of graphics appearing on the Web site.
9	Loading speed	Evaluate the speed by which the Web site's elements are loaded.

The criteria are constructed in way that does not demand to state the fact by numeric value. They rather allow users to express the evaluation using their natural language. Thus, the evaluating questions are formulated in such way to obtain a proper vague expression as an answer of it. Brief definition of criteria is presented in Table 5.

Table 5: Characteristic of the criteria, source: own

Criterion	Characteristics
Accessibility	Defines how easily the Web site is readable and viewable. Focuses on factors that make difficult to use the Web site for people with various kinds of disabilities, but also what should be avoided in order to increase the accessibility for healthy people. For instance, low contrast between the background and the content of the Web page, too many colors, wrong used colors, small fonts negatively affect the accessibility. Users should be able to answer the evaluating question after a short interaction with the Web site.
Instant comprehension	Affects both accessibility and content quality. The content might not be easily understood by all users due to the bad expressing capabilities of the editor. The content has to be understandable without much thinking, memorable, able to be processed, grammatically and typologically correct, reliable, well-structured, clearly labeled, etc. To evaluate the criterion, it is recommended to let user read some article or paragraph found on the Web site.
Information retrieval	The user has to evaluate the satisfaction searching capabilities and its structure. Desired information should be available instantly. The style of information structure should be based on logic inductions, having strong accent on user's view. Good Web site should have implemented the information structure based on the catalogue search engine, structuring the information according to various fields of interest. Users evaluate the level of satisfaction with searching the desired information according to their interests.
Recency	The Web site should be frequently updated and contain actual information. The recency of information increases users' trust, favor and preference. The information must be valid or else is useless. Good information should be correct, proved, actual, certain and clear. When evaluating the criterion, users are free to qualify whether they find the information recent or not.
Navigation simplicity	Navigation is the only element making possible to move along the Web site. High level of user's identification with navigation is necessary. Good navigation is instantly understandable and allows user to adapt its style. Bad navigation is distinguished by "more aiming than shooting", when the user is focused more on understanding than the utility to perform the tasks.
Design preference	May reveal the impropriety of the graphic design for WPPA. Users usually negatively reflect if the graphic design is not uniform, the colorfulness is not appropriate, etc.
Orientation	The users are tested whether they are sure about their current location in the Web site structure. Knowledge of user's current position decreases the time spent by performing new tasks, positively affects the user's involvement. Criterion might by evaluated by examining whether user knows current position in the site's structure, how to reach the home page, how to get back on the current place.
Amount of graphics	Criterion is testing the level of user's identification with the interface. User specifies if the amount of graphics is excessive or not adequate (which are both negative states) or if the number of graphics matches with the amount of text and other elements making the content interesting.
Loading speed	Determines user's level of satisfaction with the speed by which are the elements of the Web site (pages, images, forms, database, etc.) loaded. The evaluation is subjective to the customs and habits. Every Internet user has some experience and idea about the loading speed.

As stated above, the criteria are based on set of guidelines obtained from current usability studies and experts' recommendations. The list of related guidelines for each criterion is presented in Table 6.

Table 6: Criteria and related usability guidelines, source: own, [2], [16], [17], [19], [21]

No.	Evaluating question	Related Web usability guideline(s)
1	Specify how easily is the Web site's content legible (readable) and viewable for you.	There is sufficient contrast between backgrounds and foregrounds. Each non-text element carrying information has its text alternative. There are no designs on backgrounds that impede legibility.
2	How much do you consider the information instantly comprehensible?	Web sites present information using simple language and understandable formats. Homepages clearly describe the purpose and substance of a Web site. The name of the Web site or its operator is clear. Each Web page has a meaningful title that reflects its content. More extensive content blocks are always divided into smaller, concisely titled units.
3	How simply (and fast) is to find some kind of information on Web site?	How accurately does the Web site meet the minimal requirements for the information content.
4	How much do you consider the information found on the Web site actual?	Usable Web site should provide actual and reliable information. Update content often.
5	Evaluate simplicity and level of comprehension to the Web site's navigation.	Navigation and content information on Web pages are clearly separated. Navigation is understandable and consistent throughout all the Web pages. The labeling of each link clearly describes its target without relying on the surrounding context. The number of links to other pages is adequate but not excessive.
6	How much does the graphic design of the Web site fulfill your expectations or meet your preferences?	The Web site style should be uniform. How much does the design style of the interface reflect the users' characteristics. Colorfulness should be adequate to the content.
7	How good is the knowledge of your current location through the Web site at any moment during the browsing?	All the Web pages of more extensive Web sites contain links to a clear map of the Web site. Each Web page (except the homepage) contains a link to the higher level in the Web site hierarchy and a link to the homepage. A separate Web page includes contact details of the technical administrator and a clear declaration of the defined accessibility level of the site and its sections. All other pages include links to this page.
8	Qualify your level of satisfaction with the amount of graphics appearing on the Web site.	The consensus in the literature is that the number of images needs to be minimized to improve download speed. The amount of graphics should not be extremely low or extremely high.
9	Evaluate the speed by which the Web site's elements are loaded.	The loading speed is an important attribute of usable Web site. Information provided by the server side should be retrieved instantly.

2.2.5 Parameters of evaluation

In this step of the fuzzy usability evaluation process, the evaluator should determine:

- fuzzy constructs of the evaluated criteria,

- way of conducting testing and evaluation phases,
- parameters of membership functions, linguistic states of input and output variables,
- used reference scale and significance of the sample to represent the whole population.

After identifying relevant input and output variables and ranges of their values, the meaningful linguistic states (i.e., values of linguistic variables) for each variable has to be selected and expressed by appropriate membership functions. These fuzzy sets represent linguistic labels such as "low", "medium", "high".

2.3 Testing phase

To conclude the proposed methodology of fuzzy usability evaluation defined earlier in this chapter, the following procedures were not yet defined:
- scale definition,
- fuzzy rule base definition.

The establishment of both procedures is based on values obtained from a finite number of testing users by evaluating a set of selected WPPAs (see Figure 2),
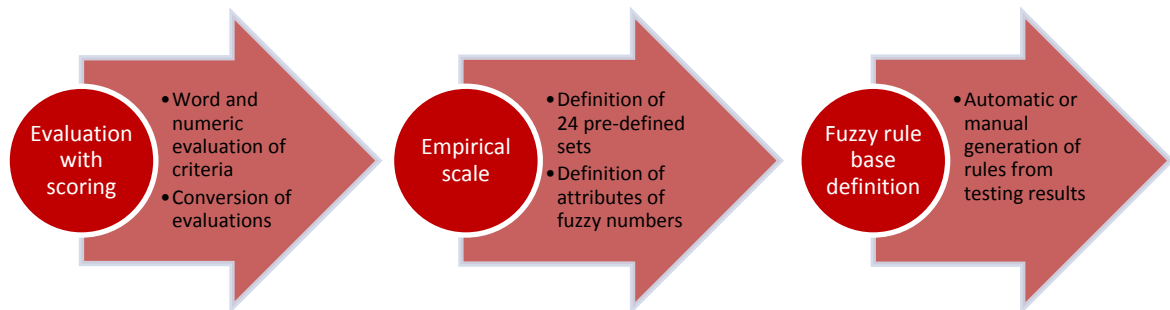
Figure 2: Diagram of the testing phase, source: own

Once testing phase is performed, there is no need to repeat it again in future. The results of scale are generally acceptable for wide group of users. The same applies for the rule base. Once defined, it might be used repeatedly.

2.3.1 Process of scale definition

The empirical scale is a metric that helps expressing natural language by telling which values stand for particular evaluation. Its universe of discourse lies on range between 0 and 100 and is divided into 24 sub-ranges of various sizes. The size and position of each sub-

range on empirical scale is defined by users who indirectly provide this information during the testing phase of the fuzzy usability evaluation process. In principle, there are several reasons to create an empirical scale:

- evaluations cannot be expressed accurately as single values,
- to respect users' language and variety of word expressions that they use to state some level of quality,
- to retain the uncertainty in the evaluations.

Scoring is a method for developing the empirical scale. It establishes a relationship between a theoretically designed range and the measure obtained by the users. The reason of scoring is to induce users' natural sense of understanding commonly used evaluation truths. The users are inquired to qualify the evaluation by using their natural language and then they are asked to evaluate the same fact by a numeric value. It is important to note, that the users should feel free to evaluate the linguistic fact by any number from the scale of 0 to 100.

In early stages of the development, the scale was originally defined only by dividing the universe of discourse to a number of equally distributed sub-ranges. This theoretical scale provides good results, however the nature of problem shows that users' evaluations are vague terms. The evaluations do not possess prescript boundaries and users are uncertain how exactly would they define such ranges if they were directly inquired. Thus, establishing of an artificial scale for the large set of users would decrease the accuracy of the output, since every particular user understands the meaning of some evaluation way different from the others.

Every user has own idea about the particular evaluation and is able to determine whether the direction of the evaluation is negative, neutral or positive. Users understand the meaning of evaluation, but the range of values and position on scale of such evaluation is implicit. The users do not think about where exactly lies the border between something "good" and something "bad". They have learnt to distinguish between these states by creating ones that are more specific.

As defined previously, the universe of discourse of empirical scale is divided to the 24 pre-defined sets of evaluations that express some degree of quality. Each of these sub-ranges has its own label as well as universe of discourse (see Table 7).

Table 7: Overview of pre-defined classes of evaluations, source: own

Label of the subset		
Negative meaning	**Neutral meaning**	**Positive meaning**
extremely (-)	approximately (0)	relatively (+)
very very (-)	more below (0)	quite (+)
relatively very (-)	slightly below (0)	more or less (+)
very (-)	below (0)	relatively very (+)
quite (-)	slightly above (0)	very very (+)
relatively (-)	more above (0)	very (+)
more or less (-)	above (0)	extremely (+)
(-)	(0)	(+)

The sense or the direction of the particular evaluation has negative, neutral or positive meaning. Each of these categories consists of eight specific labeled evaluation classes. Every label name consists of the hedge [24] (e.g., "very very") and category of the meaning: (-) for negative meaning, (0) for neutral meaning and (+) for positive meaning. This labeling allows grouping multiple expressions under one class where both the hedge and core of the evaluation (i.e., a word that stands in place of category name) might be different from the class label. Each label stands for one evaluation word representing the most common word of that class of words (synonyms) that can be considered as members of same sub-range having the same meaning as the class representative (label).

Testing users are during the sessions asked to evaluate the set of criteria that affects the usability of WPPA. They are stating the evaluations by using word expressions that represents some state of input variable. Such evaluation may be for instance as follows: "good", "quite satisfied", "not ok", "not very fast", "normal", "better than average", etc.

Furthermore, they are asked to evaluate the same state of input variable also by assigning a single numeric value from scale 0 – 100. The idea is to define a set of values that belong to the same class of evaluations. A mistake would be to ask for assigning a numeric value directly to the evaluation expressed by words. The users might started using well known patterns like "average is 50", "very bad is 0", "good is 100", etc., and scale might become uniform.

One user may state "good" and evaluate criterion by 80 points, or state "good" and evaluate by 95 points when evaluating different criterion of the same system, while another user may report "good" and assign 75 points to the criterion. That is however perfectly normal, since the users must feel free to express their feelings during the testing scale definition. Only in this case, the fuzzy nature of vagueness of the evaluations can be retained.

During the scale definition, number of relations in form (word_evaluation; numeric_evaluation) is obtained. These are processed as follows:

1) If user used an evaluation that does not directly correspond to one of the 24 classes of evaluations, they are translated by a special database.

2) In case the evaluation is not in this database, the appropriate class of evaluations has to be selected to define the relation between them.

3) Numeric evaluation is stored in the special database under the respective class of evaluations.

4) After terminating inquiries with testing users, the average of each 24 classes of evaluations is calculated together with the standard deviation of such sample.

5) The mean value defines a base of a fuzzy triangular number while subtracted or added multiple of standard deviation[1] (σ) to the mean forms left and right border of the fuzzy number respectively,

6) The result of the scale definition is a set of 24 fuzzy numbers, for instance fuzzy number with label "very (+)".

The reason why the triangular fuzzy numbers were chosen is that these are easier to manipulate and implement. Author considers proposed way of expressing linguistic evaluations in form of fuzzy numbers as statistically reliable, since the mean of the collected evaluations has degree of membership [31] equal to 1 while the other values that are spread around the mean has lower degree of membership up until they reach the left or right border of the fuzzy number.

Lastly, it must be noted that the defined normalized sets in form of fuzzy numbers are not reversibly convertible to the form of single values. The particular fuzzy numbers must

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[1] The value of one sigma expresses 68.72% of all values, two sigma 95.45% of all values and three sigma 99.73% [46].

not be comprehended as single value defined only by a support of this number (mean value).

2.3.2   Rule base definition

In [37], the authors state that much human thought can be expressed in rules. It is convenient to use the systems that have implemented some of the human knowledge since these systems has its own intelligence and they use computer's fast instructions to obtain the results.

The process of drawing conclusions from existing data is called inference, since new truths are inferred from old ones [24]. The purpose of the inference is to combine measurements of input variables with relevant fuzzy rules in order to make inferences regarding the output variables. The knowledge is usually represented by a set of fuzzy rules, which connect antecedents with consequents, premises with conclusions, or conditions with actions [33]. As presented by [24], knowledge base will be represented as a set of rules in form (1):

$$\text{If (this is true) then (do that).} \qquad\qquad (1)$$

Then the problem of inference regarding the output variable becomes the problem of approximate reasoning with multiple conditional fuzzy propositions as discussed in [33].

There are in principle two ways to define the fuzzy inference rules [33]. One is to elicit them from experienced human operators, which the matter of experience, knowledge or previous measurement(s). The other way is to obtain them from empirical data by suitable learning methods, usually with the help of neural networks [38].

After the empirical scale definition, every following user evaluates only by word expressions. In this moment, the rule base is empty. Without any rules in the rule base, inference system cannot work. The evaluator may decide to either add rules according to the expert knowledge or use the evaluations that were already obtained from testing users.

As previously defined, each rule has its antecedent and consequent. The elements of the antecedent are connected with some logic connection (AND, OR, etc.). Number of elements is equal to number of criteria. Since each evaluation is a relation in form (2):

$$(evaluation\_1, evaluation\_2, evaluation\_3, …, evaluation\_n), \quad (2)$$

n… number of criteria

It might be therefore used as a rule antecedent. The evaluator (or another human expert) only needs to determine appropriate consequent of the rule. Each new evaluation can be used to define new fuzzy rule. However, the number of rules based on testing users' evaluations would not be probably enough to create sufficient number of rules. Note that the number of rules depends on number of linguistic states of each variable and number of criteria. In case of 3 linguistic states for each criterion (for instance low, medium and high) and 10 criteria, $3^{10} = 59,049$ rules should be defined. However, for accurate results is this number significantly lower [33], [39].

It is possible that dividing the universe of discourse only to the 3 linguistic states would be too rough to express the nature of uncertainty for some problems, and therefore not that accurate. On the other hand, in case of five linguistic states for each of the 10 input variables, the number of rules is 9,765,625. Although the granularity of five linguistic states would be better, the author suggests using three linguistic states, since the number of rules is not too excessive.

2.4 Evaluation phase

In the second phase of the fuzzy usability evaluation process, the evaluation itself is performed. As a result of evaluating desired amount of users, a set of evaluations expressed in users' natural language is obtained. Each criterion that affects the usability is evaluated by one word expression that is then converted to the form of the fuzzy number as described above and depicted in Figure 3.
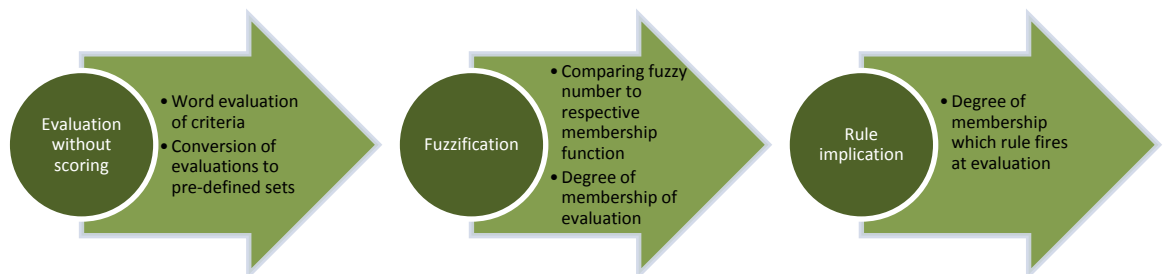
Figure 3: Steps of regular usability evaluation, source: own

It must be noted that the nature of evaluating is purely subjective. There are no criteria requiring the user to qualify an objective measure. That is however impossible, since

the human brain does not operate as a measuring device or computer. The users are unable to state any of the measures by single real numbers. They are able to qualify these measures just about certain variables like age, height, telephone number or any other measure where a single crisp value is obtained. The nature of the problem defined in this work is uncertain itself and cannot be therefore expressed or evaluated by certain measures.

2.4.1 Usability evaluation based on fuzzy approach

The evaluations of criteria express users' feelings about the tested WPPA. They are not qualifying facts that require expert knowledge. Users are not pushed to answer as needed (in some prescribed way). They can use their own expressions to state the evaluation. This way of evaluating allows them to be accurate and honest, since they do not need to adopt any special terminology, only their natural language.

As previously stated, the evaluations are converted to one of the 24 evaluation classes. Then the particular fuzzy number from empirical scale is then compared to the appropriate membership function of particular criterion. Basically, this is comparing of two fuzzy numbers as defined in [24]. Process can be treated as a fuzzy controller [33].

Generally, fuzzy controllers are special expert systems [24] that are in contrary to classical controllers capable of utilizing knowledge elicited from human operators [33]. While this knowledge is also very difficult to express in precise terms, an imprecise linguistic description of the control problem might be used instead. This linguistic description consists of a set of control rules that inheres in the knowledge base.

A general structure of fuzzy controller as defined by [33] is depicted in Figure 4 and consists of the following elements:
- fuzzy rule base (knowledge base),
- fuzzy inference engine,
- fuzzification module,
- defuzzification module.
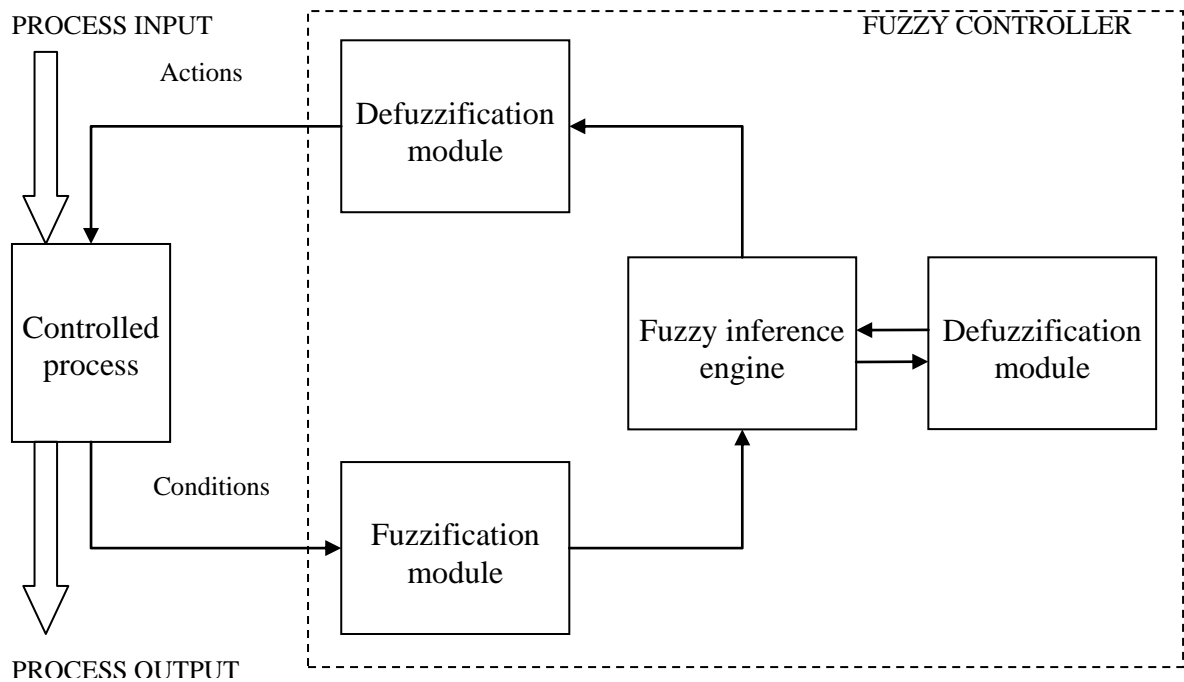
Figure 4: A general scheme of a fuzzy controller, source: [33]

A fuzzy controller operates by repeating a cycle of the actions and [33] define the process of inference as follows (Table 8):

Table 8: Fuzzy controller cycle, source: [33]

Step	Action	Description
1	Obtaining measures	Measurements are taken (e.g., the facts are evaluated, the simulation is executed, etc.) of all variables that represent the process.
2	Fuzzification	Measurements are converted into appropriate fuzzy sets to express measurement uncertainties. This step is called a fuzzification.
3, 4	Inference	Fuzzified measurements are then used by the inference engine to evaluate the control rules stored in the fuzzy rule base. The inference engine of a fuzzy system operates on a series of production rules and makes fuzzy inferences or it may also use knowledge regarding the fuzzy production rules in the knowledge base. The result of this evaluation is a fuzzy set (or several fuzzy sets) defined on the universe of possible actions.
5	Defuzzification	Resulting fuzzy set(s) is then converted, into a single (crisp) value (or a vector of values) that, in some sense is the best representative (approximation) of the fuzzy set (or fuzzy sets). This conversion is called a defuzzification.

Figure 5 depicts the steps of fuzzy controller with fuzzified input measures.
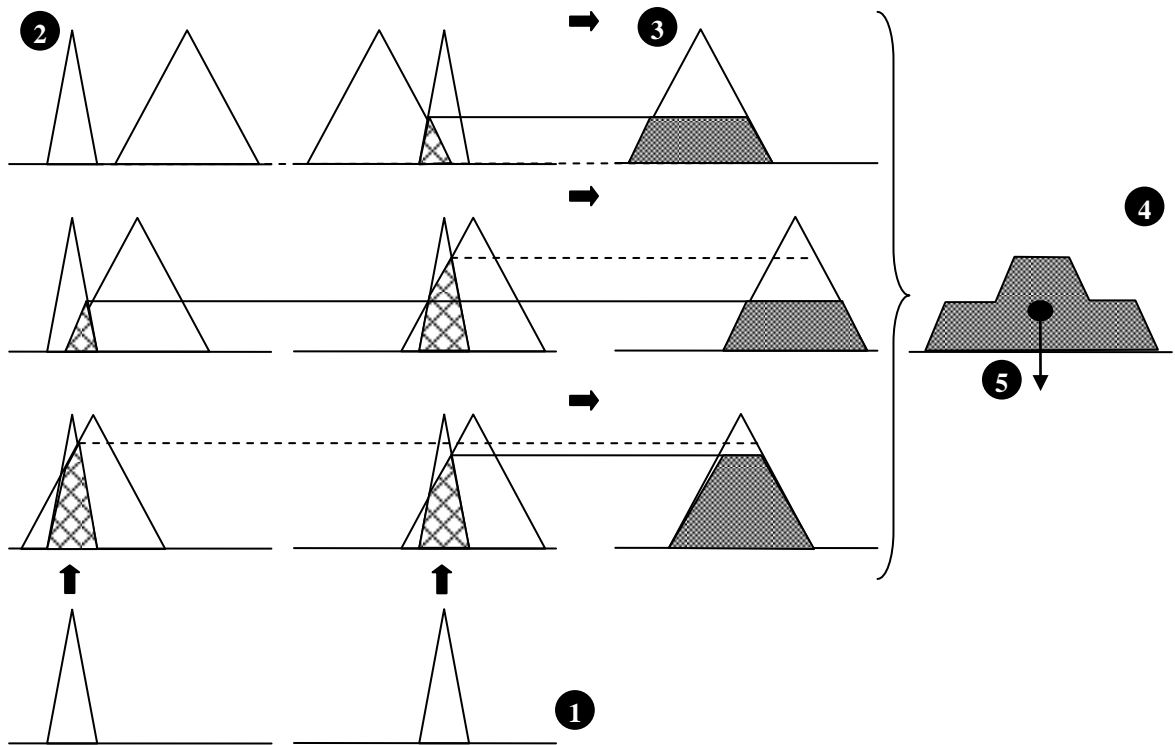
Figure 5: Process of fuzzy inference with fuzzified input measures, source: [33]

There are several fuzzy models based on fuzzy rules. Among the most known belong following methods [40]:

- Mamdani method,
- Takagi and Sugeno method (TS).

