

# User Experience Design of University Schools' Web Portals: Comparative Analysis of State-owned Technical Faculties in Serbia

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**Abstract:** *In aim to improve information service to students and all university schools information stakeholders, it is very important to make and maintain institutional web portals structure and design to be modern, functional and pleasant for use. This paper is focused on analysis of web portals designs, with special attention to university portals of technical sciences schools having information technology-related study programmes. In this empirical research, an evaluation model to be applied upon the sample web portals is formulated according to the framework of user experience design cumulatively, by extraction of web pages, elements and their characteristics from web portals in the research sample. This evaluation model is applied in analysis of characteristics of each item in the sample, i.e. each web portal of schools of technical sciences that belong to state-owned universities in Serbia. Conclusions are related towards formulating a set of web design quality characteristics which could be applicable in benchmarking, redesign or creating new web portals.*

**Keywords:** *web design, evaluation model, software quality, technical sciences university schools.*

## 1. INTRODUCTION

In the modern world, it is a common practice to have all important institutional information at the appropriate web site [1]. Most universities have their web portals with all university and affiliated schools data joined under the common URL [2], which makes web design and data organization at web pages harmonious.

There is a significant role of social media and social networking web sites [3], as well smart educational software for mobile devices [4] in higher education. Still, educational institutions' web portals keep their importance for information presentation and educational process support, and, therefore, remain in scientific and professional focus, particularly for the aspect of their quality evaluation and ranking [5].

Aim of this paper is to address the web design aspect of educational web portals – particularly for schools of technical sciences at universities. Sample for this research represent faculties of technical sciences at Serbian state-owned universities. By analysis of web portals of these educational institutions, a cumulative evaluation model will be created and applied to all web portals in the sample. This way, a comparative analysis of web design characteristics of these web portals will be performed.

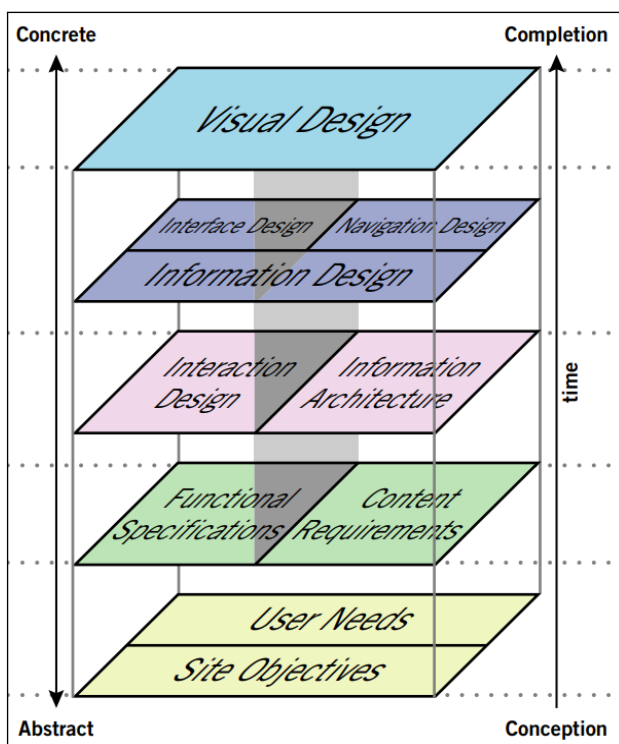
The structure of this paper is as follows: section two brings theoretical background with explanation of basic terms related to human-computer interaction (HCI), web sites user experience and web design aspects; section three provides a short literature review of related work regarding HCI development and evaluation of university web portals; section four presents research method and sample; section five presents results of the empirical research and the last section provides conclusions and future work directions.

## 2. BACKGROUND – HCI, WEB USER EXPERIENCE AND WEB DESIGN

According to [6], the Human-Computer-Interaction (HCI) could be categorized as a craft, applied scientific and engineering discipline, which "concerns humans and computers interacting to perform work effectively" [6]. This definition implies three components that are part of the scope of the general problem addressed by the discipline o HCI – human, computer and work (domain of application). General HCI problem could be decomposed to [6]: a) Design of humans interacting with computers (human factors, training and ergonomics with physical and mental aspects); b) Design of computers interacting with humans (software engineering hardware design).