While the Takagi-Sugeno method uses only a weighted average in fuzzy inference, the Mamdani method combines the fuzzy rule outputs [40]. Author suggests using Mamdani type of fuzzy inference system because of the reasons presented in the Table 9.

Table 9: Overview of fuzzy inference types, source: own

Mamdani inference system		Takagi-Sugeno inference system	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Easier to understand the logic since the rule consequent is expressed by linguistic variable (fuzzy set). Model retains the linguistic manner of evaluation.	Process of getting output is relatively complicated. Consequent of rules is not expressed by single value.	Easy to obtain the overall output since no defuzzification methods are necessary. Output is obtained as a combination of input parameters by weighted average.	Human expert cannot determine the numeric consequent, unless this is obtained by machine or from the results of previous research.

2.4.2 Score of usability evaluation

The process of computing a scalar from fuzzy conclusion is called defuzzification [24]. A suitable defuzzification method(s) must be selected in order to convert the conclusions obtained by the inference engine, which is in this phase expressed in terms of a fuzzy set, to a single number. The resulting number, which defines the action taken by the fuzzy controller, in some sense summarizes the constraint imposed on possible values of the output variable by the fuzzy set. Defuzzification is a more complex process than fuzzification.

Many different methods have been proposed in the literature [24], [33], [41], [42]. The results of various researches show that different defuzzification methods provide different defuzzified values. After analyzing the results of various defuzzification methods, author selected two methods and derived a new one combing advantages of both previous:

- method based on the computation of center of area,
- method computing weighted average of singletons [24],
- method computing weighted center of area.

Table 10 summarizes used defuzzification methods:

Table 10: Overview of the defuzzification methods, source: own

Defuzzification method	Description	Advantages	Disadvantages
Center of gravity (COG)	The usability score is computed as a center of gravity of the area below the accumulated line (see step 5 depicted in Figure 5).	Considers every active rule with membership degree higher than 0, therefore representative and accurate.	The calculation of the output is relatively demanding. Method is not useful in case of one firing fuzzy rule.
Height method (HM)	The usability score is computed as a weighted average of singletons of clipped membership functions of the output variable.	The output of the method is calculated very easily.	The method sometimes produces inaccurate outputs because it does not take in mind all values. Method is not useful in case of one firing rule.
Weighted center of area (WCA)	The usability score is computed as a center of weighted average of particular areas below the clipped membership functions.	Method combines advantages of both previous methods.	Method is not useful in case of one firing rule.

The common disadvantage of COG method is its behavior in cases of very low and very high input values [42]. In such cases, the output variable Usability never reaches the left or right utmost boundary of its universe of discourse (0 to 100). In order to overcome this problem, [42] suggests formal extension of the boundary as shown in Figure 6. This change allows the method to achieve minimal or maximal values of Usability.
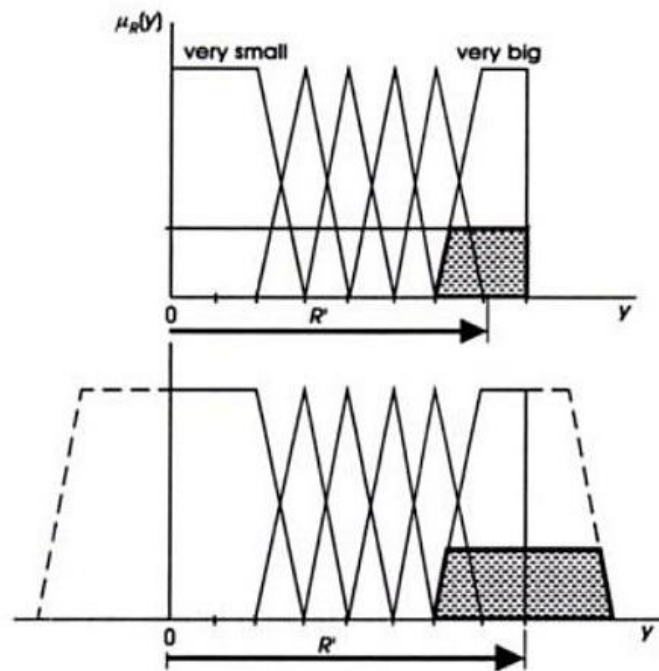
Figure 6: Formal extension of boundaries in case of extreme values, source: [42]

There is however another situation that might happen. In case there is only one fuzzy rule firing at the output membership functions, the presented defuzzification methods are unable to compute the overall output [42]. The defuzzified value is in such case always equal to the base of the membership function not taking in mind the degree of membership (see Figure 7). Thus, in case of "low usability" the defuzzified value is equal to 0, in case of "medium usability" 50 and in case of "high usability" 100.
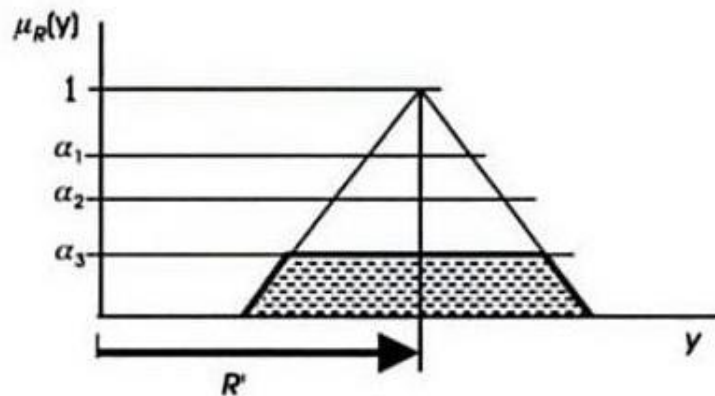
Figure 7: Defuzzification for one-rule fuzzy inference, source: [42]

Despite the relative difficulty of the center of area method, this method provides the most accurate results, since retains the most of the resulting fuzzy set [33].

Hence, the overall usability score for particular system is obtained as the best possible approximation of multiple rules that interpret the evaluation. Defuzzified output represents

the score of the particular evaluation. Such score is a number that lies between 0 and 100 representing overall usability of the tested system and meets all requirements defined above.

2.5 Conclusions, objectives and practical research

The results of research helped to get the idea of how to solve the initial problem. The decomposition helped to understand particular fields from which the problem consists of. Author considers that the most complicated part is the coherence between usability evaluation and fuzzy theory, since there is no scientific background or research studies regarding this approach for measuring the usability.

The methodology of usability evaluation of Web Portals as an example of Information Systems in Public administration based on fuzzy approach was presented in this chapter. The procedures necessary to conclude methodology of the fuzzy usability evaluation were systematically discussed providing a theoretical framework. In order to evaluate functioning of the methodology, a practical demonstration should be realized.

Although the implementation of methodology does not rely on any platform or software product, it might be quite difficult to realize the fuzzy usability evaluation without having any suitable environment.

For the purposes of this work, a commonly known working environment should be used. Such environment must offer simple and advanced feedback to its users as well as a user-friendly graphical user interface (GUI), graphical outputs or simple databases. Microsoft Excel has been chosen as a fully convenient environment, since the results can be easily interpreted in graphical form and all calculations are transparent.

3. Development of the Fuzzy Usability Evaluator

There is a need to develop an interactive application specific for the proposed methodology of fuzzy usability evaluation. Fuzzy theory is a powerful apparatus helping to manage the uncertainties, but very truly, its advanced techniques are very difficult to understand, especially for those who are only interested in getting the usability score of some system. The entire fuzzy inference engine should therefore stand in the background, not visible for those who does not need or want to deal with it.

From presented reasons, the author developed a multipurpose interactive application – Fuzzy Usability Evaluator that significantly eases entire process and minimizes its complexity only to the understanding the theoretical framework. The application is designed to evaluate usability of ISPAs, might be however used for evaluation of any UI if the criteria and parameters of evaluation were appropriately changed. This chapter is dedicated to the description of the Fuzzy Usability Evaluator and conducting fuzzy usability evaluation in its environment.

3.1 Purpose of the Fuzzy Usability Evaluator

The Fuzzy Usability Evaluator (FUE) is an analytical application developed in Microsoft Excel consisting of multiple collaborating modules. It is a lightweight application that does not require a high educated and experienced operator trained for particular application environment. FUE can be considered as an expert system, since besides the powerful computation engine it consists of several databases including expert knowledge and fuzzy inference system, giving the FUE new possibilities how to deal with uncertainty and vagueness.

The reasons of developing FUE were the lack of transparency, ease of use and low usability of powerful multipurpose tools. It is possible to perform entire process of usability evaluation in single application, without losing following possibilities:
- transparency of computations,
- customization,
- re-use,
- modification,
- graphical feedback,
- generalization.

With FUE, one can:

- evaluate the usability,
- collect the results of usability evaluation,
- use the results to get the score for evaluated Web portal,
- extend the fuzzy rule base manually or automatically,
- obtain new knowledge by testing,
- use own set of characteristics (input variables) for use in different environment,
- display the entire process of usability evaluation in graphical way,
- fully customize the parameters of usability evaluation,
- make experiments for research purposes.

3.2 Description of modules

The FUE consists of several modules. Each of them has specific function. There are nine modules (divided into separated sheets) in current version of FUE. The overview and short description of particular modules is listed in Table 11.

Table 11: Overview of FUE's modules, source: own

Module	Description
Overview	List and characteristics of the criteria
Questionnaire	Simple questionnaire suitable for inquiries
Detailed questionnaire	Questionnaire containing detailed information about particular usability evaluation

Evaluation	Graphical overview of evaluated criteria including:
	- basic information,
	    o membership functions,
	    o degrees of membership,
	    o parameters of fuzzy numbers, etc.,
	- advanced information,
	    o parameters of evaluation,
	    o spread of fuzzy numbers,
	    o intersection coordinates, etc.

Inference	Includes all necessary information about fuzzy usability evaluation process: - output membership functions, - implication, - aggregation and accumulation, - usability score, - defuzzification methods, - fuzzy rule base and rule management, - advanced feedback, etc.
Scales	Parameters of theoretical and empirical scales
Linguistic convertor	Set of databases that convert users' evaluations to the suitable expressions treatable by FUE
Score collector	Database containing values obtained during the testing phase that help to define parameters of the empirical scale
Evaluation base	Stores particular evaluations together with the usability score

In order to explain how FUE utilizes the proposed methodology of the fuzzy usability evaluation, each module will be briefly described. For more details, consult the user manual in the appendix.

3.2.1 Module Overview

Module Overview offers a structured list of criteria affecting the usability of WPPAs. They are divided into the criteria regarding the quality of the content and the criteria expressing the quality of design. These are as follows:

- Accessibility and Content,
- Structure and navigation, Visual design and Functionality.

The lowest level of overview consists of the list of criteria. Some of the criteria are shared by two subcategories, since a complex criterion may affect more than one characteristic. Each criterion is defined by a question, the same question that will be used in the questionnaire.

Table 12: Structure of the module Overview, source: own

CONTENT QUALITY		DESIGN QUALITY		
ACCESSIBILITY	CONTENT	STRUCTURE AND NAVIGATION	VISUAL DESIGN	FUNCTIONALITY
Specify how easily is the Web site's content legible (readable) and viewable for you.		Evaluate simplicity and level of comprehension to the Web site's navigation.	How much does the graphic design of the Web site fulfill your expectations or meet your preferences?	
How much do you consider the information instantly comprehensible?		How good is the knowledge of your current location through the Web site at any moment during the browsing?	Qualify your level of satisfaction with the amount of graphics appearing on the Web site.	Evaluate the speed by which the Web site's elements are loaded.
	How simply (and fast) is to find some kind of information on Web site?			
	How much do you consider the information found on the Web site actual?			

As defined earlier, each criterion is described by the list of related Web usability guidelines that have been used for its establishment (see Table 6 in previous chapter). Since the WPPAs are not very different to other types of Web sites, there was no need to create a set of specific characteristics. Instead, a general set of characteristics was chosen, though fully respecting the characteristics of the WPPA environment as described previously.

3.2.2 Module Questionnaire

The questionnaire lists the criteria where each of them is represented by one question. The questionnaire preserves a simple structure suitable for personal inquiries or remote testing.

Depending on the phase of the usability evaluation process, evaluator may choose whether the users evaluate the criteria by only word expressions or they also state the numeric score to define the empirical scale. Hence, there are following two types of questionnaire:

- usability evaluation questionnaire,
- usability evaluation questionnaire with scoring.

After inputting the evaluations to the questionnaire, these are simultaneously converted to one of the 24 pre-defined classes of evaluations. To maintain the maximal simplicity of the questionnaire, the results of these conversions are not displayed on this place.

3.2.3 Module Detailed questionnaire

In order to describe the process of evaluation and conversion of the evaluation words, detailed questionnaire was developed. It provides the evaluator with additional information, details of the linguistic conversion process and other suitable indicators of the evaluation.

It lists the criteria denoted by their names, abbreviations and evaluation question. The values in the questionnaire may be inputted either manually or copied from the simple questionnaire. The rest of the questionnaire displays the decomposition process of the evaluations into the core of the evaluation, which is usually an adjective or adverb, and the linguistic hedge. Both core and hedge might be converted. This conversion is performed by versatile database stored in module Linguistic convertor. The result of the conversion is normalized evaluation, one of the 24 pre-defined classes of evaluations, i.e. fuzzy number. The parameters of these numbers are also displayed.

3.2.4 Module Evaluation

Module Evaluation continues to explain the evaluated criteria in both graphical and mathematical way. It allows determining the following attributes of evaluation:

- type of scale,
    - o empirical scale,

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- o theoretical scale,
- the spread of fuzzy numbers around their center values,
  - o value of one sigma (σ),
  - o value of two sigma (2σ),
  - o value of three sigma (3σ).

Although FUE allows choosing both kinds of scale, it is recommended to use empirical scale, since it respects the user language. The value of spread around the mean (i.e., left/right border of the fuzzy numbers representing the classes of evaluations) determines the accuracy of the sample to represent entire population of users and it is interpreted by multiple of standard deviation.

The module is structured to several segments. In vertical line are displayed the particular evaluations of the criteria, in horizontal line are listed various kind of attributes.

Beginning from the left, an overview of the evaluated criterion is first displayed. Below this overview is displayed a graphical form of the evaluation. The graph includes the membership functions of particular linguistic states of the criterion, the evaluation in form of fuzzy number, the intersections with membership functions and their coordinates (i.e., the grades of membership).
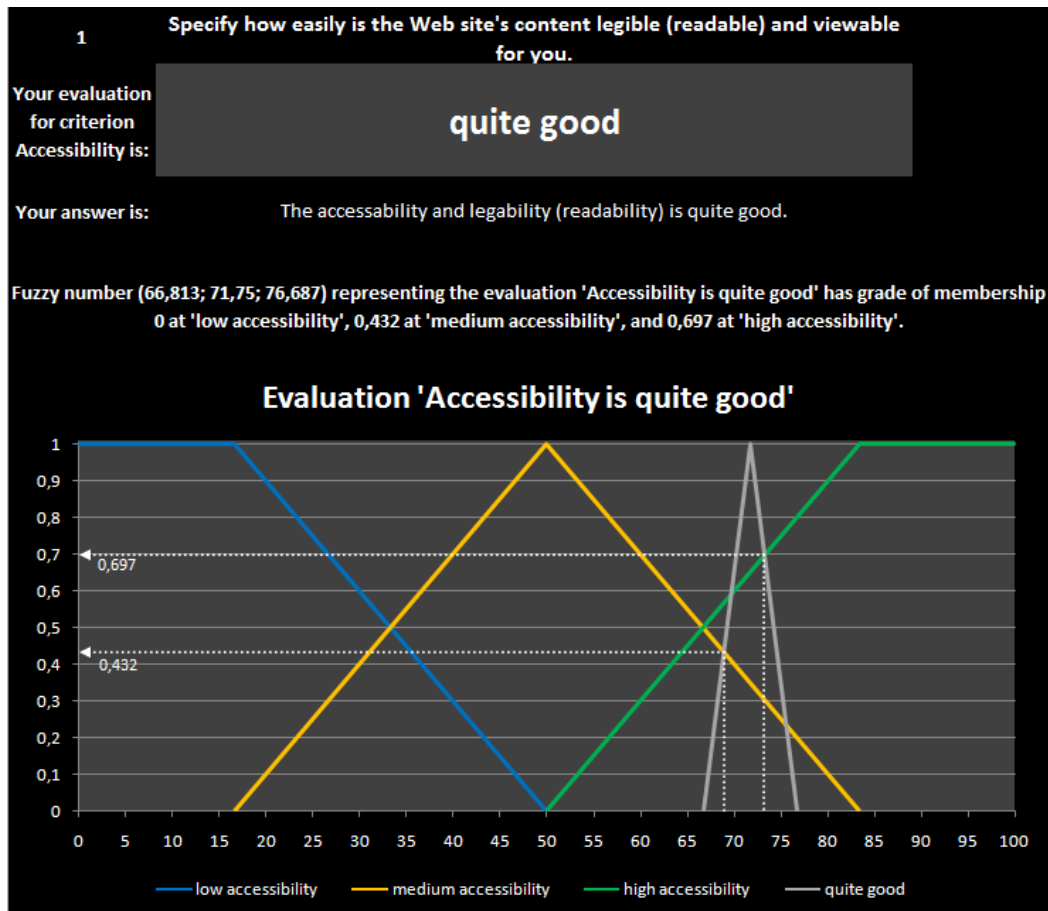
Figure 8: Evaluated criterion in module Evaluation, source: own

Next to this panel is located a table that contains results of comparing the evaluation with the membership functions of the evaluated linguistic variable (i.e., their intersections coordinates). Right next to this table, there is another that allows the evaluator to change the parameters of particular membership functions. FUE has three linguistic states for each input variable as well as for the output variable Usability. Dividing the universe of discourse of the linguistic variable to more linguistic states, would increase the output's accuracy. On the other hand, the number of rules that should be defined for such model would be in case of nine input variables excessive.

The possibility of customization the parameters of membership functions gives large freedom to the evaluators. They can change both parameters of the membership functions, which are the slope (usually denoted as k) and shift (usually denoted as q). The former defines an angle, which the line forms with the horizontal axis, while the latter expresses the shift (movement) of the initial point of line to the right or to the left from the zero

on horizontal axis. The default parameters of the membership functions of all variables are predefined as follows:

- The membership function expressing the "low" state of each input variable has k equal to 1.5 and q equal to 16.667.
- The membership function expressing the "medium" state of each input variable has k equal to 1.5 and q equal to 0.
- The membership function expressing the "high" state of each input variable has k equal to 1.5 and q equal to -16.667.

The universe of discourse for each variable is therefore divided into three equal segments.

The presented version of FUE can only represent the triangular shape of the membership functions. It would bring many implementation difficulties and for the purposes of this work, triangular membership functions would do the same job.

The most valuable information gained from this module is the grades of membership of particular criterion evaluations that will be used in the most important module of FUE, which is without question the Inference.

3.2.5 Module Inference

Module Inference is the most important part of FUE. It consists of various kinds of graphical output, fuzzy rule base and other important information regarding the process of fuzzy inference. It provides sufficient mathematical and visual feedback for evaluator. Inference module works not only with the current evaluation data obtained from the Detailed questionnaire, it can also process data that were previously stored in the Evaluation base.

As well as the other modules, also Inference consists of several elements that should be described. At the top of the module, there is a current evaluation, which is either loaded from questionnaire or from Evaluation base, and its score of usability evaluation.

The evaluator may choose from following defuzzification methods:

- Center of gravity (COG),
- Height method (HM),
- Weighted center of area (WCA).

Since these defuzzification methods are not computing the output properly in cases of very high and very low fuzzy input measures and in cases when only one fuzzy rule fires at the evaluation, these issues are resolved in FUE by:

- formal extension of the borders of "low" and "high" output membership functions to -50 or 150 respectively,
- modification of rule implication, while the degree(s) of membership of the other membership functions are calculated as a weighted average of its values.

Although all three methods provide similar results, it is recommended to use the first method since it is considered as the one providing most accurate results [33].

There are three very important graphs right below the top part. The first of them shows the shape of the membership functions and linguistic states of the output linguistic variable Usability. The membership functions are represented by triangular fuzzy sets, dividing the universe of discourse to three equal parts depicted in Figure 9.
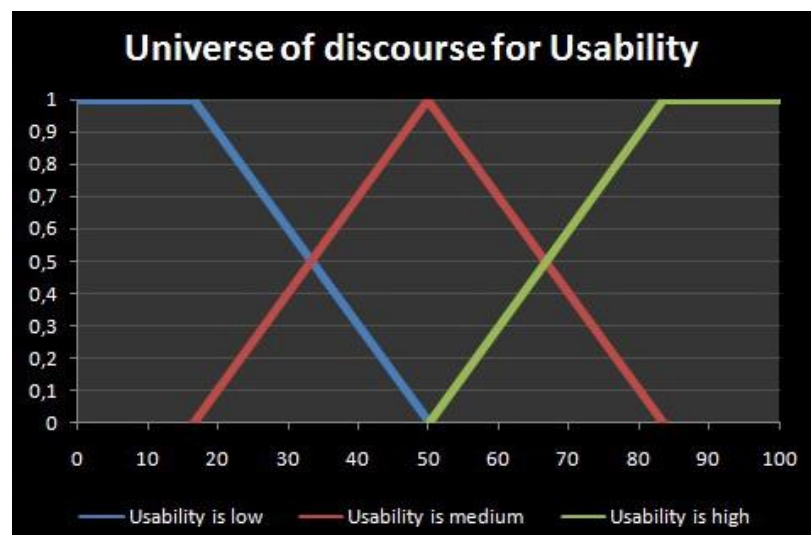
Figure 9: Output variable Usability, source: own

Second graph depicts the situation after comparing the evaluation to the knowledge in the rule base. It shows maximal degree of membership with which rules in the rule base fire at each membership function of Usability (see Figure 10). These membership functions are:

- low usability (defined on range from 0 to 50),
- medium usability (defined on range from 16.667 to 83.333),
- high usability (defined on range from 50 to 100).
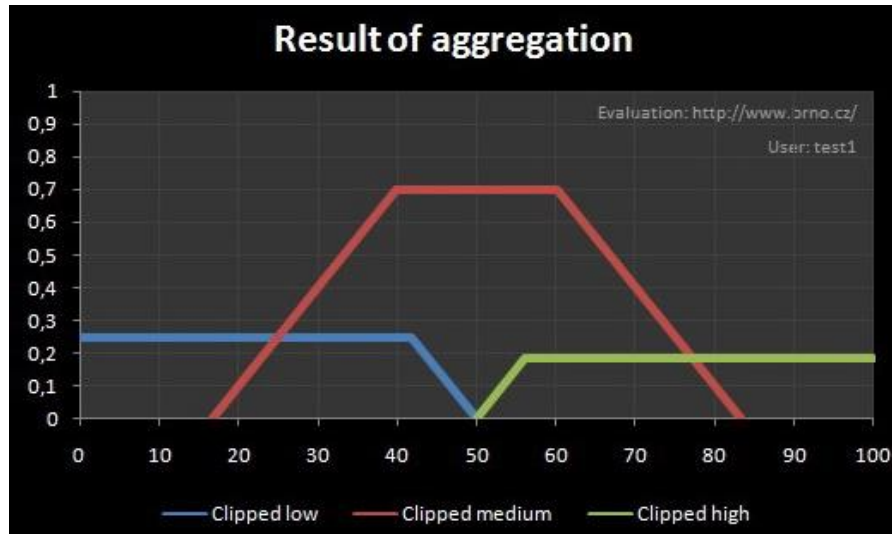
Figure 10: Clipped membership functions of output variable Usability, source: own

The third graph shows the result of the accumulation after inferring the knowledge from fuzzy rule base and defuzzification. Due to problem described above, the shape of the membership functions needs to be extended so that fuzzy inference system can produce correct result also in very low or very high values of input. Therefore, the area of "low" and "high" usability is twice larger and membership functions are extended to the -50 and 150 respectively. Nonetheless, the defuzzified value will be always a number between 0 and 100.
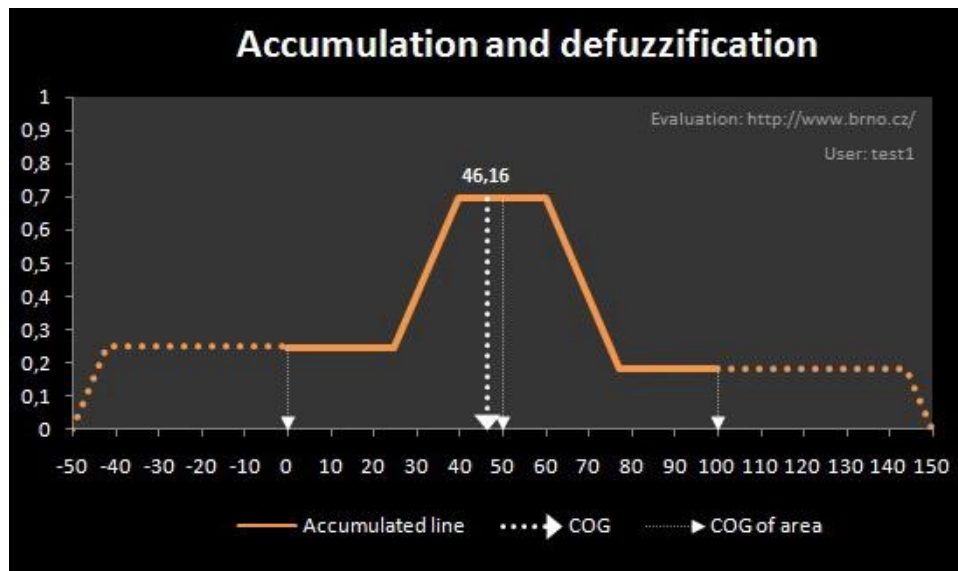
Figure 11: Accumulation and defuzzification, source: own

The rules are stored in the lower part of the module. The knowledge stored in the base might be extracted from results of evaluation of the testing group of users or manually

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by defining both the antecedent and consequent of the rule. Rules are displayed in its typical form that has been discussed earlier.

It is important to denote, that rules have Mamdani type of consequent expressed by a linguistic state of the output variable (low usability, medium usability or high usability). The consequent is obtained from an expert who evaluates particular fuzzy rule and make a conclusion about it. FUE however eases the process of assigning a proper linguistic state to the consequent and allows even to generate the rules automatically.

The former is done by the help of WA method that is used to compute numeric value, an equivalent of Takagi-Sugeno consequent, from the rule antecedents and current evaluation. Such values indicate where approximately lies the output variable and helps to decide about the rule consequent.

The latter is an automatic rule generating method that has been developed to create new rules from existing evaluations stored in the database. There are three automatic rule generation techniques in FUE (see Table 13).

Table 13: Automatic rule generation techniques, source: own

Technique	Description
Truth-match	This technique extracts the core of each criterion of the current evaluation and creates the rule antecedent by assigning the same linguistic states as the criteria of the evaluation according to the meaning of the core (negative, neutral, positive). Resulting rule matches with the current evaluation assigning each criterion maximal degree of membership. For such rule, the consequent needs to be determined.
Max-match	Max-match technique also extracts the cores of particular evaluated criteria of current evaluation. However, the rule antecedent consists of the highest linguistic states for each evaluated criterion where degree of membership is higher than 0. This is possible since an evaluation may have some degree of membership of "medium" as well as of "high" membership function.
Min-match	Min-match use the opposite way of generating the rule antecedents than the previous technique. It assigns the lowest possible linguistic state of each linguistic variable in rule antecedent that has degree of membership higher than 0 with the selected evaluation.

By treating the process as a fuzzy controller, the fuzzy inference continues by implicating each rule in knowledge base. The resulting degree of membership of each rule serves as an input for inferencing. The way of getting the output is more complex. First, the maximal resulting degree of memberships of each linguistic state of output

variable is selected from the set of all rules. The resulting degrees of memberships are then used to clip the output membership functions. This is displayed by the second graph, where the clipped membership functions are showed. These are then aggregated together, resulting in a multiple-segmented line, which is depicted in the third graph. The line represents the fuzzy inference of the evaluation on the set of fuzzy rules, and it is realized as the best possible approximation of the stated truths inferred from the knowledge stored in the fuzzy rule base.

At the end, the overall output is defuzzified according to the selected method. In case of COG method, the entire multiple-segmented line is divided to a number of triangles and rectangles whose area can be easily determined. The overall output is computed using the weighted average of particular areas and their COGs.

The rest of the module contains various auxiliary tables describing the entire process of inference and defuzzification. The evaluator might observe this information for better understanding the whole process.

3.2.6 Module Scales

This module stores parameters of both scales that may be used in FUE - theoretical and empirical. The structure of the theoretical scale is illustrated in the upper part of the module. It is also possible to select an evaluation to see its position on the theoretical scale.

Theoretical scale is a result of assigning linguistic evaluations to a 100-point line and dividing them to a set of equivalent intervals where each one of them expresses some range of scores denoted by a label of such class. As presented previously, the empirical scale is based on experience and observations, therefore is more suitable, since respects the user language.

3.2.7 Module Linguistic convertor

Since users are free to use any expressions to qualify the evaluation, there is a need to have reliable mechanism converting these expressions to a set of normalized evaluations easing the work both the FUE engine and the evaluator. Such database might be for instance defined when gathering the data for empirical scale definition.

Linguistic convertor is a powerful database that contains expert knowledge of semantics, meaning of various types of synonyms and linguistic hedges.

This module simultaneously converts the expressions obtained by users to one of the 24 pre-defined labeled classes of evaluations. However, the database of commonly used evaluation expressions is already implemented in the database. New knowledge can be easily added or modified. Several situations may happen when defining a new evaluation and its appropriate counterpart:

- Core of the evaluation is added to the table of new evaluation words, direction (meaning) and corresponding class of evaluation words are chosen.

- Hedge of the evaluation is added to the table of new hedges and corresponding hedge is assigned to the new one.

- Combination of previous two situations, both hedge and core is added to the appropriate tables.

- In case new evaluation is not decomposable into hedge and core, the evaluation is added to the table of special words, corresponding hedge and core needs to be defined.

The evaluator has to be very careful when adding or modifying records in the Linguistic convertor. These changes may significantly influence the output. The database consists of three tables.

The first defines the group of adjectives (or adverbs), assigning them a meaning type: (-), (0) or (+), where first represents some adjective with negative meaning (e.g., bad, faulty, slow, etc.), (0) the adjective with a neutral or discrete evaluation adjective (e.g., average, normal, approximate, etc.) while (+) states some positive meaning (e.g., nice, large, well). It is very important to distinguish among the evaluation expressions, since some of them might be confusing and lead to ambiguities.

Second table converts unknown hedges decomposed from the evaluations to the well-known hedges. When evaluating something, people got use to combine multiple words to qualify the proposition. Such combination might confuse both FUE and the evaluator. Hedges should be converted correctly since they can significantly increase or decrease level of importance of the evaluation [33].

The third table contains the list of the special words that cannot be converted using the hedge-core decomposition. It is very typical for users to use these words instead of using regular expressions. The evaluator must be therefore ready to face the vagueness surrounding the qualitative evaluation and recognize the true meaning of evaluation.

3.2.8 Module Score collector

The results of testing phase are stored in this module. After every evaluation with scoring, evaluator needs to add the values to the database. The evaluations from the simple questionnaire are already converted by Linguistic convertor and automatically assigned to the proper class of evaluations.

The optimal number of scores to create a representative evaluation is assumed to be at least five, however not all classes of evaluations are well defined. While some of them may indicate high level of agreement among the tested users, there are of course evaluations that show many abnormalities. Standard deviation is therefore used to define the spread of the sample. The higher is the standard deviation, the higher is the spread of the values around the mean. As described previously, the mean value of each class of evaluations defines the base of its fuzzy number and standard deviation left and right edge.

3.2.9 Module Evaluation base

The last module implemented in FUE collects the results of evaluations. Together with the evaluation, which is stored as a set of normalized evaluations, (i.e., hedge and meaning of the core), FUE stores also the score of usability evaluation for each defuzzification method. Usability score can be updated at any moment during the entire usability evaluation process.

As stated above, the evaluations are stored only in the normalized form. It is not possible to obtain the original hedge or adjective. This eases the orientation and analysis of the results in the evaluation base.

4. Usability evaluation of selected WPPAs

Since the initial problem has been solved by establishing the methodology of usability evaluation based on fuzzy approach and developing the Fuzzy Usability Evaluator, there is a need to to validate its functionality and to verify the accuracy and efficiency of the model. From these reasons, a study of usability evaluation based on proposed methodology will be performed. The study has following goals:

- perform usability evaluation of selected WPPAs,
- obtain a usability score of each evaluated WPPA,
- analyze results and make appropriate conclusions.

The study will respect the methodology of the fuzzy evaluation process presented in Chapter 2. The establishment phase and methodic guidelines of the testing phase will be described in this chapter. Next chapter will focus on analysis of results obtained during the study.

4.1 Utility of the study

The purpose of the study is to establish an objective measure of quality of use of selected WPPAs to arise the interest and competiveness on the field of Public administration. Although one may argue that evaluating usability of a WPPA has practically no utility, since there is usually one Web portal of each municipality and the users either use it or they do not, there are several arguments that prove its significant utility:

- According to the detected problems, proper person can make a decision that will improve the usability of the WPPA.
- The results of usability evaluation might initiate performing of additional tests that will detect severe lack of usability.
- Although the Public administration is not a private sector, the knowledge of score may increase the interest in further development, amount of available resources (human, capital, etc.) and competiveness among the participants. All for the welfare of its users.
- Good presentation not only satisfies the public but may also attract investors or private subjects to carry business in the particular area.

- Information services provided by the WPPA save additional time and costs (telephone, electricity, etc.) that might be used somewhere else.
- Results might be broadly analyzed, described and segmented according various kinds of users (families, tourists, students, retired).

The utility of this study can be therefore generally qualified as:
- improvement of provided information services,
- costs minimization,
- new opportunities by attracting private sector.

4.2 Object of evaluation

The set of selected Information Systems is defined in terms of Public administration of the Czech Republic, since there are constraints like knowledge of foreign language, knowledge of local habits and characteristics of environment, difficulties with establishing a group of users.

In order to evaluate the usability, a set of ten various WPPAs has been selected. The selection was made partially by choosing WPPAs of largest cities of the Czech Republic and partially by selecting WPPAs according to the previous results of the Zlaty Erb[2]. Not only good WPPAs were chosen, there are also those that do not conform to usability guidelines. In these cases, users' opinions are very important since they might reveal the lack of usability. Following table contains list of evaluated WPPAs.

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[2] Zlaty erb is a challenge that annually selects the best WPPAs in the Czech Republic.

Table 14: List of tested WPPAs, source: own

Name of the municipality	URL of the WPPA
Brno	http://www.brno.cz/
Chrudim	http://www.chrudim-city.cz/
Hradec Králové	http://www.hradeckralove.org/
Jihlava	http://www.jihlava.cz/
Opatovice nad Labem	http://www.opatovice-nad-labem.cz/
Ostrava	http://www.ostrava.cz/
Pardubice	http://www.mesto-pardubice.cz/
Praha	http://www.praha.eu/
Přelouč	http://www.mestoprelouc.cz/
Svitavy	http://www.svitavy.cz/

4.3 Target group of users

General profile of a typical user of the WPPA was described previously. From such universe were chosen 20 users and divided into two following groups:

- 10 testing users,
- 10 users to evaluate usability of selected WPPAs.

Second group was selected to meet the following criteria:

- Sex,
   - o 5 men,
   - o 5 women,
- Age,
   - o 3 users of age between 15 and 25 years,
   - o 5 users of age between 26 and 55 years,
   - o 2 users older than 55 years,
- Skills and experience,
   - o 2 users with no or low level of computer skills and experience with Web browsing,
   - o 6 users with average computer skills and experience of Web browsing,
   - o 2 users with high or expert computer skills and experience of Web browsing.

Table 15 summarizes the distributions of users to particular classes.

Criterion	Sex		Age			Skills and experience		
Condition (quantity)	Male (5)	Female (5)	15 – 25 (3)	26 – 55 (5)	56 and more (2)	Low or none (2)	Average (6)	High or expert (2)
Testing users	User 1 - User 5	User 6 - User 10	-	User 1 - User 10	-	-	User 1 - User 10	-
Users to evaluate the usability	User 1 User 6 User 7 User 8 User 10	User 2 User 3 User 4 User 5 User 9	User 3 User 6 User 10	User 1 User 2 User 5 User 7 User 8	User 4 User 9	User 5 User 9	User 3 User 4 User 6 User 7 User 8 User 10	User 1 User 2

Due to time and budget limitations of the study, the sample of users attending in the study is relatively small. Thus, the level of significance of the conclusions made according to the results of the particular classes is not high. With larger budget, the size of the sample would be appropriately bigger.

4.4 Criteria of evaluation

The set of criteria defined in Chapter 2.2.4 lists the most important characteristics of the WPPAs and is therefore suitable for usability evaluation. Each of the criteria were previously defined and described. The same set of criteria is implemented in the FUE, the tool that will be used to conduct the usability evaluation.

4.5 Parameters of evaluation

Table 16 lists all parameters necessary to conduct the usability evaluation process of the 10 selected WPPAs.

Table 16: Parameters of the fuzzy usability evaluation process, source: own

Parameter	Characteristics of the parameter	Value(s) of the parameter
Construction of fuzzy elements	Each criterion of evaluation is seen as an input variable, while usability is seen as an output variable	8 input and 1 output linguistic variables Input variables are denoted in the same way like the criteria Output variable is denoted as Usability
Parameters of variables	Definition of the membership functions, linguistic states, universe of discourse	Each linguistic variable has triangular membership functions, 3 linguistic states (low, medium, high) and universe of discourse in range from 0 to 100 Linguistic state "low" has degree of membership equal to 1 on (0; 16.667) and equal to 0 at 50 Linguistic state "medium" has degree of membership equal to 0 at 16.667 and 83.333 and 1 at 50 Linguistic state "high" has degree of membership equal to 0 at 50 and 1 on (83.333; 100)
Scale	Type of the scale used to establish the input fuzzified measures	Empirical scale based on the users' evaluations
Level of significance	Prediction level of the sample to respect the variance among the values of the base	Spread of two sigma around the mean value
Structure of the evaluation	The way of conducting the usability evaluation	Testing phase to define empirical scale and fuzzy rule base Usability testing: personally (80%), e-mail questionnaires (20%)

4.6 Definition of empirical scale

During the scale and rule definition phase, 10 testing users were inquired, while each of them evaluated five randomly chosen WPPAs from the list in Table 14 providing:

- 50 different sets of evaluations,
- 90 evaluations of criteria,
- 90 various scores per user,
- 450 relations in the form (linguistic_evaluation; numeric_evaluation).

Before the tests were initiated, five randomly selected WPPAs from the list of tested Web portals were assigned to each user. This is summarized in Table 17.

Table 17: Summary of selected WPPAs for testing users, source: own

Testing user	Testing evaluation				
	1st evaluation	2nd evaluation	3rd evaluation	4th evaluation	5th evaluation
Testing user 1	Brno	Chrudim	Jihlava	Opatovice nad Labem	Ostrava
Testing user 2	Chrudim	Opatovice nad Labem	Ostrava	Praha	Přelouč
Testing user 3	Hradec Králové	Opatovice nad Labem	Pardubice	Praha	Svitavy
Testing user 4	Jihlava	Opatovice nad Labem	Pardubice	Praha	Svitavy
Testing user 5	Chrudim	Hradec Králové	Praha	Přelouč	Svitavy
Testing user 6	Brno	Jihlava	Opatovice nad Labem	Ostrava	Svitavy
Testing user 7	Chrudim	Jihlava	Pardubice	Přelouč	Svitavy
Testing user 8	Hradec Králové	Jihlava	Opatovice nad Labem	Ostrava	Svitavy
Testing user 9	Chrudim	Opatovice nad Labem	Přelouč	Praha	Svitavy
Testing user 10	Chrudim	Přelouč	Praha	Pardubice	Svitavy

4.7 Process of rule base definition

Since it would be complicated to define all possible fuzzy rules ($3^9 = 19{,}683$), each of the 50 sets of evaluations obtained during the evaluation with scoring, helped to establish the fuzzy rule base. Rules were generated automatically using the techniques implemented in FUE as described previously.

The automatic rule generation is more efficient than definition of the entire fuzzy rule base by an expert. First, it would take a lot of time and effort to create enough rules and second the number of errors would be probably high. The proposed way is more convenient because the user itself defines the most frequent evaluations that might occur. Users are able to evaluate the criteria if they understand them. However, they are not able to evaluate some rule without expert knowledge. Human expert reviews the rules and according to own knowledge and experience, makes a conclusion. There should be

however manually generated some number of rules by thorough analysis of the current rule base.

4.8 Usability evaluation of selected WPPAs

After definition of all necessary parameters and terminating the testing phase, the regular usability testing may be initiated. The evaluation was performed by personal inquiries and by e-mail questionnaires.

Personal inquiries were performed on a personal computer equipped with Windows XP and fixed Internet connection (ADSL 4 Mbps/256 Kbps). Tested users were first introduced to the problematic and informed about the evaluated characteristics. It was explained that evaluation could be qualified by any expression stating some level of like or dislike. Each session took about 5 – 15 minutes according to the experience and skills of the user. Every user evaluated 10 Web portals from the list presented in Table 14. The author was in role of moderator, evaluator and human expert.

E-mail questionnaires used the same structure of questions. Users were instructed how to perform evaluation. Users sent filled questionnaires back to the evaluator and these were processed the same way like personal inquiries.

Finally, the usability score of the each evaluation based on the used defuzzification methods were stored in the Evaluation base. In case of some changes, score might be automatically recalculated. The results of the usability evaluation will be analyzed in the following chapter.

5. Results analysis

Although current version of FUE does not have module that analyzes and presents the results, the data might be easily processed. It is not difficult to export data to any other application. The analyzed data will be described by both graphical and verbal way.

5.1 Analyzing results of testing phase

The results of testing phase are identical to those obtained during the evaluation phase, yet they do not figure in the overall results. That is because of the following reasons:

- Testing users provided linguistic and numeric evaluations and there might be risk of targeting on a desired result.
- The fuzzy rule base was constructed generally from the results of testing. Thus, there are at least three defined rules (generated by truth-match, max-match and min-match techniques) for each testing evaluation. The results should be therefore very precise in terms of inferring the knowledge from the base, actually even more precise than the results of "regular" evaluation.
- Sample of testing was not selected according to any special criteria and thus it might not be representative.

From these reasons, the score of usability evaluation will not be analyzed from the results of testing phase. On the contrary, it is very useful to analyze the development of empirical scale and fuzzy rule base.

5.1.1 Analysis of defined scale

As described previously, each of the 10 testing users evaluated 5 randomly chosen WPPAs from a set of all tested portals. Theoretically, 10 users evaluated 5 WPPAs where each of them has 9 criteria, that are 450 various scores. The situation after performing testing phase is summarized in Table 18 and depicted in Figure 12 and Figure 13.

Table 18: Situation after performing testing phase, source: own

Class of evaluations	Number of scores	Mean	σ	2σ	3σ	Occurrence in "regular" evaluations
extremely (-)	13	1.31	2.18	4.35	6.53	1.0%
very very (-)	11	6.18	4.35	8.71	13.06	0.7%
relatively very (-)	2	17.50	3.54	7.07	10.61	0.0%
very (-)	29	15.72	8.35	16.70	25.05	3.6%
quite (-)	8	25.25	7.78	15.56	23.33	1.0%
relatively (-)	9	27.33	3.94	7.87	11.81	1.2%
more or less (-)	4	27.50	2.89	5.77	8.66	0.4%
(-)	41	22.62	10.78	21.56	32.33	5.6%
approximately (0)	3	48.00	3.61	7.21	10.82	1.1%
more below (0)	5	36.60	2.70	5.40	8.11	0.8%
slightly below (0)	3	45.00	3.00	6.00	9.00	0.3%
below (0)	14	40.71	3.85	7.70	11.55	1.9%
slightly above (0)	4	56.25	1.50	3.00	4.50	0.6%
more above (0)	4	61.75	2.36	4.73	7.09	0.7%
above (0)	16	61.19	2.88	5.76	8.64	3.4%
(0)	31	52.73	5.18	10.36	15.54	6.9%
relatively (+)	19	70.11	5.02	10.04	15.06	6.3%
quite (+)	29	71.79	4.97	9.93	14.90	5.2%
more or less (+)	6	67.00	8.00	16.00	24.00	1.2%
relatively very (+)	15	79.07	5.90	11.80	17.69	1.8%
very very (+)	44	89.13	4.82	9.63	14.45	10.1%
very (+)	41	80.19	6.88	13.75	20.63	19.2%
extremely (+)	31	97.80	2.44	4.88	7.32	6.2%
(+)	68	74.09	13.54	27.08	40.61	20.8%
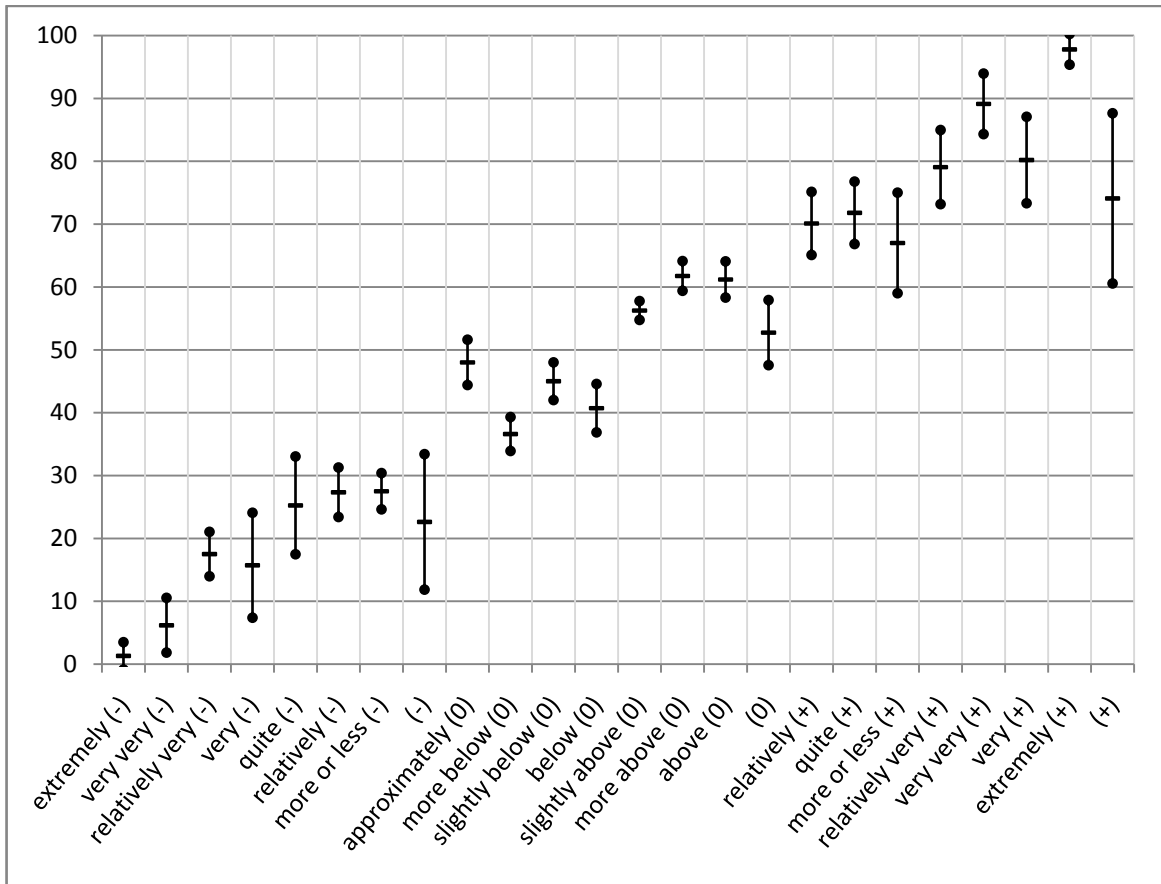
Figure 12: Resulting fuzzy numbers, source: own
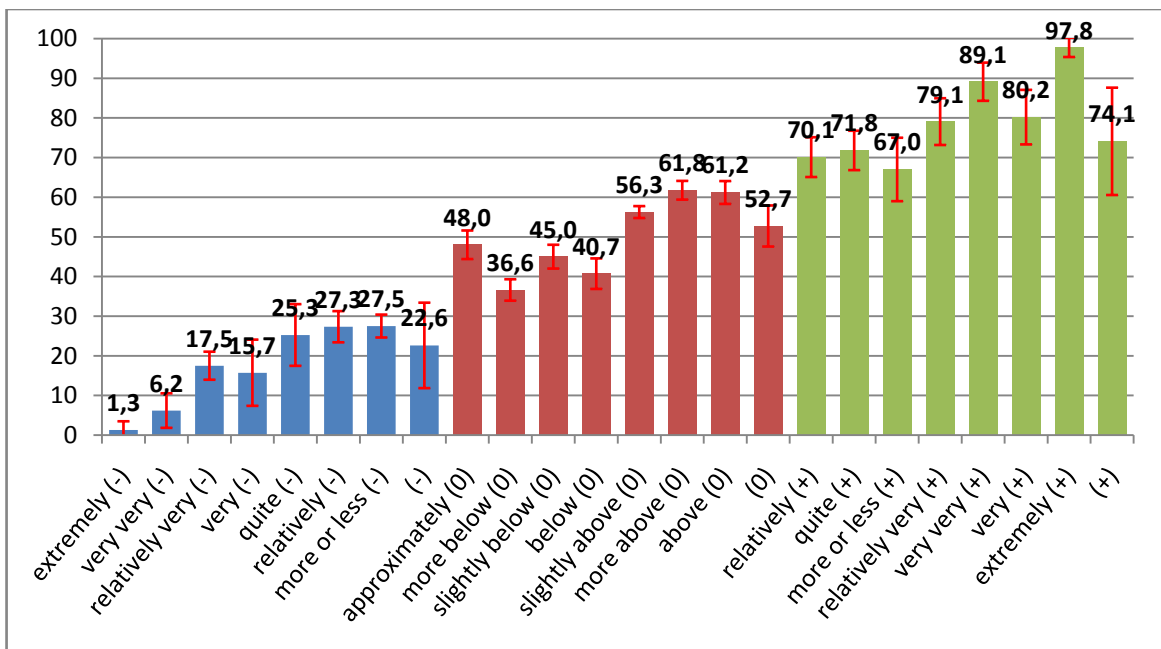
Figure 13: Resulting fuzzy numbers, another perspective, source: own

As can be seen from Table 18, most of the evaluation classes were defined sufficiently. There is however a number of evaluations that were not very used frequently and thus

the parameters of resulting fuzzy numbers are based only on few observations. Last column in the table summarizes occurrence of each evaluation class in evaluation phase. For instance, in case of evaluation "relatively very (-)", which is defined only by two scores during the testing phase, the occurrence is 0% in the evaluation phase. Because of limited size of the sample, the probability of defining properly all classes is lower. With larger sample, the amount of scores would be higher as well as the occurrence.