Interaction design aspect of HCI has been particularly addressed as a scientific field [7], where engineering, anthropology and behavioral scientists could make influence to the results of HCI practitioners. In [7], it has been stated that in early days of HCI, term "design" within HCI was related to usability engineering, i.e. "the process of modeling users and systems and specifying system behavior such that it fitted the users' tasks, was efficient, easy to use and easy to learn". In later definitions [7], creative design is distinguished from engineering design, where creative designers continually reframe the problem, i.e. constantly question about the underlying assumptions that are directing the product development.

According to [8], important aspects of web site design that could influence web sites user experience are: information architecture, site architecture, page structure, interface design, graphic design, typography, images and video. Elements of user experience are defined at [9], with the concept of basic duality in web design – having web pages as software interface and information resource based on hypertext system. By the development of web technologies, there is a sophisticated diversification and integration of front-end and back-end parts of web applications. According to [9], elements of user experience design are presented at Figure 1.



Web design, according to [9] is oriented towards enabling appropriate web site user experience and it is based on user needs and the web site objectives, which are formulated into functional and content requirements, followed by interaction design, information architecture, information

design, interface design, navigation design and visual design.

### 3. RELATED WORK

#### 3.1. HCI Development

In [10], a brief history of HCI is given with presenting important aspects such as user interface design, activity and linguistic theories-based approach and contextual design (having context of the interaction in focus). According to [10], recent research in HCI field is directed towards "practice" as a paradigm, where particular areas of application could be addressed, such as information systems and computer supported cooperative work. Other relevant "practice" oriented aspects of modern HCI include: performance measurement and adjustments, digital ecologies (i.e. family of artifacts), materiality of artifacts and embodiment with human activities and solving problems in real world.

HCI area follows information technology and application changes (they are called "waves"). Integration of different waves is addressed in [11]. According to [11] [12] there were three mayor HCI waves with focus on:

1. First wave – cognitive aspect of human being, industrial engineering and ergonomics;
2. Second wave – groups of people working with multiple applications, work settings within well-established communities of practice, situated action, distributed cognition, activity theory, information flow;
3. Third wave – interactive computing always present in life (both work and home), applications are built on the fly, collaboratively by people in specific context, meaning construction, creation is variable (people and context change, big diversity of actors, needs and contexts, hyper-relativization), new elements as factors of interaction (culture, emotion, experience), extension to personal life, art and leisure (non-work, non-purposeful, non-rational), designers seek inspiration from use.

Having "computer" side of HCI in focus, there are recent results in using patterns and pattern languages in both software engineering and design part of the HCI development [13]. According to [13], "patterns provide some rationale for particular design decisions", but also they provide alternative patterns for similar problems, that could be used in different contexts; the patterns are often provided together with advice on the context of applicability. Research [14] provides insight in recent trends in HCI research and practice with using artificial intelligence and machine learning techniques in: explainable artificial intelligence systems, recommender systems, context-aware systems, rules extraction and production, implicit sensing etc.

### 3.2. Evaluation of university web portals

University web portals have been evaluated from different perspectives.

In [15] results of empirical research on university websites effectiveness are presented. Particular design characteristics that were examined were: information content, navigation, usability, customization, download speed, security. The empirical research has been conducted upon 50 colleges and universities in USA. It has been concluded that universities should improve updating information, presenting layout and visual attractiveness, and offer a better support to navigation, search and location of information, customization and security.

Research [5] presents an approach to rank educational web sites on usability. Factors that affect the usability of a website are defined according to literature review and they are: ease of use, response time, download speed, navigation, accessibility, personalization, availability, content, security and aesthetics. The importance of each of these factors were estimated by decision makers, where linguistic scale values were related to fuzzy numbers for importance level of the factor influencing usability. After formulating the decision matrix, four educational web sites were evaluated and applicability of the proposed evaluation model was empirically proved.

Accessibility of higher education institution web sites in the State of Kuwait has been examined in research [16]. The evaluation criterion was the conformance to the WCAG 2.0 Web Content Accessibility Guidelines standard. Sample consisted of 41 homepages of higher education institutions and colleges. In the research some tools were used, such as AChecker, Total Validator, WAVE etc. It has been concluded that none of the analyzed web portals were fully conformed to the WCAG2.0 standard. It was clear that these web portals were not developed to be aligned with WCAG2.0 standard and that they need to be improved, in aim

to provide appropriate accessibility to people with disabilities.

## 4. RESEARCH METHODOLOGY

### 4.1. Research method

Research method in this paper is related to:

1. Creating an evaluation model to be applied in comparison of web designs included in user experience design;
2. Applying this evaluation model to elements of web design at university schools of technical sciences web portals.