As for the distribution of used evaluations, there is evident majority of evaluations with positive meaning, where the most commonly used are: (+), very very (+), very (+), extremely (+) and quite (+). As for the neutral, there is an apparent majority of simply constructed evaluations like: (0), above (0) and below (0). In the negative meanings, the majority holds: (-) and very (-).

Hence, the conclusion is that testing users tended to use:
- easily constructed, not very specific evaluations,
  o because they do not always posses the knowledge to certainly evaluate some facts and they express them more generally, keeping some kind of reserve,
- evaluations with positive meaning,
  o because the majority of selected WPPAs was very good or good in terms of usability.

As for the other information included in the Table 18, the parameters of input fuzzy measures - fuzzy numbers - are defined by mean and multiple of the standard deviation forming its left and right boundary.

It is also convenient to present the most common synonyms that belong to the same class of evaluations. This base is implemented in the Linguistic convertor and has been extended during the testing phase of the study. The list of commonly used evaluations is presented in the Table 19.

Meaning of the evaluation		
Negative (-)	**Neutral (0)**	**Positive (+)**
low	normal	high
less	average	good
small	medium	well
poor	common	fully
weak	middle	fast
bad	intermediate	easy

Linguistic convertor also converts the hedges of evaluations to those that can be recognized by FUE. The same applies for special words that cannot be decomposed into hedge and core. Table 20 shows the example of converting the hedges and special words. The database in the Linguistic convertor is however more rich.

Table 20: Conversion of the hedges and special evaluations, source: own

Conversion of hedges		Conversion of special words	
Original hedge	**Converted hedge**	**Special word**	**Converted evaluation**
slightly	relatively	worse	relatively poor
almost	more or less	better	relatively good
absolutely	extremely	not at all	extremely low
really	very	not good	poor
approximately	more or less	best	extremely good
maximally	extremely	great	extremely good
minimally	extremely	at average	approximately average
quite above	more above	not so good	relatively poor
about	more or less	optimal	very very good
quite very	relatively very	quite normal	approximately average

5.1.2 Analysis of the fuzzy rule base

After defining the scale, each testing evaluation was used to generate three types of rules according to the techniques described previously. The evaluator only needed to choose appropriate consequent of such rules. FUE however displays calculated numeric consequent that might help evaluator to choose correct linguistic state of consequent if necessary.

Taking in mind there were 50 testing evaluations, 150 fuzzy rules were generated and three fundamental rules (9× evaluation low = low usability, 9× evaluation medium = medium usability, 9× evaluation high = high usability). Afterwards, number of complementary rules was defined, making total of 200 rules. In the next step, for testing evaluations that were disputable other rules were defined. At the end, an amount of rules without any connection to the testing results was defined. Overall, there are 241 fuzzy rules.

Although this number is relatively small, compared to the number of all possible rules, which is $3^9 = 19,683$, it is important to note that rules were created right against the users' evaluations. In contrary to the "blind" generation of hundreds of rules, this approach is not time-consuming and inefficient. Generally, the higher number of rules, the higher is the accuracy of the output. There are rare cases when any rule fires at the evaluation. The results of unknown evaluations should be therefore approximated accurately, but the highest possible level is not always guaranteed.

5.2 Analyzing results of the usability evaluation

The most important part of the study is obviously the analysis of the results obtained by usability evaluation. As described previously, there are several perspectives how to observe the data. These might be divided as follows:

- results by portals,
- results by users.

The usability evaluation was performed by the 10 users who evaluated the 10 selected Web portals of Public administration. First, let analyze the overall results without constraining to any classification criteria. The average score of all three defuzzification methods are depicted in Figure 14 together with the 95% confidence intervals for the mean values. Due to the smaller and heterogeneous sample of users, the confidence intervals are in some cases larger.

It may be concluded that the average scores of different defuzzification methods are very similar. As can be also seen, HM defuzzification method mostly produces lower scores than COG whose values are very similar to those obtained by WCA method. The author considers the results obtained by COG and WCA method as preferable.
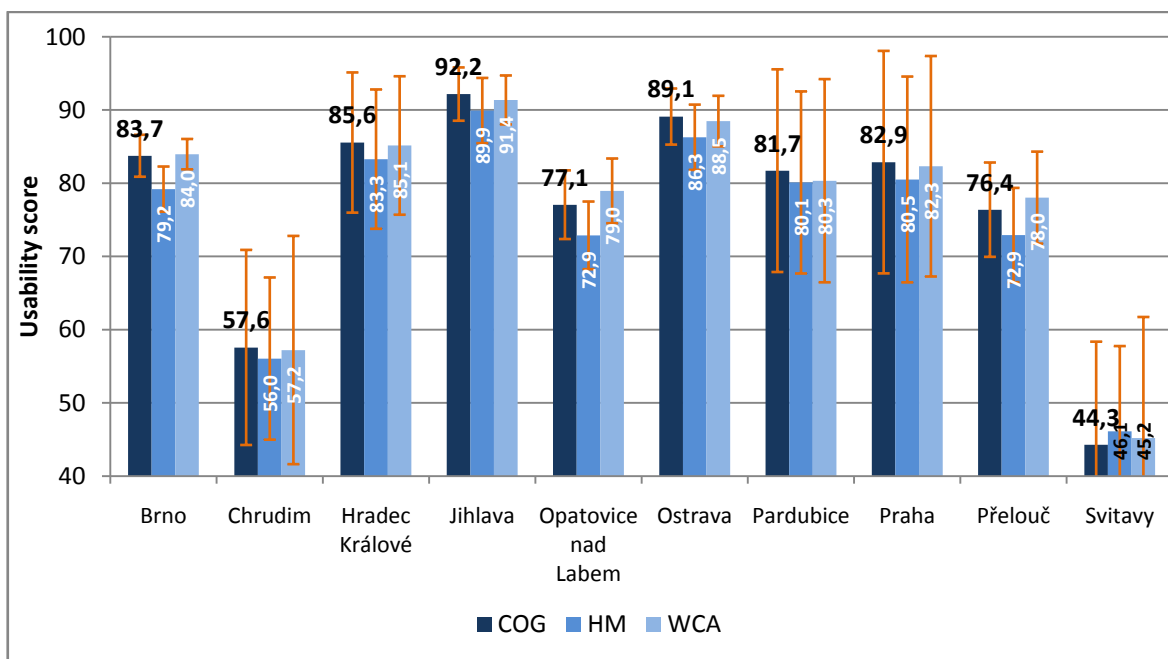
Figure 14: Overall results of usability evaluation per portal, source: own

The overall results are summarized in Table 21. As can be seen, the score orders of COG and WCA methods are the same, while of HM method is slightly different between the 4th and the 6th position. The score of first WPPA – Jihlava is relatively very high taking in mind, that 10 different users evaluated the usability. The average score of the worst evaluated WPPA – Svitavy is just slightly below average.

Table 21: Summary of results of usability evaluation per portal, source: own

Position	WPPA	COG	HM	WCA
1	Jihlava	92.17	89.92	91.37
2	Ostrava	89.10	86.27	88.48
3	Hradec Králové	85.55	83.28	85.15
4	Brno	83.75	79.19	83.97
5	Praha	82.87	80.51	82.31
6	Pardubice	81.71	80.10	80.34
7	Opatovice nad Labem	77.06	72.87	78.95
8	Přelouč	76.38	72.91	78.03
9	Chrudim	57.56	56.04	57.21
10	Svitavy	44.28	46.13	45.21

The other interesting analysis of overall results is performed by classifying users according the predefined criteria: sex, age and experience. These results are depicted in Figure 15.
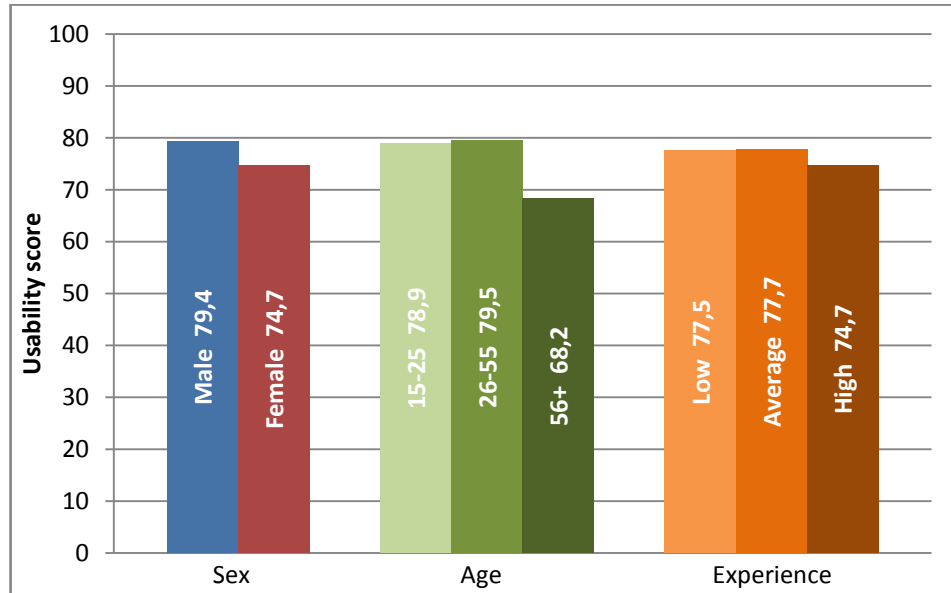
Figure 15: Overall results of usability evaluation per user, source: own

As can be seen from Figure 15, the women in the sample evaluated with slightly lower score. As for the age, users from 15 to 55 years evaluated very similarly, while users older than 55 years evaluated with significantly lower scores on average 68.2 points. Finally, classifying according to the experience brought similar results, which is according to the fact that users as non-experts evaluated usability just by using their natural language, very good demonstration that criteria used in FUE are not confusing. As can be seen, the average score of evaluation by experienced users is lower. This can be explained by a fact, that advanced users are more critical, since they have learnt to distinguish between what is good and what is not.

5.2.1 Particular results per portals

In other words, this scope focuses on the results classification by the objects of evaluation – the particular WPPAs. Each portal is be described by average score of COG method, scores of particular users, approximate average value of each criterion and results of evaluation by classifying users according to the predefined criteria.

Table 22: Particular results per portal – Brno, source: own

WPPA: Brno									
URL: http://www.brno.cz/									
Average score (COG): 83.75									
Usability score per user (COG method) and distance to average									
User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	User 10
80.29	82.61	85.01	86.79	86.79	87.48	87.48	87.29	73.43	80.29
-	-	+	+	+	+	+	+	-	-

Brno — Level of criteria (Low / Medium / High) for Criteria of evaluation: A, IC, IR, R, NS, DP, O, AG, LS

Brno — Usability score by Sex (Male 84,6; Female 82,9), Age (15-25 84,3; 26-55 84,9; 56+ 80,1), Experience (Low 80,1; Average 85,7; High 81,4)

There is an obvious similarity of scores among the users. The evaluation provided by User 9 is the most different, that might be however caused by the low experience of this user. Overall score is high, with low variance.

All evaluated criteria tend to be high. Accessibility (A) and Information retrieval (IR) are the weakest and strongest characteristics of the portal.

As for the classification of users according to the criteria, the results apply to the overall values. There are no significant deviations.

Table 23: Particular results per portal – Chrudim, source: own

WPPA: Chrudim

URL: http://www.chrudim-city.cz/

Average score (COG): 57.56

Usability score per user (COG method) and distance to average									
User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**	**User 7**	**User 8**	**User 9**	**User 10**
30.28	47.48	67.63	81.84	30.14	78.32	57.21	75.91	30.28	76.52
-	-	+	+	-	+	-	+	-	+

There is a high variance among the particular scores. The lowest scores, that are significantly different from the average, were provided by users with low and high experience.

Most of the criteria were evaluated as low or medium, while Navigation structure (NS) is the worst and Recency (R) the best one. Orientation (O) throughout the site is however evaluated positively.

Users with high experience tend to be more critical, sometimes too much if the evaluated object does not meet their criteria. On the other hand, users with low skills might experience using the site. Users with average experience are usually more satisfied. This could be concluded about users between 15 - 25 years that think more dynamically.

Table 24: Particular results per portal – Hradec Králové, source: own

WPPA: Hradec Králové
URL: http://www.hradeckralove.org/
Average score (COG): 85.55

Usability score per user (COG method) and distance to average

User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	User 10
96.38	98.15	98.39	46.13	84.13	85.05	96.37	87.48	82.59	80.86
+	+	+	-	-	-	+	+	-	-

Hradec Králové

Level of criteria: High / Medium / Low

A, IC, IR, R, NS, DP, O, AG, LS

Criteria of evaluation

Hradec Králové

Usability score

Male 89,2 | Female 81,9 | 15-25 88,1 | 26-55 92,5 | 56+ 64,4 | Low 83,4 | Average 82,4 | High 97,3

Sex | Age | Experience

The average score is very high, with concentration of values around the mean. The portal is evaluated very high by users with expert knowledge and low by users older than 55 years.

Most of the criteria are evaluated extraordinary high. Users consider the weakest criteria Recency (R) and Loading speed (LS).

70

Table 25: Particular results per portal – Jihlava, source: own

WPPA: Jihlava
URL: http://www.jihlava.cz/
Average score (COG): 92.17

<table>
<tr><th colspan="10">Usability score per user (COG method) and distance to average</th></tr>
<tr><th>User 1</th><th>User 2</th><th>User 3</th><th>User 4</th><th>User 5</th><th>User 6</th><th>User 7</th><th>User 8</th><th>User 9</th><th>User 10</th></tr>
<tr><td>96.32</td><td>97.95</td><td>87.48</td><td>81.69</td><td>96.50</td><td>87.48</td><td>87.48</td><td>98.25</td><td>91.16</td><td>97.40</td></tr>
<tr><td>+</td><td>+</td><td>-</td><td>-</td><td>+</td><td>-</td><td>-</td><td>+</td><td>-</td><td>+</td></tr>
</table>

Jihlava

Bar chart – Criteria of evaluation (Level of criteria: Low, Medium, High): A, IC, IR, R, NS, DP, O, AG, LS

Jihlava

Bar chart – Usability score by Sex, Age, Experience:
Male 93,4; Female 91,0; 15-25 90,8; 26-55 95,3; 56+ 86,4; Low 93,8; Average 90,0; High 97,1

Jihlava obtained the highest average score of Web portals evaluated in the study. There is a low variance of particular scores around the mean value, since all users evaluate similarly.

The criteria are evaluated very uniformly. All of them possess high linguistic levels.

The highest evaluations were obtained by expert users. Older users evaluate slightly lower.

Table 26: Particular results per portal – Opatovice nad Labem, source: own

WPPA: Opatovice nad Labem

URL: http://www.opatovice-nad.labem.cz/

Average score (COG): 77.06

	Usability score per user (COG method) and distance to average								
User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	User 10
74.32	76.56	73.58	87.09	87.09	78.87	82.22	79.41	66.85	64.61
-	-	-	+	+	+	+	+	-	-

Average score is relatively high, optimally distributed around the mean value.

The users mostly criticized the inability to retrieve information. On the other hand, they found Recency (R) and Loading speed (LS) as strong factors of the portal.

It is positively evaluated by older users and women in the test. The evaluations are similar among users with different experience.

Table 27: Particular results per portal – Ostrava, source: own

WPPA: Ostrava									
URL: http://www.ostrava.cz/									
Average score (COG): 89.10									
Usability score per user (COG method) and distance to average									
User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**	**User 7**	**User 8**	**User 9**	**User 10**
85.15	84.84	96.47	78.04	97.43	87.48	96.74	87.48	88.73	88.65
-	-	+	-	+	-	+	-	-	-

Portal is suitable for large scale of users and was evaluated with very high average score.

Some users however do not prefer the amount of graphics (AG) and they found Loading speed (AS) as moderate. On the other hand, the Orientation (O) and Navigation structure (NS) is evaluated very highly.

The highest score is provided by users between 15 and 55 years and users with low experience.

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Table 28: Particular results per portal – Pardubice, source: own

WPPA: Pardubice									
URL: http://www.mesto-pardubice.cz/									
Average score (COG): 81.71									
Usability score per user (COG method) and distance to average									
User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**	**User 7**	**User 8**	**User 9**	**User 10**
85.30	87.86	96.31	19.45	87.29	87.09	85.01	83.02	89.17	96.60
+	+	+	-	+	+	+	+	+	+

The design of the Web portal has been recently changed. Although overall score is high, users evaluate Amount of graphics (AG) as insufficient and they do not prefer the design style.

There is a large difference between evaluation provided by young and older users (almost 40 points). The portal is evaluated very high by experienced users, lower by women. User 4 (female, older than 55 years, average experience) evaluated the portal with absolutely lowest score – 19.45 points.

Table 29: Particular results per portal – Praha, source: own
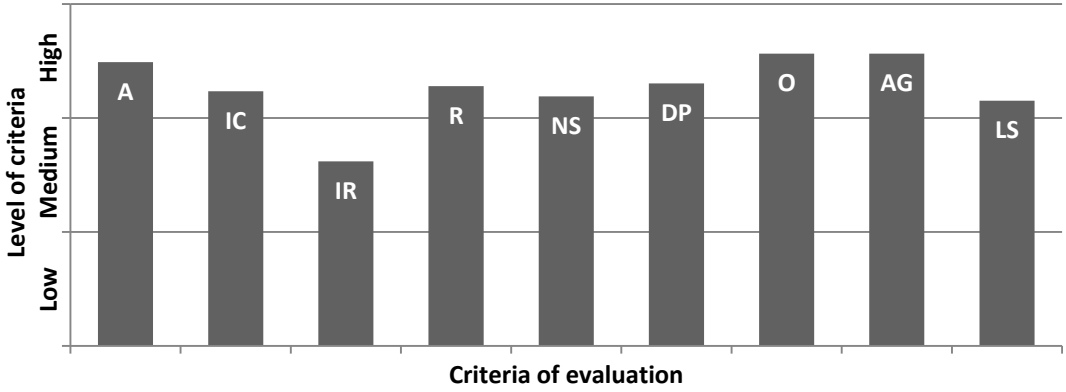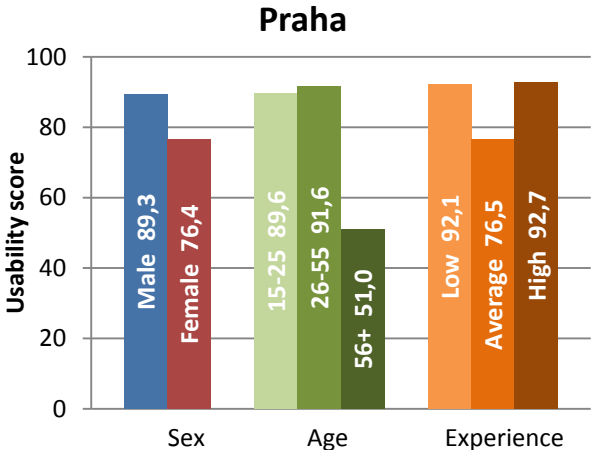
WPPA: Praha

URL: http://www.praha.eu/

Average score (COG): 82.87

Usability score per user (COG method) and distance to average									
User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**	**User 7**	**User 8**	**User 9**	**User 10**
98.35	87.09	96.36	14.63	96.88	89.68	88.73	87.09	87.29	82.63
+	+	+	-	+	+	+	+	+	-

Web portal of the capital of the Czech Republic was evaluated with very high scores.

The portal is evaluated on average by users older than 55 years and women. User 4 provided again significantly low score that affected the overall value.

The users consider that the portal has medium Information retrieval (IR), they are however familiar with the structure (NS).

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Table 30: Particular results per portal – Přelouč, source: own

WPPA: Přelouč									
URL: http://www.mestoprelouc.cz/									
Average score (COG): 76.38									
Usability score per user (COG method) and distance to average									
User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**	**User 7**	**User 8**	**User 9**	**User 10**
57.32	75.52	73.94	95.91	66.99	82.91	82.91	81.69	73.94	72.70
-	-	-	+	-	+	+	+	-	-

The portal with moderately high score evaluated positively especially by older users.

Users with high experience evaluate with lower score.

The criteria lie above average, the Amount of graphics (AG) is the lowest one. Loading speed (LS) is however evaluated highly.

Table 31: Particular results per portal – Svitavy, source: own

WPPA: Svitavy									
URL: http://www.svitavy.cz/									
Average score (COG): 44.28									
Usability score per user (COG method) and distance to average									
User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**	**User 7**	**User 8**	**User 9**	**User 10**
23.48	28.89	29.62	22.60	66.85	29.83	67.63	79.41	66.85	27.64
-	-	-	-	+	-	+	+	+	-

The worst evaluated Web portal that was tested.

Negatively evaluated by average experienced, high experienced and young users.

The criteria were evaluated moderately. The users consider the structure of navigation (NS) and Information retrieval (IR) to be very low.

5.2.2 Particular results per users

The results classified according to the evaluations of particular users are presented in this chapter.

Table 32: Particular results per user – User 1, source: own

User: User 1
Profile: Male, 26 - 55 years, high or expert experience

User 1

- Evaluations mostly close to the average.
- Tend to be more critical in evaluations.
- Uses full spectrum of evaluations.
- In case of personal like, evaluates very positively. In case of dislike, evaluates very negatively.

Table 33: Particular results per user – User 2, source: own

User: User 2
Profile: Female, 26 - 55 years, high or expert experience

User 2

- Evaluations are very close to the average.
- Tend to be more critical in evaluations.
- Uses full spectrum of evaluations.
- Evaluates fairly, taking in mind other users' likes and dislikes.

Table 34: Particular results per user – User 3, source: own

User: User 3

Profile: Female, 15 - 25 years, average experience

User 3

Brno: Score of portal 85,0
Chrudim: Score of portal 67,6
Hradec Králové: Score of portal 98,4
Jihlava: Score of portal 87,5
Opatovice nad Labem: Score of portal 73,6
Ostrava: Score of portal 96,5
Pardubice: Score of portal 96,3
Praha: Score of portal 96,4
Přelouč: Score of portal 73,9
Svitavy: Score of portal 29,6

Legend: ■ Score of portal ■ Average score

Y-axis: Usability score

- Evaluates moderately far from the average.
- Ability to recognize good and bad portals.
- In case of like evaluates with very high score.

Table 35: Particular results per user – User 4, source: own

User: User 4

Profile: Female, 56+ years, average experience

User 4

Brno: Score of portal 86,8
Chrudim: Score of portal 81,8
Hradec Králové: Score of portal 46,1
Jihlava: Score of portal 81,7
Opatovice nad Labem: Score of portal 87,1
Ostrava: Score of portal 78,0
Pardubice: Score of portal 19,5
Praha: Score of portal 14,6
Přelouč: Score of portal 95,9
Svitavy: Score of portal 22,6

Legend: ■ Score of portal ■ Average score

Y-axis: Usability score

- Evaluations mostly very far from average.
- Prefers conservative and simple design styles and those rates with high score.
- Failure to evaluate, in case of dislike. Tends to evaluate all the criteria negatively. Might result from higher age or lower experience.

Table 36: Particular results per user – User 5, source: own

User: User 5

Profile: Female, 26 - 55 years, low or no experience

User 5

- Evaluations usually very close to the average score.
- Tends to evaluate positively, due to the inability to recognize good and bad portal.

Table 37: Particular results per user – User 6, source: own

User: User 6

Profile: Male, 15 - 25 years, average experience

User 6

- Evaluations usually close to the average value.
- Scores mostly in range 78 – 90 points.
- Steady but dynamic recognition of strong and weak aspects.

Table 38: Particular results per user – User 7, source: own

User: User 7

Profile: Male, 26 – 55 years, average experience

User 7

- Evaluations mostly above the average.
- Able to express likes, steady to express dislikes.

Table 39: Particular results per user – User 8, source: own

User: User 8

Profile: Male, 26 - 55 years, average experience

User 8

- Evaluates slightly but very closely to average score.
- Range of scores between 75 and 90 points.
- Tends to evaluate very highly.
- Lower ability to recognize bad portals.

Table 40: Particular results per user – User 9, source: own

User: User 9

Profile: Female, 56+ years, low or no experience

- Sometimes far from mean value due to the low experience.
- Ability to recognize and comprehend to modern design styles.

Table 41: Particular results per user – User 10, source: own

User: User 10

Profile: Male, 15 - 25 years, average experience

- Sometimes evaluates at the mean value, sometimes more far.
- Uses large spectrum of scores.
- Ability to recognize good and bad design styles.

5.3 Validation of the results

In order to validate the reliability of proposed methodology of fuzzy usability evaluation and functionality of the FUE, the results of study need to be validated.

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The validation is based on performing a usability evaluation on some method of usability engineering. For this validation, is chosen the same group of users and WPPAs from performed study. There was a slight time gap between the study and validation of the results.

The results were validated by evaluating set of criteria affecting the usability of Web portals. The criteria are similar to the ones used for evaluation of the usability in FUE. Choosing a set of completely different criteria is not suitable due to the following reasons:

- The fundamental aspects that truly affect the usability of Web portal in Public administration were already defined. Thus, it would be inefficient and redundant to define another set.

- The score of usability evaluation might be significantly different if the evaluation is based on another set of criteria. Validation would be not successful.

Although there is no clear consensus how to measure usability obtaining a score of usability evaluation, there are some concepts that instruct how to obtain some simple measure. For instance, [25] presents SUS score based on evaluating criteria on some scale. The most suitable seems to use the Likert scale [43] with range of values from 1 to 7. Users evaluate the fact by choosing the value of scale in simple questionnaire (see Table 42). These criteria were previously presented in some studies [44], [45]. The overall score is than computed as presented in [25].

Table 42: Questionnaire for results validation, source: own

Criterion / Scale
I like the graphic interface of the Web portal: Strongly disagree 1 2 3 4 5 6 7 Strongly agree
The information provided by the Web portal is easy to understand: Strongly disagree 1 2 3 4 5 6 7 Strongly agree
It is easy to find information I needed: Strongly disagree 1 2 3 4 5 6 7 Strongly agree
I am satisfied with how easy is to use this Web portal: Strongly disagree 1 2 3 4 5 6 7 Strongly agree
Overall, I am satisfied with this Web portal: Strongly disagree 1 2 3 4 5 6 7 Strongly agree

The questionnaire consists of five questions. Users evaluate by assigning values from 1 to 7, where 1 means that user strongly disagree and 7 that strongly agree with the statement.

The validation was performed as follows: each of the 10 users that evaluate the usability had to evaluate 2 randomly chosen WPPAs from the list. The following table lists the WPPAs that were validated by each user.

Table 43: Randomly selected WPPAs for validation, source: own

User	Validation 1	Validation 2
User 1	Ostrava	Hradec Králové
User 2	Svitavy	Chrudim
User 3	Praha	Přelouč
User 4	Chrudim	Přelouč
User 5	Hradec Králové	Svitavy
User 6	Praha	Brno
User 7	Opatovice nad Labem	Hradec Králové
User 8	Svitavy	Brno
User 9	Pardubice	Přelouč
User 10	Opatovice nad Labem	Svitavy

The overall results were than compared to the ones presented previously (see Table 44).

Table 44: Results of validation, source: own

User	WPPA	Evaluation No.					SUS	COG
		1	**2**	**3**	**4**	**5**		
User 1	Ostrava	7	5	6	7	6	**86.67**	85.15
	Hradec Králové	7	7	7	6	6	**93.33**	96.38
User 2	Svitavy	1	4	1	3	3	**23.33**	28.89
	Chrudim	2	6	5	2	3	**43.33**	47.48
User 3	Praha	6	6	7	7	6	**90.00**	96.36
	Přelouč	5	6	6	4	5	**70.00**	73.94
User 4	Chrudim	4	6	6	7	6	**80.00**	81.84
	Přelouč	6	6	7	6	6	**86.67**	95.91
User 5	Hradec Králové	7	5	6	7	6	**86.67**	84.13
	Svitavy	4	4	2	3	4	**40.00**	66.85
User 6	Praha	6	7	4	6	6	**80.00**	89.68
	Brno	6	5	6	6	6	**80.00**	87.48
User 7	Opatovice nad Labem	5	6	4	5	6	**70.00**	82.22
	Hradec Králové	7	6	7	7	7	**96.67**	96.37
User 8	Svitavy	4	6	5	3	5	**60.00**	79.41
	Brno	6	7	6	6	6	**86.67**	87.29
User 9	Pardubice	5	7	7	7	6	**90.00**	89.17
	Přelouč	5	6	6	5	5	**73.33**	73.94
User 10	Opatovice nad Labem	2	6	3	5	5	**53.33**	64.61
	Svitavy	1	4	3	3	3	**30.00**	27.64

The results of randomly chosen WPPAs evaluated by SUS method are very similar to those provided by FUE. However, there are differences caused by the different complexity of criteria and lower precision of the SUS method, since it cannot take all values between 0 and 100. However, it is also natural that users might have changed opinion between both sessions.

5.4 Conclusions of the study

The goal of the study was to evaluate 10 selected Web portals serving the Public administration. Author assumes that the goal was successfully reached. The defined

empirical scale proved to be versatile; taking in mind that group of testing and "regular" users was different.

Although the sample of users that participated in the test is lower, the study gives a methodological example how to perform the usability evaluation based on the fuzzy approach.

The Web portal that reached the highest score of usability evaluation in this study combines all features of the good Web site. The design style is relatively simple, uniform and easily manageable. Furthermore, portal is kept to be updated and it is legible with optimal amount of graphic elements. In this case might be concluded that sometimes less means more.

It is a fault trying to include as much information as possible, since that decreases the accessibility and comprehension. Another typical symptom is an inappropriate amount of graphic elements just in order to fill the empty space. Although users react positively on graphic elements, they prefer simple structure, which they might learn and use.

The difference between the best and worst evaluated portal is significant. Although, one may argue about the reason to improve the usability while there is only one Web portal per municipality and users either like it or not, the utility inheres specifically in such argument. While citizens of Jihlava may efficiently deal with the common problems involving interaction with Public administration, the citizens of Svitavy, will probably give up looking for information on the city's Web portal and choose another communication channel. That will cost some resources and time. Although average usability score of Svitavy is slightly below average, the value itself is not critical. However, among the tested Web portals is this value relatively low. It must be noted that there is a number of worse Web portals.

Looking at the other results evaluation, one can make useful conclusions. For instance, in case of Web portal of Hradec Králové, a decision to put actual information on the homepage could be made. In case of Pardubice or Přelouč, the amount of graphical elements might be reconsidered.

Although utility and reasons to maintain quality of private and public services are different, there is a number of factors why measure, compare and improve the quality of use of the public information services as the one presented hereby – Web portals.

6. Generalization, critics and future objectives

The author combined latest and well-known knowledge in order to create the methodology of fuzzy usability evaluation. In previous chapters were presented a theoretical framework, methodology itself and an instrument – Fuzzy Usability Evaluator. Furthermore, author performed a case study to present the fuzzy usability evaluation process, analyzed and validated results and demonstrated possible conclusions.

The idea of general methodology arose during the establishment of the methodology. Author believes that the methodology is neither only dependent on the environment of Public administration nor on evaluating the usability of Web user interface. It might be used to perform usability evaluation of any user interface in different environment. In such case, the criteria of evaluation would have to be re-defined in order to respect the characteristics of the target systems.

There are large possibilities of future research, whether for experimental purposes or measuring. The current version of FUE may be modified and adjusted to deal with the usability evaluation of general user interface. Future version of FUE might be also able to deal with the bell-shaped input fuzzy variables that were not implemented in the current version due to the severity of the calculations. Table 45 summarizes strong and weak parts of the FUE:

Table 45: Strong and weak parts of FUE, source: own

Strong parts	Weak parts
Easy, intuitive user interface with large number of graphical outputs	The scale and rule base definition, configuration of the Linguistic convertor, choosing right parameters of evaluation requires advanced knowledge and needs to be done carefully
The only tool to deal with the usability evaluation based on user language	The number of input variables or higher granularity of variables increases the number of fuzzy rules exponentially. Five linguistic states and more input variables would however increase the power of the output.
Possibility of generalization to deal with the usability evaluation of any user interface	Quantitative evaluation of usability on first place, not attuned to be a lack-of-usability detection tool

However, there are other particular issues that were detected during the establishment of the methodology. For instance, it is strongly up to the evaluator's judgment how to set

up the Linguistic convertor. Users are not asked if they consider "quite good" to be equal as "not so bad". The interpretation is dependent on judgment and knowledge of the evaluator to deal with these facts.

It is also question if there is equality among the particular evaluation words stating the same truth. For instance, one can classify evaluations as "not so good" and "quite bad" as equivalent or corresponding to some universal evaluation such as "quite (-)", that can group more evaluations like this.

To prevent these and other problems, a number of auxiliary procedures might be executed.

Conclusion

This work proposes a new methodology of usability evaluation based on the fuzzy approach that deals with the uncertainty and vagueness inhering in user language. As a result of a particular evaluation, a score is obtained. The score combines various factors affecting the usability of a Web portal of Public administration. The input variables are difficult to be measured objectively by using some quantitative method. It is therefore a paradox that common users are able to provide valuable feedback in order to evaluate such complex manner.

Although the result of one evaluation will not provide any conclusion about entire population, still it is valuable information. The results should be compared across the various criteria. That is the only way, how to learn, improve and maintain the usability of the particular system.

This metric as the only one by now, truly represents the user language, allowing users to feel free expressing their thoughts even if they are not fully able to understand, explain and interpret them. They may have inner feeling about the fact and that feeling might not been precisely qualified, but expressed by the use of natural language.

The author demonstrates the methodology on the example of usability evaluation of an Information System in the Public administration. Web portals representing the municipalities were chosen since they are easily accessible, their use has a general utility for citizens and affect wide group of users that might take part in the survey with particularly lower costs than in the private sector with narrow requirements.

To ease the performance of the usability evaluation process, author developed a multi-purpose application attuned to computations, analysis and graphical output. Although Fuzzy Usability Evaluator is still in early stage of its product life, there is a large potential to use this application to evaluate general usability of any system. Let the innovation and improvements are subjects of future research.

Usability is young field and in the past greatly underestimated factor of a product's success. It has its irreplaceable role in the engineering and quality. Whoever says that usability is not important is wrong. Product is designed for user, without user there would not been any utility and no sales. Presently, we can usually make a choice what product we want to use. If users experience troubles with using some product, they will give up on using it and replace it with another. However, user may not have any alternative

of replacing the source of information, since there is not usually too many choices among the Web portals of the particular municipality.

The opponents of the idea of dealing with the usability of ISPAs, improving it and maintaining it, usually argue that dwelling on usability of a subsidiary public service as the Web portal is not a priority. That is truth, since quality of use and efficiency of public services has no direct impact on profit. It is aimed at the other objectives, in the first place on public welfare. Information services should be therefore presented in the way to please the citizens, making them feel comfortable with the very thing that should serve them on the first place. Usability evaluation of Information Systems of Public administration is therefore worthy, beneficial and rapid process, and may be made with low costs and high efficiency even with the small sample of population as presented in this work.

References

[1] Nielsen, Jakob. *Usability Engineering.* 13th edition. San Francisco : Morgan Kaufmann Publishers Inc., 1994. p. 362. ISBN 0-125184-06-9.

[2] —. *Designing Web Usability: The Practice of Simplicity.* Thousand Oaks : New Riders Publishing, 1999. p. 419. ISBN 1-56205-810-X.

[3] Krug, Steve. *Don't Make Me Think: A Common Sense Approach to the Web.* 2nd edition. Thousand Oaks : New Riders Publishing, 2005. ISBN 0-32134-475-8.

[4] Karahoca, Adem, et al. Usability Evaluation of Cell Phone User Interfaces. *WSEAS Transactions on Information Science and Applications.* August 2006, Vol. 3, Issue 8, pp. 1582-1588.

[5] *What is Usability?* Bevan, Nigel and Kirakowski, Jurek. [ed.] H. J. Bullinger. Stuttgart : Elsevier Science, 1991. In Proceedings of the 4th International Conference on Human Computer Interaction. pp. 651-655.

[6] International Standards Organisation (ISO). International Standard ISO 9126. Information technology: Software product evaluation: Quality characteristics and guidelines for their use. 1991.

[7] *Complementarity and convergence of heuristic evaluation and usability test: a case study of universal brokerage platform.* Law, Lai-Chong and Hvannberg, Eba Thora. Aarhus : ACM, 2002. NordiCHI '02: Proceedings of the second Nordic conference on Human-computer interaction. pp. 71-80. ISBN 1-58113-616-1.

[8] *Usability evaluation.* Scholtz, Jean. Gaithersburg : IAD National Institute of Standards and Technology, 2004, Encyclopedia of Human-Computer Interaction.

[9] Shackel, Brian. Usability - context, framework, definition, design and evaluation. [book auth.] Brian Shackel and Simon J. Richardson. *Human factors for informatics usability.* New York : Cambridge University Press, 1991, Chapter 2, pp. 21-37.

[10] Shneiderman, Ben and Plaisant, Catherine. *Designing the User Interface: Strategies for Effective Human-Computer Interaction.* 4th edition. New York : Addison Wesley, 2004. p. 672. ISBN 0-32119-786-0.

[11] Dix, Alan, et al. *Human-Computer Interaction.* 2nd edition. Upper Saddle River :

Prentice Hall, 1998. p. 656. ISBN 0-13239-864-8.

[12] Ivory, Melody Yvette. *An Empirical Foundation for Automated Web Interface Evaluation.* UC Berkeley Computer Science Division. 2001. PhD. Dissertation.

[13] Gray, Wayne D. and Salzman, Marilyn C. Damaged Merchandise? A Review of Experiments that Compare Usability Evaluation Methods. *Human-Computer Interaction.* 1998, Vol. 13, Issue 3, pp. 203-261.

[14] Nielsen, Jakob and Mack, Robert L. *Usability Inspection Methods.* New York : John Wiley & Sons, Inc., 1994. p. 413. ISBN 0-471-01877-5.

[15] Hub, Miloslav and Zatloukal, Michal. Methodology of Fuzzy Usability Evaluation of Information Systems in Public Administration. 2008, Vol. 5, Issue 11, pp. 1573-1583.

[16] Hartson, Rex H., Andre, Terence S. and Williges, Robert C. Criteria for Evaluating Usability Evaluation Methods. *International Journal of Human-Computer Interaction.* 2003, Vol. 15, Issue 1, pp. 145-181.

[17] Rivlin, Christopher, Lewis, Robert and Cooper-Davies, Rachel. *Guidelines for Screen Design.* Henley-on-Thames : Alfred Waller Ltd., 1990. p. 112. ISBN 0-63202-686-3.

[18] Preece, Jenny, et al. *Human-Computer Interaction.* New York : Addison Wesley, 1994. p. 816. ISBN 0-20162-769-8.

[19] Rigden, Christine. 'The Eye of the Beholder' - Designing for Colour-Blind Users. *British Telecommunications Engineering.* January 1999, Vol. 17, Issue 1, pp. 2-6.

[20] Sklar, Joel. *Principles of Web Design.* Florence : Course Technology, 2000. p. 205. ISBN 0-61901-526-8.

[21] Lynch, Patrick J. and Horton, Sarah. *Web Style Guide: Basic Design Principles for Creating Web Sites.* 6th edition. New Haven : Yale University Press, 1999. p. 176. ISBN 0-30007-675-4.

[22] Ivory, Melody Y. and Hearst, Marti A. Towards Quality Checkers for Web Site Designs. *IEEE Internet Computing.* 2002, Vol. 6, Issue 2, pp. 56-63.

[23] Graham, Ian. *A Pattern Language for Web Usability.* Boston : Addison-Wesley Longman Publishing Co., Inc., 2002. ISBN 0-20178-888-8.

[24] Siler, William and Buckley, James J. *Fuzzy Expert Systems and Fuzzy Reasoning.* 1st edition. Hoboken : John Wiley & Sons, Inc., 2005. p. 424. ISBN 0-471-38859-9.

[25] Tullis, Thomas and Albert, William. *Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics.* Burlington : Morgan Kaufmann, 2008. ISBN 0-12373-558-0.

[26] Stair, Ralph and Reynolds, George. *Principles of Information Systems.* 5th edition. Boston : Course Technology, 2001. p. 724. ISBN 0-61903-357-6.

[27] Comparative analysis definition. *BusinessDictionary.com.* [Online] [Cited: May 25, 2008.] http://www.businessdictionary.com/definition/comparative-analysis.html.

[28] Kan, Stephen H. *Metrics and Models in Software Quality Engineering.* 2nd edition. Boston : Addison-Wesley Longman Publishing Co., Inc., 2002. p. 512. ISBN 0-20172-915-6.

[29] Rabin, Jack. *Encyclopedia of public administration and public policy.* New York : Marcel Dekker, 2003. p. 1318. ISBN 0-82474-299-0.

[30] Pojmy aneb ztraceni v ISVS? *ISVS.CZ - Informační Systémy Veřejné Správy.* [Online] [Cited: June 20, 2008.] http://www.isvs.cz/isvs-teorie/pojmy-aneb-ztraceni-v-isvs.html.

[31] Zadeh, Lofti Asker. Fuzzy Sets. *Information and Control.* 1965, Issue 8, pp. 338-353.

[32] —. Fuzzy Sets and Systems. *International Journal of General Systems.* 1990, Vol. 17, Issue 2, pp. 129-138.

[33] Klir, George J. and Yuan, Bo. *Fuzzy Sets and Fuzzy Logic: Theory and Applications.* Upper Saddle River : Prentice Hall, 1995. p. 574. ISBN 0-13-101171-5.

[34] Paternò, Fabio and Santos, Ines. Designing And Developing Multi-User, Multi-Device Web Interfaces. [book auth.] Gaëlle Calvary, et al. *Computer-Aided Design Of User Interfaces V.* Dordrecht : Springer Netherlands, 2008, Chapter 9, pp. 111-122.

[35] Mihaliková, Eva. Portals in public administration and assumptions of its efficiency. *Studia Negotia.* 2006, Vol. LI, Issue 2, pp. 45-50.

[36] *Citizen Information Services using Internet Technologies.* Bouras, Christos, Kastaniotis, Spyridon and Triantafillou, Vassilis. Wien : Wirtschaftsunivsitat Wien, 2000. Proceedings of the 8th European Conference on Information Systems, Trends in Information and Communication Systems for the 21st Century, ECIS 2000. Vol. 1, pp. 1123-1130.

[37] Anderson, John Robert and Bellezza, Francis S. *Rules of the mind.* Hillsdale : Lawrence Erlbaum Associates, 1993. p. 320. ISBN 0-8058-1200-8.

[38] Gurney, Kevin. *An introduction to neural networks.* London : CRC Press, 1997. p. 234. ISBN 1-85728-503-4.

[39] *Stabilization of an inverted pendulum by a high-speed logic controller hardware system.* Yamakawa, T. Issue 2, 1989, Fuzzy Sets and Systems, Vol. 32, pp. 161-180.

[40] Yen, John and Langari, Reza. *Fuzzy logic: intelligence, control, and information.* 1st edition. Upper Saddle River : Prentice-Hall, Inc., 1999. p. 548. ISBN 0-13525-817-0.

[41] Mizumoto, M. Improvement of Fuzzy Control Methods. [book auth.] Hua Li and Madan M. Gupta. *Fuzzy Logic and Intelligent Systems.* s.l. : Springer Netherlands, 1995, 1, pp. 1-16.

[42] Virant, Jernej. *Design Considerations of Time in Fuzzy Systems.* Dordrecht : Kluwer Academic Publishers, 2000. p. 512. ISBN 0-7923-6100-8.

[43] Likert, R. A technique for measurement of attitudes. *Archives of Psychology.* 1932, Vol. 140, Issue 55.

[44] Brooke, John. SUS: a quick and dirty usability scale. [book auth.] Patrick W. Jordan. *Usability evaluation in industry.* Bristol : CRC Press, 1996, 21, pp. 189-194.

[45] Lund, A. M. Measuring usability with the USE questionnaire. *Usability interface.* 2001, Vol. 8, Issue 2.

[46] Pande, Peter S. and Holpp, Lawrence. *What is six sigma?* New York : McGraw-Hill Professional, 2001. p. 87. ISBN 0-07-138185-6.

List of abbreviation

COG	Center of gravity
FUE	Fuzzy Usability Evaluator
GUI	Graphical user interface
HCI	Human-computer interaction
HF	Human factors
CHI	Computer-human interaction
IS	Information System
ISPA	Information System of Public administration
IT	Information technologies
TS	Takagi-Sugeno approach
UCD	User-centered design
UI	User interface
WA	Weighted average
WPPA	Web portal of Public administration
WWW	World Wide Web

List of symbols

n   number of criteria

σ standard deviation

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Appendix A: Fuzzy Usability Evaluator - user manual

Appendix B: Overview of the evaluated Web portals of Public administration

Appendix C: Czech version of the usability evaluation questionnaire

Appendix A: Fuzzy Usability Evaluator - user manual

Complete list of the features of Fuzzy Usability Evaluator and the guide how to use it to perform the usability evaluation process is presented in this user manual. The manual can be used as a learning aid for those who are interested in using FUE for performing the usability evaluation.

Description of the Fuzzy Usability Evaluator

Fuzzy Usability Evaluator is a multipurpose application developed in Microsoft Excel using some features of Visual Basic programming language. It allows the *evaluator - a* person responsible for the usability evaluation process to solve the problem completely in single environment. Fuzzy Usability Evaluator is a graphical analytical tool with a user-friendly interface suitable for both novice and experienced users. The purpose of developing this application is to provide a suitable environment for evaluating the usability based on the fuzzy approach. The output of the evaluation is expressed as a single value – usability score.

Figure: User interface of FUE, module Inference

Although FUE is designed especially for evaluating the usability of Information Systems in Public administration, another properly defined set of input variables (linguistic variables, criteria) might be used.

The advantages of FUE are summarized by the following list of features:

- extendable rule base containing expert knowledge,
- intuitive graphical output supporting the ease of use and understanding,

- transparent calculations providing advanced feedback,
- sophisticated linguistic convertor allowing to use various evaluating expressions,
- database of previous evaluations making possible to observe the progress of particular evaluation,
- unique empirical scale of evaluating expressions based on users' opinions.

Detailed module description

FUE consists of nine collaborating modules:
- Overview,
- Questionnaire,
- Detailed questionnaire,
- Evaluation,
- Inference,
- Scales,
- Linguistic convertor,
- Score collector,
- Evaluation base.

Each module will be characterized in the following sections. You will also learn how to use them to perform own usability evaluation process. Note that the structure of the FUE respects the proposed methodology of fuzzy usability evaluation presented in this work. Theoretical background was provided at the same place.

Module Overview

The Overview provides a simple visual structure of the criteria and its classification into several categories. Going down in the hierarchy, general categories become specific criteria denoted by the evaluating question. Each cell containing the evaluating question also consists of tips how to evaluate it and list of used Web usability guidelines on which basis is the criterion constructed. This information shows up when hovering the mouse pointer over the top right corner of the particular cell.

Figure: Module Overview

Module Questionnaire

The questions used for evaluation are arranged in simple questionnaire. The inquiries with users might take place right here. First of all, there are two types of questionnaires that can be selected:

- usability evaluation questionnaire (without scoring),
- usability evaluation questionnaire with scoring.
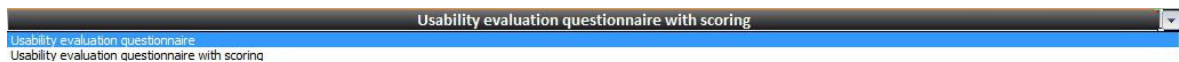
Figure: Types of questionnaires

First type of questionnaire gathers the evaluations from users that will take part in the usability evaluation. That might be performed only after definition of scale rule base (to be discussed later). The evaluations are entered manually, as an answer for one of nine evaluating questions. The form of such answer is quite benevolent, since users are free to use any phrase or expression stating some kind of rating. However, if evaluator recognizes that unknown evaluation expression is not included in the Linguistic convertor (to be defined later), such expression needs be added together with the corresponding normalized evaluation into which will be converted.

	Usability evaluation questionnaire	
ID	Full question	Evaluation
1	Specify how easily is the Web site's content legible (readable) and viewable for you.	above average
2	How much do you consider the information instantly comprehensible?	good
3	How simply (and fast) is to find some kind of information on Web site?	good
4	How much do you consider the information found on the Web site actual?	quite good
5	Evaluate simplicity and level of comprehension to the Web site's navigation.	very very good
6	How much does the graphic design of the Web site fulfill your expectations or meet your preferences?	more or less poor
7	How good is the knowledge of your current location through the Web site at any moment during the browsing?	quite good
8	Qualify your level of satisfaction with the amount of graphics appearing on the Web site.	quite poor
9	Evaluate the speed by which the Web site's elements are loaded.	more or less good

Figure: Usability evaluation questionnaire without scoring

The second type of the questionnaire allows beside the standard possibility of evaluating, capturing a score. The score is a numeric evaluation of the question

criterion. The score is not a numeric representation of the linguistic evaluation, although both of them arise as a result of the particular evaluation. There is a risk of creating a relation between these measures, which could affect the accuracy of the output.

The users are asked to qualify the answer using linguistic evaluations. That is to express something that they "feel", since this is not an objective measure. To qualify the score, they are asked to evaluate the same answer by score on scale from 0 to 100, where 0 is the worst rating and 100 is the best. It is perfectly normal if the user use same evaluation repeatedly by assigning different score, since the user "feels it particularly that way".

	Usability evaluation questionnaire with scoring		
ID	Full question	Evaluation	Score
1	Specify how easily is the Web site's content legible (readable) and viewable for you.	above average	55
2	How much do you consider the information instantly comprehensible?	good	80
3	How simply (and fast) is to find some kind of information on Web site?	good	75
4	How much do you consider the information found on the Web site actual?	quite good	82
5	Evaluate simplicity and level of comprehension to the Web site's navigation.	very very good	95
6	How much does the graphic design of the Web site fulfill your expectations or meet your preferences?	more or less poor	33
7	How good is the knowledge of your current location through the Web site at any moment during the browsing?	quite good	80
8	Qualify your level of satisfaction with the amount of graphics appearing on the Web site.	quite poor	25
9	Evaluate the speed by which the Web site's elements are loaded.	more or less good	70

Figure: Usability evaluation questionnaire with scoring

There is one or two control buttons below the questionnaire (depending on which type of questionnaire is selected). The first one allows deleting current evaluation from the questionnaire, so this can be re-used repeatedly during another session. The other button, that is visible only when the questionnaire with scoring is selected, deletes entered scores.

Reset evaluations

Reset scores
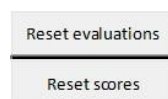
Figure: Available control buttons in Questionnaire

Module Detailed questionnaire

This module represents more sophisticated form of questionnaire, than the simple one from previous module. The evaluations can be entered either manually in the form or automatically by copying the values from the module Questionnaire using one of the control buttons below the form. The questionnaire displays following information about the current evaluation:

- criterion name and its internal ID used throughout the program,
- evaluation question,
- evaluation that is either manually entered or copied from the module Questionnaire,

- original hedge (if present) and evaluation adjective,
- converted hedge and converted evaluation adjective,
- converted evaluation and corresponding fuzzy number,
- family of evaluation adjectives to which the evaluation belongs,
- answer for the evaluating question including the entered evaluation.

No.	Criterion	ID	Full question	Evaluation	Hedge	Evaluation adjective	Converted hedge	Converted evaluation adjective	Converted evaluation	Set of evaluation adjectives	Input fuzzy number	Answer
1	Accessibility	A	Specify how easily is the Web site's content legible (readable) and viewable for you.	above average	above	average	above	average	above average	poor|average|good	(55,427; 61,188; 66,948)	The accessability and legability (readability) is above average.
2	Instant comprehension	IC	How much do you consider the information instantly comprehensible?	good		good		good	good	poor|average|good	51,712; 76,257; 100,801	The level of instant and simultaneous comprehensibility to information is good.
3	Information retrieval	IR	How simply (and fast) is to find some kind of information on Web site?	good		good		good	good	poor|average|good	51,712; 76,257; 100,801	The satisfaction when looking for any kind of information is good.
4	Recency	R	How much do you consider the information found on the Web site actual?	quite good	quite	good	quite	good	quite good	poor|average|good	(61,859; 71,793; 81,727)	The degree of recency of the informatioun found on website is quite good.
5	Navigation simplicity	NS	Evaluate simplicity and level of comprehension to the Web site's navigation.	very very good	very very	good	very very	good	very very good	poor|average|good	(83,674; 90,961; 98,248)	The degree of the navigation simplicity and comprehensibility is very very good.
6	Design preference	DP	How much does the graphic design of the Web site fulfill your expectations or meet your preferences?	more or less poor	more or less	poor	more or less	poor	more or less poor	poor|average|good	(21,726; 27,5; 33,274)	The level of which the design style fulfills expectations or meet requirements is more or less
7	Orientation	O	How good is the knowledge of your current location through the Web site at any moment during the browsing?	quite good	quite	good	quite	good	quite good	poor|average|good	(61,859; 71,793; 81,727)	The level of certainty about current location and/or progress through the system is quite good.
8	Amount of graphics	AG	Qualify your level of satisfaction with the amount of graphics appearing on the Web site.	quite poor	quite	poor	quite	poor	quite poor	poor|average|good	(9,694; 25,25; 40,806)	The level of satisfaction with number of pictures (graphics) appearing on website is quite
9	Loading speed	LS	Evaluate the speed by which the Web site's elements are loaded.	more or less good	more or less	good	more or less	good	more or less good	poor|average|good	(51; 67; 83)	The speed by which are the elements of website loaded is more or less good.

Figure: Structure of Detailed questionnaire

Together with the questionnaire, the couple of buttons can be found below the form. The first copies the current evaluation from simple questionnaire, while the other deletes evaluations from Detailed questionnaire.

Figure: Available control buttons in Detailed questionnaire

Module Evaluation

Evaluation module allows an efficient administration of the evaluation process. The results are displayed transparently. This module provides large possibilities of customization that may significantly affect the overall output of the fuzzy inference system. First of parameters is type of the scale. There are two types of scale that might be chosen:
- theoretical scale,
- empirical scale,

The difference between these scales will be defined later.
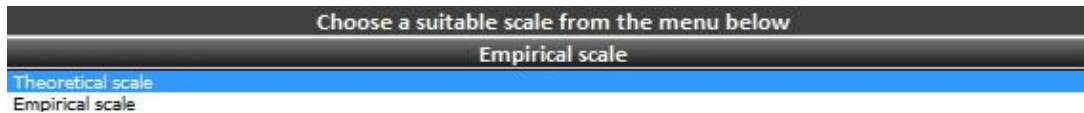
Figure: Types of scales

As well as the type of scale, the spread width around mean, which defines the center value of the fuzzy number, can be selected. There are three options:

- σ (interval of one standard deviation),
- 2σ (interval of two standard deviations),
- 3σ (interval of three standard deviations).

The size of σ (sigma) determines the left and right boundary of the fuzzy number. The higher the sigma is, the wider is the range between the left and right boundary.

Figure: Types of spread widths around the mean value

The vertical structure of the module consists of nine summaries, each of them for one criterion.

Figure: Evaluation summary for particular criterion

The lower part of these panels displays graphically the evaluation using the particular membership functions for the criteria and evaluations in form of fuzzy numbers.
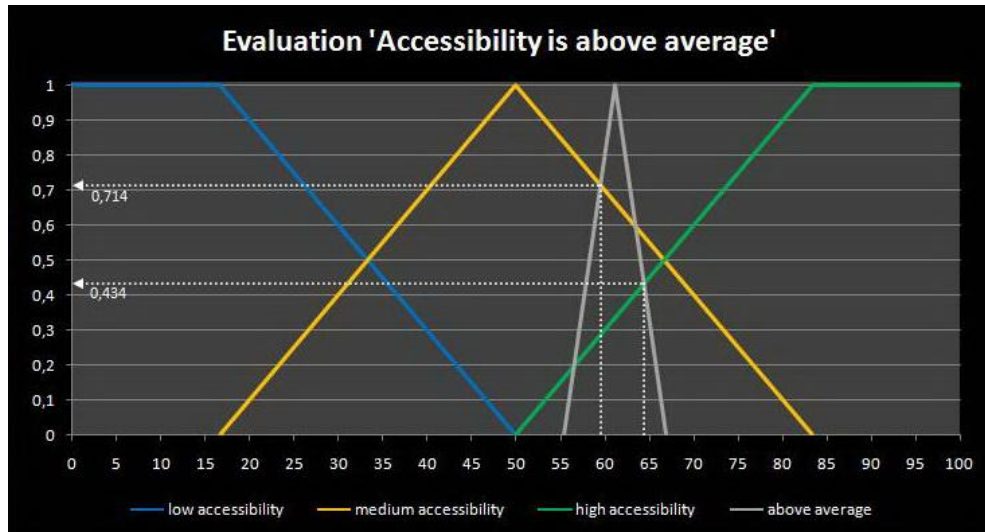
Figure: Graphical output for particular evaluation

The horizontal structure includes further information about the evaluation process. Primarily, there is a table of intersections' coordinates depicted in the graph of particular evaluation.

Intersections		x	y	x|max x y	max y
low1 A	above average1				
low1 A	above average2			0	0
low2 A	above average1				
low2 A	above average2				
medium1 A	above average1				
medium1 A	above average2			59,54	0,714
medium2 A	above average1	59,54	0,714		
medium2 A	above average2	63,52	0,594		
high1 A	above average1	56,56	0,197		
high1 A	above average2	64,45	0,434		
high2 A	above average1			64,45	0,434
high2 A	above average2				

Figure: Coordinates of membership functions' intersections for particular evaluation

Among the other customization possibilities belong the parameters of membership functions for each criterion. Since these are in form of triangular fuzzy numbers, there are only two parameters to change:

- vertical shift (q),
- sloppiness (k).

Figure: Customizable parameters of particular membership functions

Going more to the right in horizontal structure, the parameters of input fuzzy numbers are displayed.

Fuzzy number coordinates	Mean - n*σ	Mean	Mean + n*σ
x	65,0987342	70,2857143	75,4726943
y	0	1	0

Figure: Parameters of particular evaluation fuzzy number

Module Inference

Probably the most important module in FUE is the Inference. It allows to:
- see the overall output in comprehensive way with number of graphical outputs,
- consult expert knowledge included in the fuzzy rule base,
- watch the process of fuzzy inference,
- display previously saved evaluations,
- analyze and make experiments using features dedicated for advanced users.

The top part of the module displays current evaluation and overall output (usability score). The evaluator can choose from three defuzzification methods:

- Center of gravity (COG),
- Height method (HM),
- Weighted center of area (WCA).

Criterion	Accessibility	Instant comprehension	Information retrieval	Recency	Navigation simplicity	Design preference	Orientation	Amount of graphics	Loading speed	Evaluations from base	Usability score COG
Evaluation	quite good	good	approximately average	very good	below average	below average	more or less poor	very poor	quite poor	1	46,163

Figure: the upper panel with current evaluation and output

If necessary, the evaluations that were previously saved in the Evaluation base might be displayed. These are selected according to the ID under they have been saved.
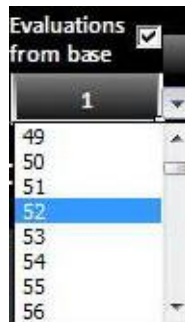
Figure: Panel accessing previously saved evaluations from evaluation base

Below this panel are displayed, the membership functions for output variable Usability.
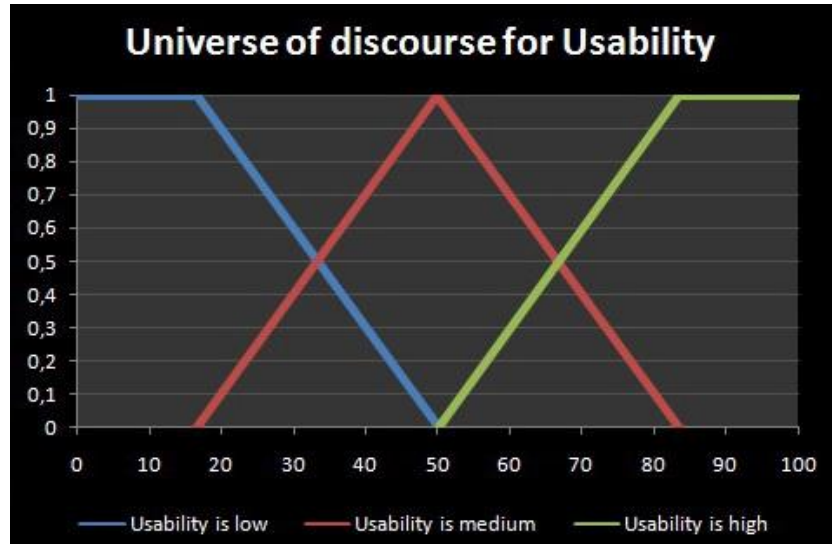
Figure: Membership functions for output variable Usability

As a result of fuzzy rule aggregation, the second graph displays clipped membership functions for output variable Usability.
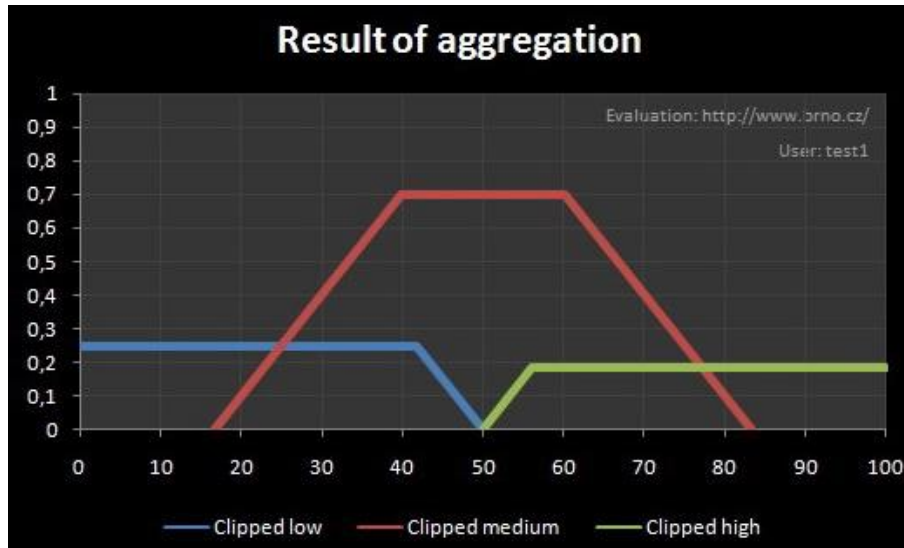
Figure: Clipped membership functions for Usability after rule implication

The accumulated curve is displayed on the third graph, which also shows the result of defuzzification - single crisp value. The output of the system is the best approximation of the knowledge contained in the fuzzy rule base.
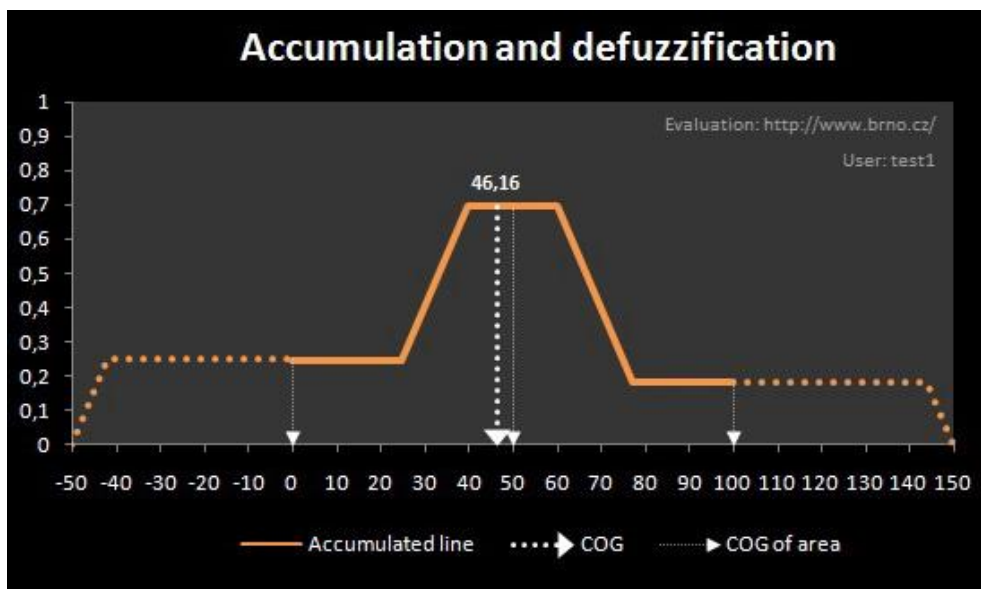
Figure: Aggregated output line with defuzzified crisp output

Below this graphical part of the module lies the entire fuzzy rule base. It consists of large number of fuzzy rules. The evaluator or another human expert must determine the form of linguistic consequent during the rule definition. There is however a numeric consequent that helps to decide which consequent should be chosen.

Rule base

Rule No.	Accessibility	Instant comprehension	Information retrieval	Recency	Navigation simplicity	Design preference	Orientation	Amount of graphics	Loading speed		Mamdani consequent	Numeric consequent	Rule generation
					Rule antecedent							**Rule consequent**		
Rule 1 IF	A is low AND	IC is low AND	IR is low AND	R is low AND	NS is low AND	DP is low AND	O is low AND	AG is low AND	LS is low	THEN	Usability is low	C = 0	truth-match 1
AND	0 low	0 low	0,152 low	0 low	0,346 low	0,346 low	0,706 low	1 low	0,793 low				
Rule 2 IF	A is medium AND	IC is medium AND	IR is medium AND	R is medium AND	NS is medium AND	DP is medium AND	O is medium AND	AG is medium AND	LS is medium	THEN	Usability is medium	C = 50	truth-match 1
AND	0,432 mediu	0,486 mediu	0,946 mediu	0,249 mediu	0,755 mediu	0,755 mediu	0,39 mediu	0,184 mediu	0,408 medium				
Rule 3 IF	A is high	IC is high	IR is high	R is high	NS is high	DP is high	O is high	AG is high	LS is high	THEN	Usability is high	C = 100	truth-match 1
AND	0,697 high	0,803 high	0,043 high	0,922 high	0 high	0 high	0 high	0 high	0 high				
Rule 4 IF	A is high AND	IC is high AND	IR is medium AND	R is high AND	NS is medium AND	DP is medium AND	O is low AND	AG is low AND	LS is low	THEN	Usability is medium	C = 49,5	truth-match 1
AND	0,697	0,803	0,946	0,922	0,755	0,755	0,706	1	0,793				
Rule 5 IF	A is high AND	IC is high AND	IR is medium AND	R is high AND	NS is high AND	DP is medium AND	O is medium AND	AG is medium AND	LS is medium	THEN	Usability is high	C = 74,9	max-match 1
AND	0,697	0,803	0,043	0,922	0,755	0,755	0,39	0,184	0,408				
Rule 6 IF	A is medium AND	IC is medium AND	IR is low AND	R is medium AND	NS is low AND	DP is low AND	O is low AND	AG is low AND	LS is low	THEN	Usability is low	C = 12,9	min-match 1
AND	0,432	0,486	0,152	0,249	0,346	0,346	0,706	1	0,793				
Rule 7 IF	A is high AND	IC is high AND	IR is low AND	R is high AND	NS is low AND	DP is medium AND	O is medium AND	AG is low AND	LS is low	THEN	Usability is medium		truth-match 1
AND	0,697	0,803	0,152	0,922	0,346	0,755	0,39	1	0,793				
Rule 8 IF	A is high AND	IC is high AND	IR is medium AND	R is high AND	NS is medium AND	DP is medium AND	O is high AND	AG is medium AND	LS is medium	THEN	Usability is high		max-match 2
AND	0,697	0,803	0,946	0,922	0,755	0,755	0	0,184	0,408				
Rule 9 IF	A is high AND	IC is high AND	IR is low AND	R is medium AND	NS is low AND	DP is low AND	O is low AND	AG is low AND	LS is low	THEN	Usability is low		min-match 2
AND	0,697	0,803	0,152	0,249	0,346	0,346	0,706	1	0,793				
Rule 10 IF	A is high AND	IC is high AND	IR is medium AND	R is high AND	NS is medium AND	DP is high AND	O is medium AND	AG is high AND	LS is high	THEN	Usability is high		truth-match 3
AND	0,697	0,803	0,946	0,922	0,755	0	0,39	0	0				

Figure: Fuzzy rule base

The definition of new rule starts with clicking on control button "New rule".

New
rule

Figure: Control button for rule definition

A window with rule parameters appears.

Define new rule

Choose type of rule

AND

Automatic rule generation

truth-match

Evaluation from base

1

Create
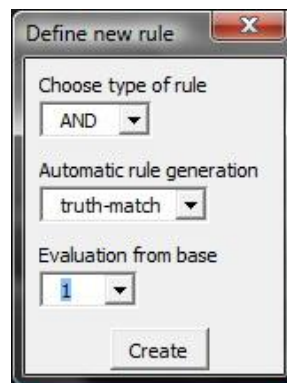
Figure: Definition of new fuzzy rule

Evaluator might choose the following types of rules:

- AND rule,
- OR rule,
- PROD rule.

Each type of rule has different way how its value is implicated.

Second parameter is allowing to decide whether the rule antecedent will be generated automatically. There are three types of automatic rule generation and an option to define rule antecedent manually. The automatic rule generation techniques are described in the following table.

Table: Defuzzification techniques

Technique	Description
Truth-match	This technique extracts the core of each criterion of the current evaluation and creates the rule antecedent by assigning the same linguistic states as the criteria of the evaluation according to the meaning of the core (negative, neutral, positive). Resulting rule matches with the current evaluation assigning each criterion maximal degree of membership. For such rule, the consequent needs to be determined.
Max-match	Max-match technique also extracts the cores of particular evaluated criteria of current evaluation. However, the rule antecedent consists of the highest linguistic states for each evaluated criterion where degree of membership is higher than 0. This is possible since an evaluation may have some degree of membership of "medium" as well as of "high" membership function.
Min-match	Min-match use the opposite way of generating the rule antecedents than the previous technique. It assigns the lowest possible linguistic state of each linguistic variable in rule antecedent that has degree of membership higher than 0 with the selected evaluation.

Last parameter of new rule is the ID of evaluation from the Evaluation base on which basis the selected technique generates the rule. In case of manually entered antecedent, this field is empty.

The advanced part of this module provides additional information about parameters of the clipped membership functions.

Result of aggregation	x_0	x_1	x_2	x_3	x_4	x_5	x_50
Clipped low	0	0	16,6667	16,667	38,967	50	50
Clipped medium1	0	0	16,6667	16,667	38,967	50	50
Clipped low_y	0	0	0	0	0	0	0
Clipped medium1_y	0	0	0	0	0,669	0,669	0,669

Result of aggregation	x_50	x_1	x_2	x_3	x_4	x_5	x_100
Clipped medium2	50	61,033	66,4667	66,867	100	100	100
Clipped high	50	61,033	66,4667	66,867	83,333	100	100
Clipped medium2_y	0,669	0,669	0,506	0,494	0	0	0
Clipped high_y	0	0,331	0,494	0,494	0,494	0,494	0

Figure: Results of aggregation

The same feedback is also provided for accumulated line and process of COG defuzzification.

Accumulation	COG									
x coordinates	-16,67	-16,67	16,6667	16,667	38,967	61,033	66,867	66,867	133,13	133,133
max clipped y	0	0	0	0	0,669	0,669	0,494	0,494	0,494	0,494
area (rectangle or triangle)	0	0	0	7,4594	14,763	0,5104	0	32,736	0	
area below triangle	0	0	0	0	0	2,8817	0	0	0	
total area	0	0	0	7,4594	14,763	3,3921	0	32,736	0	
COG (rectangle, triangle)	-16,67	0	16,6667	31,533	50	62,978	66,867	100	133,13	
COG (area below triangle)	0	0	0	0	0	63,95	0	0	0	
area * COG	0	0	0	235,22	738,13	216,43	0	3273,6	0	

Figure: Accumulation and defuzzification

Accumulated line																		
x	-50	-50	0	0	16,667	16,667	38,967	50	50	61,0333	66,467	66,867	83,333	100	100	133,53	150
y	0	0	0	0	0	0	0,669	0,669	0,669	0,669	0,506	0,494	0,494	0,494	0,494	0,494	0

Figure: Parameters of accumulated line

Module Scales

In the upper part of the module, a testing evaluation can be chosen in order to be displayed on the theoretical scale, which is illustrated below.
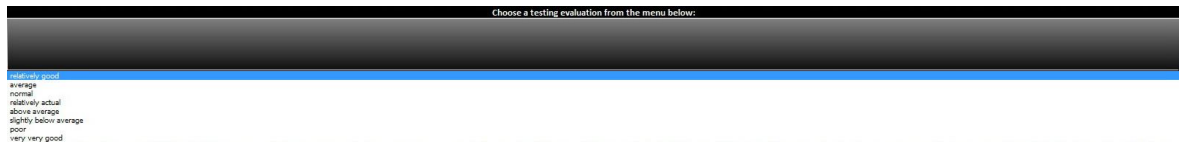
Figure: Selection of testing value from current evaluation
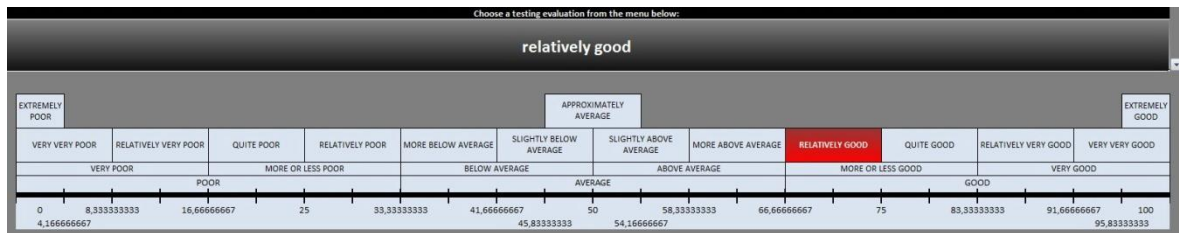
Figure: Displayed testing value on theoretical scale

Below the graph, there is a table containing the parameters for particular classes of evaluations of both scales – theoretical and empirical. While theoretical scale is made up artificially by dividing the target interval of values from 0 to 100 to the 24 predefined ranges of equal size, the empirical scale is based purely on users' opinions.

Evaluation	Theoretical evaluation				Empirical evaluation					
	Range		Mean	Standard deviation (σ)	Range		Mean	Standard deviation (σ)	2σ	3σ
	From (mean-σ)	To (mean+σ)			From (mean-σ)	To (mean+σ)				
extremely (-)	0	4,166667	2,083333	2,083333	-0,867341	3,482725	1,307692	2,175033	4,350066	6,525099
very very (-)	0	8,333333	4,166667	4,166667	1,827092	10,53654	6,181818	4,354726	8,709452	13,06418
relatively very (-)	8,333333	16,66667	12,5	4,166667	13,96447	21,03553	17,5	3,535534	7,071068	10,6066
very (-)	0	16,66667	8,333333	8,333333	7,375072	24,0732	15,72414	8,349066	16,69813	25,0472
quite (-)	16,66667	25	20,83333	4,166667	17,47183	33,02817	25,25	7,778175	15,55635	23,33452
relatively (-)	25	33,33333	29,16667	4,166667	23,39633	31,27034	27,33333	3,937004	7,874008	11,81101
more or less (-)	16,66667	33,33333	25	8,333333	24,61325	30,38675	27,5	2,886751	5,773503	8,660254
(-)	0	33,33333	16,66667	16,66667	11,84074	33,39686	22,6188	10,77806	21,55612	32,33418
approximately (0)	45,83333	54,16667	50	4,166667	44,39445	51,60555	48	3,605551	7,211103	10,81665
more below (0)	33,33333	41,66667	37,5	4,166667	33,89815	39,30185	36,6	2,701851	5,403702	8,105554
slightly below (0)	41,66667	50	45,83333	4,166667	42	48	45	3	6	9
below (0)	33,33333	50	41,66667	8,333333	36,86264	44,56593	40,71429	3,851644	7,703289	11,55493
slightly above (0)	50	58,33333	54,16667	4,166667	54,75	57,75	56,25	1,5	3	4,5
more above (0)	58,33333	66,66667	62,5	4,166667	59,38709	64,11291	61,75	2,362908	4,725816	7,088723
above (0)	50	66,66667	58,33333	8,333333	58,30725	64,06775	61,1875	2,880249	5,760498	8,640746
(0)	33,33333	66,66667	50	16,66667	47,55424	57,91242	52,73333	5,179091	10,35818	15,53727
relatively (+)	66,66667	75	70,83333	4,166667	65,08425	75,12627	70,10526	5,021008	10,04202	15,06303
quite (+)	75	83,33333	79,16667	4,166667	66,82622	76,75999	71,7931	4,966885	9,933771	14,90066
more or less (+)	66,66667	83,33333	75	8,333333	59	75	67	8	16	24
relatively very (+)	83,33333	91,66667	87,5	4,166667	73,16913	84,9642	79,06667	5,897538	11,79508	17,69261
very very (+)	91,66667	100	95,83333	4,166667	87,31758	94,60462	90,9611	3,643523	7,287046	10,93057
very (+)	83,33333	100	91,66667	8,333333	73,31602	87,06731	80,19167	6,875645	13,75129	20,62694
extremely (+)	95,83333	100	97,91667	2,083333	95,35897	100,241	97,8	2,441029	4,882057	7,323086
(+)	66,66667	100	83,33333	16,66667	63,98421	88,52885	76,25653	12,27232	24,54464	36,81696

Figure: Parameters of scale intervals for both types of scales

Module Linguistic convertor

Linguistic convertor is a powerful database containing the knowledge of equivalent evaluation words, hedges and meanings of special words.

The first one defines equivalent evaluation words. To add a new one, evaluator need to choose meaning of the evaluation, which can be negative (-), neutral (0) or positive (+). Then a suitable adjective and set of evaluation adjectives corresponding to this evaluation are selected.

Evaluation adjective	Evaluation adjective type	Converted evaluation adjective	Set of evaluation adjectives
low	(-)	low	low|medium|high
less	(-)	low	low|medium|high
small	(-)	low	low|medium|high
poor	(-)	poor	poor|average|good
weak	(-)	low	low|medium|high
bad	(-)	poor	poor|average|good
normal	(0)	average	poor|average|good
average	(0)	average	poor|average|good
medium	(0)	medium	low|medium|high
mediumly	(0)	medium	low|medium|high
common	(0)	average	poor|average|good
middle	(0)	medium	low|medium|high
intermediate	(0)	medium	low|medium|high

Figure: Base of evaluation adjectives

Second element of database converts hedges. The hedges are special kind of prefixes that can increase or decrease the intensity of the evaluation in terms of its rating. Some hedges like ("very", "quite", "above", etc.) are not converted, since they are considered as well-knows, while some of them are converted to the form of the well-known ones.

Original hedge	Converted hedge
quite	quite
very	very
very very	very very
below	below
relatively	relatively
quite very	relatively very
relatively very	relatively very
more or less	more or less
slightly	relatively
extremely	extremely

Figure: Hedge convertor

The third element of the database consists of special words that cannot be converted as simple as defined previously. First, the special evaluation word is entered and a suitable hedge and evaluation adjective that correspond to the special evaluation word need to be determined.

When decomposing entered evaluation from the questionnaire, the conversion engine first searches in the database of special words. If the result is not successful, FUE attempts to use the classic decomposition "hedge + evaluation_adjective". The hedge is searched

in the second database. The same applies for the evaluation adjective that is obtained from the first database.

Special evaluation	Hedge	Evaluation adjective
worse	quite	poor
better	quite	good
not at all	extremely	low
at all	extremely	high
not very good	very	poor
not very bad	very	good
not good	-	poor
best	extremely	good
not well	-	poor
not very well	very	poor
great	very very	good
higher	quite	high
lower	quite	low
worst	extremely	poor
not bad	-	good
not normal	more or less	low
very normal	more or less	medium
at average	more or less	average

Figure: Base of special words

Module Score collector

Score collector allows to:

- collect the scores obtained during the testing phase of the fuzzy usability evaluation process,
- overview the parameters of the empirical scale and resulting fuzzy numbers,
- compare both scales.

Evaluation	Theoretical value (mean)	Particular quantitative evaluations (score)																															Empirical evaluation			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30+	Mean	Standard deviation (σ)	2σ	3σ
extremely (-)	2,08333333	0	5	0	0	0	0	0	5	0	0	0	2	5																			1,307692	2,175033	4,350066	6,525099
very very (-)	4,16666667	10	15	7	0	5	10	0	5	5	5	6																					6,181818	4,354726	8,709452	13,06418
relatively very (-)	12,5	15	20																														17,5	3,535534	7,071068	10,6066
very (-)	8,33333333	10	0	20	20	17	20	30	25	15	15	25	0	15	10	20	12	5	25	20	10	0	20	17	20	20	0	25	20	20			15,72414	8,349066	16,69813	25,0472
quite (-)	20,8333333	35	25	32	10	20	25	30	25																								25,25	7,778175	15,55635	23,33452
relatively (-)	29,1666667	28	20	30	25	25	33	30	30	25																							27,33333	3,937004	7,874008	11,81101
more or less (-)	25	30	25	30	25																												27,5	2,886751	5,773503	8,660254
(-)	16,6666667	25	10	20	25	30	5	38	35	25	30	0	35	30	30	33	15	20	30	10	10	30	35	25	5	20	30	10	10	35	22,6		22,6188	10,77806	21,55612	32,33418
approximately (0)	50	52	47	45																													48	3,605551	7,211102	10,81665
more below (0)	37,5	38	37	35	40	33																											36,6	2,701851	5,403702	8,105554
slightly below (0)	45,8333333	45	42	48																													45	3	6	9
below (0)	41,6666667	40	35	40	45	45	40	45	35	40	45	40	40	45	35																		40,71429	3,851644	7,703289	11,55493
slightly above (0)	54,1666667	57	55	58	55																												56,25	1,5	3	4,5
more above (0)	62,5	62	60	60	65																												61,75	2,362908	4,725816	7,088723
above (0)	58,3333333	65	63	60	60	60	63	60	60	60	55	65	60	65	60	58	65																61,1875	2,880249	5,760498	8,640746
(0)	50	60	40	57	52	57	55	50	55	49	50	55	50	55	55	50	55	50	60	40	55	60	50	50	50	55	60	45	50	55	57	52,73333	5,179091	10,35818	15,53727
relatively (+)	70,8333333	80	65	72	70	75	65	65	70	75	65	65	70	75	70	70	75	75	70	60													70,10526	5,021008	10,04202	15,06303
quite (+)	79,1666667	77	72	75	73	74	72	65	65	68	75	70	75	65	73	65	70	70	65	65	80	78	75	80	75	75	70	65	70	80			71,7931	4,966885	9,933771	14,90066
more or less (+)	75	75	70	65	52	70	70																										67	8	16	24
relatively very (+)	87,5	76	84	70	80	78	75	88	80	75	70	75	80	80	90	85																	79,06667	5,897538	11,79508	17,69261
very very (+)	95,8333333	92	95	95	90	90	90	90	88	85	95	90	95	90	95	88	90	90	90	85	90	95	85	95	90	100	90	85	90	95	90,8		90,9611	3,643523	7,287046	10,93057
very (+)	91,6666667	85	85	100	83	85	82	90	78	75	85	72	80	75	70	85	70	90	85	75	77	80	72	78	75	80	75	70	80	85	83,8		80,19167	6,875645	13,75129	20,62694
extremely (+)	97,9166667	100	95	95	100	98	99	100	100	95	100	95	97	100	100	100	99	95	95	100	100	93	95	100	95	100	100	95	98				97,8	2,441029	4,882057	7,323086
(+)	83,3333333	75	65	100	70	80	100	70	75	80	85	66	65	66	60	55	66	65	60	70	80	75	70	80	75	85	100	85	95	90	79,7		76,25653	12,27232	24,54464	36,81696

Figure: Collected score for particular evaluations

On the right side of the module is displayed the current evaluation so it can be easily transferred to the Score collector.

Data from questionnaire	
Normalized evaluation	Score
relatively (+)	65
(0)	52
(0)	55
relatively (+)	70
above (0)	60
slightly below (0)	48
(-)	30
very very (+)	85
relatively (+)	68

Figure: Current evaluation from questionnaire

Module Evaluation base

The upper part of this module shows the current evaluation.

Criterion	Accessibility	Instant comprehension	Information retrieval	Recency	Navigation simplicity	Design preference	Orientation	Amount of graphics	Loading speed	Save evaluation
Current evaluation	above (0)	(+)	(+)	quite (+)	very very (+)	more or less (-)	quite (+)	quite (-)	more or less (+)	Update scores

Figure: Current evaluation overview

Below this summary lies the evaluation base. The evaluations are stored in the form of normalized expressions. As stated previously, stored evaluations can be retrieved in the module Inference by selecting appropriate ID of the evaluation. To add the current evaluation to the evaluation base, the evaluator only need to click on control button "Save evaluation".

No.	URL of the website	Normalized evaluations								
1	http://www.opatovice-nad-labem.cz/	very very (+)	extremely (+)	extremely (+)	very (+)	quite (+)	quite (+)	very (+)	more or less (+)	very very (+)
2	http://www.chrudim-city.cz/	extremely (+)	very very (+)	very (-)	quite (+)	(-)	below (0)	(0)	very (-)	relatively very (-)
3	http://www.policka-mesto.cz/	quite (+)	(+)	approximately (0)	very (+)	below (0)	below (0)	more or less (-)	very (-)	quite (-)
4	http://www.mestoholice.cz/	quite (+)	(+)	approximately (0)	very (+)	below (0)	below (0)	more or less (-)	very (-)	quite (-)
5	http://www.mestoprelouc.cz/	quite (-)	relatively very (-)	(0)	(0)	above (0)	quite (-)	(-)	(-)	very very (+)
6	http://www.mesto-pardubice.cz/	very very (+)	extremely (+)	very (+)	relatively very (+)	very very (+)	extremely (+)	relatively very (+)	slightly below (0)	very (+)
7	http://www.hradeckralove.org/	quite (+)	quite (+)	very very (+)	very (-)	slightly above (0)	extremely (+)	very very (+)	very (+)	very very (-)
8	http://www.svitavy.cz/	relatively (+)	(0)	(0)	relatively (+)	above (0)	slightly below (0)	(-)	very very (+)	relatively (+)

Figure: Evaluation base

Appendix B: Overview of the evaluated Web portals of Public administration

Brno	http://www.brno.cz/

Potřebuji si vyřídit - Další postupy k vyřízení

B R N O

VYHLEDAT ➡

- Aktuality
- ℹ O městě
- Kultura, sport a volný čas
- Doprava
- Informace pro investory
- Potřebuji si vyřídit
- Dokumenty města
- Volené orgány
- Magistrát města Brna
- Úřady městských částí
- Úřady a instituce

Další postupy k vyřízení

Vaše cesty k bezpečí (Hasičský záchranný sbor Jihomoravského kraje)

šené MMB a ÚMČ

na ÚMČ

🔍 Hledání

	Dopravní agenda (evidence vozidel, povolení vjezdu...)		Způsob zobrazení	Číslo	Odpovědná osoba	Odbor
	Osobní doklady (OP, ŘP, cestovní doklady)					
	Sociální oblast	na komunální odpad. Výměna poškozených nádob.	Z R Ú	157	Šplíchal Karel	OŽP
	Matrika, státní občanství	amy	Z R Ú	155	Došková Jindřiška	OŠMT
	Bydlení	pení motorového vozidla	Z R Ú	024	Hašová Zdenka	OSP
	Stavební řízení a památková péče	předkládání a projednání návrhů)	Z R Ú	010	Zafirelisová Alice	KPMB
	Školství	ní ve školách a školských zařízeních	Z R Ú	119	Došková Jindřiška	OŠMT
	Živnostenský úřad města Brna (ŽÚ)	dělávacími potřebami ve školách a školských zařízeních.	Z R Ú	113	Došková Jindřiška	OŠMT
			Z R Ú	112	Došková Jindřiška	OŠMT
			Z R Ú	111	Došková Jindřiška	OŠMT
	Zdraví	ání	Z R Ú	109	Došková Jindřiška	OŠMT
	Cenová mapa stavebních pozemků statutárního města Brna	na na podporu projektů v oblasti ekologické výchovy ve městě Brně	Z R Ú	151	Šplíchal Karel	OŽP
	Životní prostředí	ch částí města Brna v oblasti kultury	Z R Ú	180	Horníčková Anežka	OK
	Komunální odpad	ho města Brna v oblasti tělovýchovných a sportovních aktivit	Z R Ú	105	Došková Jindřiška	OŠMT
	Územní plán	ho města Brna v oblasti volnočasových aktivit dětí a mládeže	Z R Ú	106	Došková Jindřiška	OŠMT
	Dotace z rozpočtu města Brna	města Brna nestátním neziskovým organizacím poskytujícím sociální služby	Z R Ú	013	Hašová Zdenka	OSP
	Logo a znak - povolení užití	opatřenými dětmi	Z R Ú	015	Hašová Zdenka	OSP
	Pravidla pro udílení Ceny města Brna		Z R Ú	020	Hašová Zdenka	OSP
			Z R Ú	185	Šplíchal Karel	OŽP
	Strategie pro Brno	nakládání s odpady	Z R Ú	147	Šplíchal Karel	OŽP
	Další postupy k vyřízení	agistrátu města Brna k řízením podle stavebního zákona.	Z R Ú	229	Dominik Vladimír	OÚPR
Legalizace a vidimace			Z R Ú	130	Šujanská Helena	OZ
Legalizace a vidimace			Z R Ú	173	Sedláček Radim	OVV
Lesní pozemky - stavební řízení při dotčení zájmů chráněných zákonem o lesích			Z R Ú	066	Votava Vladimír	OVLHZ
Lesní pozemky a ochranné pásmo lesa - územní řízení při dotčení zájmů chráněných zákonem o lesích.			Z R Ú	063	Votava Vladimír	OVLHZ
Mimořádné výhody pro těžce zdravotně postižené občany – I. stupeň (TP), II. stupeň (ZTP), III. ZTP/P			Z R Ú	023	Hašová Zdenka	OSP
Místní poplatky spravované úřady městských částí			Z R Ú	168	Höhnlová Veleslava	ORF
Náhradní rodinná péče			Z R Ú	017	Hašová Zdenka	OSP

| Chrudim | http://www.chrudim-city.cz/ |

CHRUDIM

CHRUDIMSKÝ ROK HUDBY

Návštěvník   Občan   Kontakty   Mapa stránek

Nacházíte se: Občan » Aktuální informace

Aktuální informace

Vloženo: 8. 1. 2009

Přímé dotace neziskovým organizacim

Vedení města podepsalo ve středu 7. ledna 2009 smlouvy o poskytnutí přímé dotace pro 10 neziskových organizací. [..více]

Vloženo: 7. 1. 2009

Rekonstrukce kostela sv. Josefa na Muzeum barokních soch

Ve středu 7. ledna 2009 byla zahájena rekonstrukce objektu kostela sv. Josefa na Muzeum barokní sochy. [..více]

Vloženo: 6. 1. 2009

Statistika recepce Městského úřadu za prosinec

Přinášíme pro zajímavost prosincovou návštěvnost recepce, která od konce května 2008 funguje v nových prostorách přízemí Městského úřadu na Pardubické ulici. [..více]

Vloženo: 6. 1. 2009

chrudimské osmičky

Informační centrum tel, fax: 469 645 821

hledat

..:: Menu ::..   ..:: Domů ::..
Aktuální informace
▸ Přímé dotace neziskovým organizacim
▸ Začala rekonstrukce kostela sv. Josefa
▸ Statistika recepce Městského úřadu za prosinec
▸ Poslední loňský a první letošní občánek města
▸ Několika akcemi byl zahájen Chrudimský rok hudby.
▸ Převod automobilů
▸ Poplatky na podporu sběru, zpracování, využití a odstranění vybraných autovraků
▸ Rabštejnská Lhota a Mladoňovice dostaly výtěžek ze sbírky
▸ Nová auta pro Centrum sociálních služeb a pomoci
▸ Město předalo svůj plán rozvoje na ministerstvo

..:: Pondělí 12.1.2009 ::..
Svátek slaví: Pravoslav
Rek, Jonáš

..:: Aktuality ::..
5. 1. 2009 – Nové číslo Chrudimského zpravodaje
19.12.2008 – Územně analytické podklady ORP Chrudim
18.4.2008 – Regenerace sídliště Víta Nejedlého
8. 4. 2008 – Zasílání varovných SMS zpráv
listopad – Metropolitní síť

CZECHPOINT
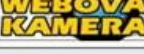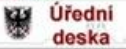
..:: Zajímavosti ::..
FOTOGALERIE
3D CHRUDIM
POŠLETE POHLEDNICI
WEBOVÁ KAMERA
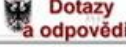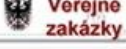
..:: Odkazy ::..
Úřední deska
Doklady on-line
Dotazy a odpovědi
Veřejné zakázky

CHRUDIM

CHRUDIMSKÝ

ROK HUDBY

chrudimské osmičky

Informační centrum
tel, fax: 469 645 821

[ ] hledat

Nacházíte se: Občan » Městský úřad

■■ **Městský úřad**

▸ Základní informace, provozní doba
▸ Elektronická podatelna
▸ Zasedací místnost
▸ Právní předpisy města
▸ Zveřejňování informací
▸ Organizační struktura
▸ Úřední deska
▸ Volná místa
▸ Seznam obcí správního obvodu
▸ Odbory MěÚ, formuláře
  ▪ Odbor kanceláře tajemníka
  ▪ Obecní živnostenský úřad
  ▪ Odbor dopravy
  ▪ Odbor finanční
  ▪ Odbor investic
  ▪ Odbor správy majetku
  ▪ Odbor sociálních věcí a zdravotnictví
  ▪ Odbor správní
  ▪ Stavební odbor
  ▪ Odbor školství a kultury
  ▪ Odbor územního plánu a regionálního rozvoje
  ▪ Odbor životního prostředí
  ▪ Útvar interního auditu a kontroly
  ▪ Městská policie
  ▪ Prevence kriminality
  ▪ Bezpečnostní rada obce s rozšířenou působností
▸ Vyřízené doklady
  ▪ Cestovní doklady
  ▪ Občanské průkazy
  ▪ Řidičské průkazy
▸ Dotazy a odpovědi
▸ Czech POINT
▸ Zasílání varovných SMS zpráv

| Hradec Králové | http://www.hradeckralove.org/ |

HRADEC KRÁLOVÉ   OFICIÁLNÍ STRÁNKY MĚSTA

■ Poplatek ze psů

RYCHLÁ NAVIGACE

Základní informace	Poplatky	Potřebné doklady
Aktuality	On-line rezervace	Související služby
Popis služby	Kontakty	Ostatní informace
Postupy	Formuláře	

ZÁKLADNÍ INFORMACE

Místní poplatek ze psů je dlouhodobě zavedený poplatek, který má především regulační charakter. Je upraven zákonem č. 565/1990 Sb., o místních poplatcích, ve znění pozdějších předpisů. Obecně závazná vyhláška města Hradec Králové **č. 4/2003**, o místním poplatku ze psů, ve znění **vyhl. č. 10/2006** a **vyhl. č. 3/2008**, stanoví sazbu místního poplatku, vznik a zánik poplatkové povinnosti, ohlašovací povinnost, splatnost poplatku, sankce a osvobození.

AKTUALITY

POPIS SLUŽBY

Poplatníkem je fyzická nebo právnická osoba, která je držitelem psa staršího 3 měsíců, a má trvalý pobyt nebo sídlo na území města Hradec Králové.

Oznamovací povinnost: držitel psa je povinen správci poplatku podat přiznání k poplatku do 15 dnů ode dne vzniku poplatkové povinnosti a v téže lhůtě oznámit každou skutečnost, která má vliv na výši poplatku (zejm. odhlášení psa z evidence z důvodu úhynu, utracení, zaběhnutí, prodeje, darování, stěhování atp.) nebo na osvobození.

Roční sazby poplatku:

- 1.200,- Kč za jednoho psa
- 300,- Kč za jednoho psa chovaného v rodinném domku, ve kterém má držitel psa trvalé bydliště
- 200,- Kč za jednoho psa, jehož držitelem je poživatel sirotčího důchodu
- 200,- Kč za jednoho psa, jehož držitelem je poživatel invalidního, starobního, vdovského, vdoveckého důchodu, který je jediným zdrojem jeho příjmu (tzn. že nepracuje, nepodniká, nepobírá žádné příspěvky, nemá příjem z pronájmu, ze zemědělské činnosti ani nemá souběh dvou důchodů a pod.)

V případě držení psa po dobu kratší než jeden rok se platí poplatek v poměrné výši, která odpovídá počtu i započatých kalendářních měsíců.

Sazba poplatku za každého druhého a dalšího psa se zvyšuje o 50 %.

Splatnost poplatku:

25. červen 2008

Způsob úhrady poplatku:

Jihlava	http://www.jihlava.cz/

Oficiální stránky města Jihlavy

Jihlava

hledat | ?

Kontakt

Město a samospráva >>

Magistrát - radnice >>

Úřad online <<

> Jak si vyřídit...
> Czech POINT a ověřování
> Elektronická podatelna
> Úřední deska
> Registr oznámení
> WebCall - elektronické objednání
> Stav vyřízení řidičského průkazu
> Formuláře ke stažení
> Povinně zveřejňované informace

Praktické informace >>

Mapy města (GIS) >>

Výběrová řízení

Výzvy - granty

Záměry pronájmů a převodů majetku

Vyhlášky a nařízení města

Integrovaný plán rozvoje města

Připravované projekty města >>

∨ ∧

Co vás zajímá

⌂ Bydlení

Potřebujete si vyřídit ...

Životní situace

Návody na řešení některých vašich problémů prostřednictvím našeho úřadu. Jak co zařídit, kam zajít, co si vzít s sebou.

∧ ∨ Změněno	∧ ∨ Název a anotace	∧ ∨ Zodpovídá
14.1.2004	**Životní situace na Portálu veřejné správy** Podrobný návod na řešení životních situací, které doklady potřebujete pro jejich vyřízení, kde, s kým, kdy a co můžete řešit, podle kterých právních předpisů máte postupovat apod.	administrator

Zobrazit výběr sloupců tabulky »

Související odkazy

Oddělení personalistiky a mezd (1)
Žádost o zaměstnání

KANCELÁŘ PRIMÁTORA (1)
Užívání znaku

KANCELÁŘ TAJEMNÍKA (2)
Stížnosti, žádost o informaci

EKONOMICKÝ ODBOR (3)
Poplatky - VHP, psi, odpady

MAJETKOVÝ ODBOR (4)
Převody a pronájmy pozemků, domů

ODBOR DOPRAVY (3)
Zábor veřejného prostranství, čistota města, řidičské průkazy

ODBOR SPRÁVY REALIT (7)
Byty, nebytové prostory, podnájmy

ODBOR SOCIÁLNÍCH VĚCÍ A ZDRAVOTNICTVÍ (4)
Pomoc v hmotné nouzi, příspěvky na péči, byty v domech zvláštního určení

Opatovice nad Labem	http://www.opatovice-nad-labem.cz/

OPATOVICE nad LABEM

Obec v Polabské nížině na spojnici měst Pardubice a Hradec Králové

Navigace

- Základní informace o obci
- Povinně zveřejňované informace
- Samospráva obce
  - Obecní úřad
  - Obecní rada
  - Obecní zastupitelstvo
  - Komise
- Historie obce
- Úřední deska
- Dokumenty podle kategorií
- Výběrová řízení
- Organizace, složky a instituce
  - Farní úřad
  - Jednotka sboru dobrovolných hasičů
  - Mateřská škola
  - Obecní knihovna
  - Obecní policie
  - Obchody a služby
  - Osvětová beseda
  - Pohostinství a ubytování
  - Sport
  - Zájmové organizace
  - Základní škola
  - Zdravotnictví
- Politické strany a sdružení
- Týká se nás
- Důležité odkazy
- Krizová telefonní čísla
- Fotogalerie
- Napište nám
- Hlášení obecního rozhlasu

Kategorie dokumentů

počet návštěv: 14303

Rozbalit / sbalit strom kategorií

- Základní informace o obci (1)
- Historie obce (1)
- Vývěska - různé (74)
  - Varování (4)
  - ⊞ Výběrová řízení
- Úřední deska (11)
- Pardubický kraj (11)
- Obecní rada
  - ⊞ usnesení
- Obecní zastupitelstvo (1)
  - ⊞ usnesení a zápisy
  - pozvánky (5)
- Vyhlášky obce (15)
- Žádosti - tiskopisy (4)
  - Stavební akce (8)
- Rozpočet (2)
- Dotace z rozpočtu obce (6)
- Komise životního prostředí
  - Zápisy z jednání (15)
- Sociální komise (3)
- Stavební komise
  - Zápisy z jednání (9)
- Volby
  Zastupitelstvo Pardubického kraje 2004
  - Poslanecká sněmovna (1)
  - Komunální volby 2006 (4)
  - Zastupitelstvo Pard kraje a Senát Parlamentu ČR (1)

Ostrava	http://www.ostrava.cz/

na celém webu | vyhledat

| **Občan** ≫ | **O městě** ≫ | **Podnikatel** ≫ | **Turista/Volný čas** ≫ |

Jste zde: Ostrava > Občan > Potřebuji si vyřídit

- Město a jeho orgány
- Kontakty a úřední hodiny

Potřebuji si vyřídit
> Bydlení
> Doprava a komunikace

Poplatky a finance
> Kultura a sport
> Sociální oblast a zdravotnictví
> Výstavba, rekonstrukce
> Životní prostředí
> Doklady, občanství, ověřování
> Živnosti
> Ostatní

- Magistrát
- Hledám informace
> Úřední deska
> Povinně zveřejňované informace
- Právní předpisy
> Veřejné zakázky

Potřebuji si vyřídit

Postupy při řešení životních situací

Popis životní situace představuje souhrn praktických návodů na řešení některých vašich problémů prostřednictvím našeho úřadu. Dozvíte se v nich jak co zařídit, kam zajít, co si vzít s sebou. Tématicky rozdělené situace obsahují body, ve kterých najdete postup řešení.

Pro lepší přehlednost lze volit ze tří možností zobrazení životní situace. Základní (obsahuje jen nejdůležitější body), rozšířené a kompletní (zobrazí veškeré dostupné informace).

Témata

- Potřebuji si vyřídit
  - Bydlení
  - Doprava a komunikace
  - Poplatky a finance
  - Kultura a sport
  - Sociální oblast a zdravotnictví
  - Výstavba, rekonstrukce
  - Životní prostředí
  - Doklady, občanství, ověřování
  - Živnosti
  - Ostatní

Pardubice	http://www.mesto-pardubice.cz/

PARDUBICE

OFICIÁLNÍ INTERNETOVÉ STRÁNKY
STATUTÁRNÍHO MĚSTA PARDUBICE

HLEDÁNÍ

KONÍK ÚŘAD MĚSTO

Abecední hledání podle klíčových slov

A B C D E F G H I J K L M
N O P Q R S T U V W X Y Z

Nenašli jste
ODPOVĚĎ?

HLEDEJ

Kontakt:
Magistrát města Pardubic
Pernštýnské nám. 1
530 21 Pardubice

Tel.: 466 859 111
podatelna@mmp.cz

Úvod │ Koník │

Koník

Koník je Váš pomocník a rádce v konkrétních situacích. Pokud nenajdete odpovídající řešení vašeho problému, klikněte v horní části na "Nenašli jste ODPOVĚĎ?". Pomocí připraveného formuláře můžete odeslat svůj nenalezený problém. Budeme se stažit neprodleně odpovědět a zařadit řešení do databáze. Pomáhejte nám tak Koníka dotvářet.

Pozemní komunikace a doprava

- Bodový systém
- Pravidla silničního provozu
- Pozemní komunikace
- Řidičské průkazy
- Registr vozidel,OTP,SPZ

Ekonomika

- Vymáhání pokut, exekuce
- Pokladny, ztráty a nálezy

Kancelář magistrátu

- Primátor, náměstkové, magistrát
- Zastupitelstvo, rada, volby
- Zahraniční vztahy, cestovní ruch, PR
- Krizové situace, povodně, havárie

Majetek města

- Byty
- Nebytové prostory
- Pozemky

Všeobecné správní agendy

- Matrika evidence obyvatel
- Občanské průkazy, pasy
- Přestupky
- Památková péče

Sociální věci

- Pomoc v hmotné nouzi
- Příspěvek na péči
- Těžce zdravotně postižení
- Sociálně - právní ochrana

Praha	http://www.praha.eu/

PRAHA.EU **Portál**
hlavního města Prahy

Dnes -5°C   **Zítra** -4°C   **Pozítří** -2°C

Vyhledávání
[   ] Hledej

Občan   Podnikatel   Turista   Extra   Opencard   Služby

Úvod ⊙
Telefonické informační centrum
Služby ⌄
Magistrát hl. m. Prahy ⌄
Úřady ⌄
Daně a finance
Veřejné mínění a statistiky ⌄
Doprava ⌄
Volný čas ⌄
Ke stažení ⌄
Město ⌄
Sociální a zdravotní oblast ⌄
Bezpečnost ⌄

⊙ Úřady městských částí
⊙ Praha historická
⊙ Protikorupční portál

⊙ On-line dopravní kamery
⊙ Vím, jak řídím
⊙ Extra

Aktuální zprávy pro občany

Začala vysílat nová televize
12.1.2009

TV Barrandov je další v řadě televizí, které začaly konkurovat těm starým. Moto nové televize nenechá nikoho na pochybách, o čem to vše bude: Baví nás bavit.

⊙ **celý článek**

Bára opět zachránila život
12.1.2009

Před časem jsme informovali o statečných činech asistenčních psů. Jedním z nich je i Bára, která už podruhé zachránila život svému pánovi.

⊙ **celý článek**

Běžky a saně, jak na ně...
12.1.2009

I když meteorologové vyhrožují oteplením, milovníci zimních sportů vědí, že když mráz není minus 15 stupňů, ale jen minus pět, stejně se dá bruslit, lyžovat i sáňkovat.

⊙ **celý článek**

Praha patří vínu
10.1.2009

Tytam jsou doby, kdy se říkalo o obyvatelích Prahy, že nerozumějí vínu a na Moravě jim podstrkovali oslazené „druháky" v domnění, že jim chutná.

⊙ **celý článek**

Nejnověji v Extra...

Nejlepší evropská architektura v ČVUT

Čtyřicet nejlepších evropských staveb za rok 2007 se představuje v aule Fakulty architektury ČVUT v pražských Dejvicích.

⊙ Více

Pro koho je Praha zelená ?

Chtěli bychom představit několik náhodně vybraných velkých firem působících v Praze, na něž jsme se obrátili s anketou na téma ekologické. Jinými slovy, jak ony samy se chovají či umožňují svým zaměstnancům se chovat šetrně k životnímu prostředí. Nyní přinášíme 1. díl. Otázek je celkem šest, odpovědi jsou řazeny v pořadí, jak jsme je získali. Jsou obsáhlejší i stručnější, nicméně firmy, které jsou zde nyní a které přibudou v dalších dílech, projevily nemalou vstřícnost ke spolupráci.

⊙ Více

Profesionální přístup všech hasičů je stejný

Podle starosty Sdružení hasičů Čech a Moravy Ing. Maděry je třeba brát rozdíl mezi profesionálním a dobrovolným hasičem z několika pohledů.

⊙ Více

Šestnáct let se Švejkem

| Přelouč | http://www.mestoprelouc.cz/ |

Přelouč
Oficiální web města

- Úřední deska
- Pracovní příležitosti
- Hlášení městského rozhlasu
- Rychlá pomoc
- Elektronická komunikace s finančními úřady
- Město Přelouč
- Orgány města
  - Zastupitelstvo města
  - Rada města
  - Dokumenty města
  - Městská policie
  - Přeloučský rošt
  - Příspěvkové organizace
  - Městský úřad
  - Kulturní zpravodaj Přelouč
- Úřední desky obcí ve správním obvodu města
- Kultura
- Školství
- Sport
- Obvodní oddělení Policie ČR Přelouč
- Užitečné odkazy
- webmaster
- INFAK

rozbalit | sbalit menu

Nemovitosti, které nabízí město Přelouč k odprodeji

jména ?
Hledat

CZECHPOINT

AKTUALITY

Informační centrum pro město Přelouč (6.1.2009)
zkušební provoz
Kategorie: Aktuality

Poplatky ze psů a svozu komunálního odpadu platné od 1. 1. 2009 (5.1.2009)
Kategorie: Aktuality

Návrh rozpočtu města Přelouče na rok 2009 (28.11.2008)
Kategorie: Odbor finanční

Město Přelouč nabízí k odprodeji vybavení vhodné pro hipoterapii (15.10.2008)
Kategorie: Prodej movitého majetku

Výstavba autobusového nádraží - Přelouč (14.10.2008)
spolufinancováno Evropskou unií z Evropského fondu pro regionální rozvoj

Regionální rada
regionu soudržnosti
Severovýchod

Investice do vaší budoucnosti
Spolufinancováno Evropskou unií
z Evropského fondu pro regionální rozvoj

Kategorie: Dotace

Co se do Roštu nevešlo (6.10.2008)
od 6. 10. 2008 si můžete, na našich webových stránkách přečíst články, které se nevešly do papírového vydání Přeloučského roštu
Články najdete v menu: Orgány města - Přeloučský rošt - Co se do Roštu nevešlo
Kategorie: Aktuality

Výstavba sportovní haly - Přelouč (2.10.2008)
spolufinancováno Evropskou unií z Evropského fondu pro regionální rozvoj

Regionální rada
regionu soudržnosti
Severovýchod

Investice do vaší budoucnosti

AXIS4
Produkty a firmy Hledat

Firmy Vám samy
nabídnou své služby.
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MAPA PŘELOUČE

KONTAKT

Kde
nás najdete

zobrazit na mapě

Oficiální název:
Město Přelouč

Masarykovo nám. 25
53533 Přelouč

Úřední hodiny:

Úřední hodiny:
Pondělí:
8:00-11:30 12:30-17:00
Středa:

ÚŘEDNÍ DESKA

Pracovní příležitosti

Hlášení městského rozhlasu

Rychlá pomoc

Elektronická komunikace s finančními úřady

Město Přelouč

- Základní informace o městě
- Historie města
- Informační centrum Přelouč
- Fotogalerie města a okolí
- Historie okolních obcí
- Dotace

Orgány města

- Zastupitelstvo města
- Rada města
- Dokumenty města
- Městská policie
- Přeloučský rošt
- Příspěvkové organizace
- Městský úřad
- Kulturní zpravodaj Přelouč

Úřední desky obcí ve správním obvodu města

Kultura

Školství

Sport

Obvodní oddělení Policie ČR Přelouč

Užitečné odkazy

webmaster

INFAK

ÚŘEDNÍ DESKA
Stav ke dni 12.1.2009

ÚŘEDNÍ DESKA

Úřední deska od	Úřední deska do	Název a anotace	Změněno
8.1.2009	26.1.2009	**Veřejná vyhláška - právní oddělení** adresát: Říha Pavel oupkol_090108_97kB.pdf	8.1.2009
6.1.2009	22.1.2009	**Veřejná vyhláška - právní oddělení** adresát: Hanauer Jiří, Nohejlová Petra oupcer_090106_99kB.pdf	6.1.2009
5.1.2009	21.1.2009	**Veřejná vyhláška - Odbor stavební, vodoprávní a dopravy** Oznámení zahájení územního řízení a pozvání k veřejnému ústnímu jednání prodloužení vodovodu a vodovodní přípojky pro výstavbu 3 RD, Strašov mupc89572008_090105_449kB.pdf	5.1.2009
5.1.2009	21.1.2009	**Veřejná vyhláška - Odbor stavební, vodoprávní a dopravy** rozhodnutí o umístění stavby stavební povolení prodloužení plynovodu a plynovodní přípojky pro výstavbu 3 RD, Strašov mupc89562008_090105_520kB.pdf	5.1.2009
5.1.2009	21.1.2009	**Veřejná vyhláška - Odbor stavební, vodoprávní a dopravy** Oznámení možnosti převzít písemnost adresovanou neznámým dědicům po zemřelém Aloisi Naňkovi mupc102009_090105_138kB.pdf	5.1.2009
5.1.2009	6.3.2009	**Městská policie Přelouč - Výzva k odstranění vozidla** Typ: Škoda 120 L zelené barvy, bez SPZ mpvkovz_090105_72kB.pdf	5.1.2009
5.1.2009	6.3.2009	**Městská policie Přelouč - Výzva k odstranění vozidla** Typ: Fiat uno, vínové barvy, SPZ HKM 09-84 mpvkovv_090105_73kB.pdf	5.1.2009
5.1.2009	6.3.2009	**Městská policie Přelouč - Výzva k odstranění vozidla** Typ: Nissan bílé barvy, SPZ PUL 99-11 mpvkovb_090105_72kB.pdf	5.1.2009
5.1.2009	6.3.2009	**Městská policie Přelouč - Výzva k odstranění vozidla** Typ: Škoda 120 modré barvy, SPZ 1E5 3319 mpvkovm_090105_72kB.pdf	5.1.2009
30.12.2008	14.11.2009	**Veřejná vyhláška - Odbor stavební, vodoprávní a dopravy** Termín zkoušek odborné způsobilosti k provozování silniční dopravy pro cizí potřeby formou taxislužby na rok 2009 st89022008_081230_107kB.pdf	30.12.2008
29.12.2008	14.1.2009	**Rozhodnutí - Krajský úřad Pardubického kraje - Odbor organizační a právní** souhlas s uzavřením veřejnoprávních smluv č. 3/2008 a č. 4/2008	29.12.2008

Svitavy	http://www.svitavy.cz/

SVITAVY

\Pondělí 12.1.2009/

Aktuální informace

RSS

< Předchozí [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] Další >

Jak chodil Kuba za Markytkou

Vystaveno: 07.01.2009

O tom, že je láska slepá a hlavně o tom, že se hloupost nevyplácí, se můžete přesvědčit v pohádce o hloupém Kubovi. Divadelní představení začíná v neděli 11. ledna v 15 hodin v divadle Trám. Pro děti od 6 let hraje Mirka Venclová-Bělohlávková (divadlo Jednoho Edy). &nbs... Více...

Změna abonentního představení 12. ledna

Vystaveno: 06.01.2009

Z důvodu onemocnění Hynka Pechy zahraje Klicperovo divadlo z Hradce Králové místo Havlova Odcházení hru Arnošta Goldflama Dámská šatna. Tato hra vás zavede do tajemného, mystického a vzrušujícího místa, jakým je v každém divadle dámská šatna. Kdo nenavštívil Dámskou šatnu v podání Klicperova divadl... Více...

Jiří Černý dnes uvádí Leonarda Cohena

Vystaveno: 06.01.2009

Leonard Norman Cohen je kanadský básník a prozaik, ale proslavil se zejména jako autor a interpret lyrických písní. Stal se inspirací pro mnoho dalších písničkářů a hudebníků - byla nahrána více než stovka coververzí jeho písní. V kinokavárně Galaxie se dnes 6. ledna v 19 hodin můžete za... Více...

Končí termíny grantů na rok 2009

Vystaveno: 22.12.2008

Grantové programy v oblasti protidrogové a zdravotní politiky: V této oblasti byly vypsány dva programy (protidrogové a zdravotní politiky). Žadateli o granty v této oblasti mohou být občanská sdružení, obecně prospěšné společností, účelová zařízení církví, obce a města a další fyzické či prá... Více...

Vánoční akce

Vystaveno: 19.12.2008

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doma 39.2%
na veřejném místě 13.8%
ve Svitavách nikde 16.8%
Hlasujících: 6194

Informační centrum města Svitavy
RIS Pardubického kraje
IRIS
Mapový Server
Databáze firem Evropské databanky
E-podatelna: posta@svitavy.cz
STAV/NOVÉ PODÁNÍ

WEBKAMERA

Návštěv: 475746

SVITAVY

\Pondělí 12.1.2009/

Rezervační systém na Městský úřad Svitavy

> Vyberte agendu <

| Leden | 2009 |

| < > | < > |

Po	Út	St	Čt	Pá	So	Ne

Informace:

Vyberte agendu, na kterou se chcete objednat a zvolte Vámi požadovaný den. Každý žadatel se může objednat na určitý čas mimo úřední den – v úterý a čtvrtek, kdy bude odbaven v čase, který si sám zvolil. Tato uvedená data jsou neveřejná a dalším žadatelům se nezobrazí.

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na veřejném místě 13.8%
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IRIS

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Databáze firem Evropské databanky

E-podatelna:
posta@svitavy.cz

STAV/NOVÉ PODÁNÍ

Appendix C: Czech version of the usability evaluation questionnaire

1. Jaká je čitelnost a přehlednost obsahu stránky?
2. Ohodnoťte jak dobře (nebo jak špatně) jsou pro Vás informace na stránce okamžitě pochopitelné a vstřebatelné.
3. Jak jednoduché (a rychlé) je něco na stránkách nalézt?
4. Do jaké míry jsou informace na stránce aktuální?
5. Charakterizujte, jak jste spokojeni s navigací na stránce.
6. Nakolik grafický vzhled stránky splňuje Vaše předpoklady a/nebo preference?
7. Jak dobrá je Vaše znalost současné polohy na stránce (víte, kde se zhruba nacházíte ve struktuře stránek, víte, jak se dostat na hlavni stránku, víte, jak se dostat zpět na stejné místo)?
8. Nakolik Vám vyhovuje množství grafiky (obrázků, barev, animací, ikon, reklamy, map atd.) na stránce?
9. Jak jste spokojeni s rychlostí načítaní stránek (podle Vašich běžných zvyklostí z domova/ z práce)?