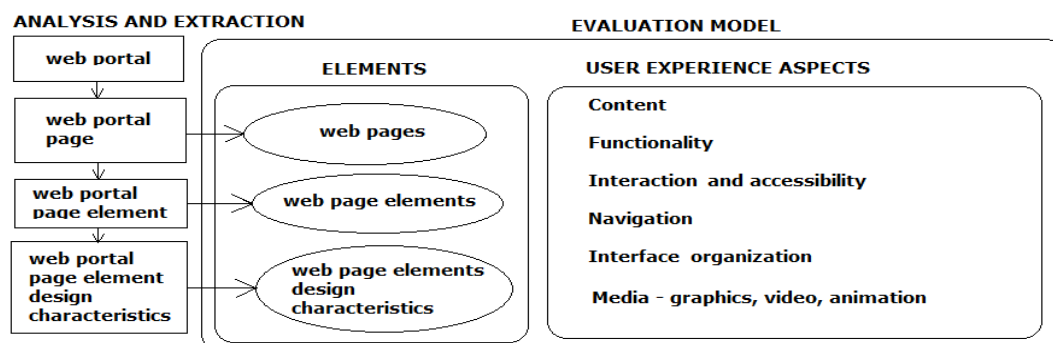
The model for user experience design evaluation is created:

- According to [9], including aspects of user experience design;
- Enhanced user experience aspects with accessibility aspect and details about media;
- Having detailed elements and characteristics obtained by cumulative approach, where each detected characteristic at particular web portal is integrated in the common evaluation model, to be applied to the whole sample.

The process of creating the evaluation model is presented at Figure 2.

### 4.2. Research sample

In this research, sample consists of web pages, elements and characteristics extracted from web portal designs of public (state-owned) university schools of technical sciences in Serbia (excluding University of Novi Sad, Technical Faculty "Mihajlo Pupin" in Zrenjanin). Criteria for selection of state-owned university schools (faculties) is to analyze schools of technical sciences (having word "technical" or "electrical engineering" in their names) having study programmes in information technologies, computer science and software engineering field. The sample (faculties and URLs) is presented at Table 1.

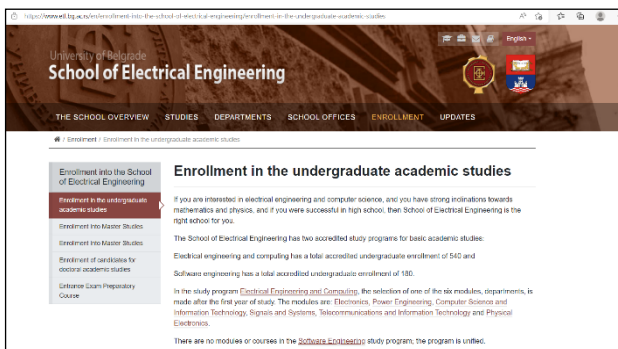


**Figure. 2.** The analysis of web portals and creation of cumulative evaluation model for evaluation of web portals user experience design

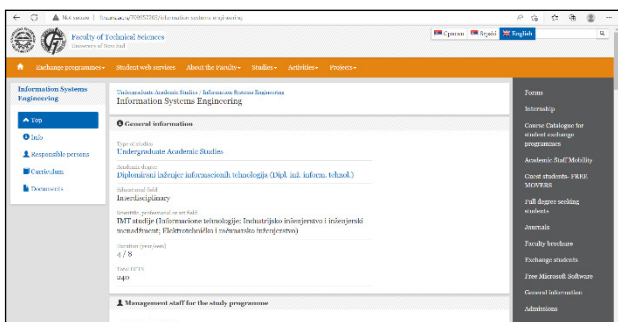
**Table 1.** Research sample – web portals of state-owned faculties of technical sciences in Serbia

No	Public University School of Technical Sciences	Web portal URL
1	University of Belgrade School of Electrical Engineering	[17]
2	University of Novi Sad, Faculty of Technical Sciences	[18]
3	University of Nis, Faculty of Electronic Engineering	[19]
4	University of Kragujevac, Faculty of Technical Sciences Cacak	[20]
5	State university of Novi Pazar, Department for Technical Sciences	[21]
6	University of Pristina, (temporary in Kosovska Mitrovica), Faculty of Technical Sciences	[22]

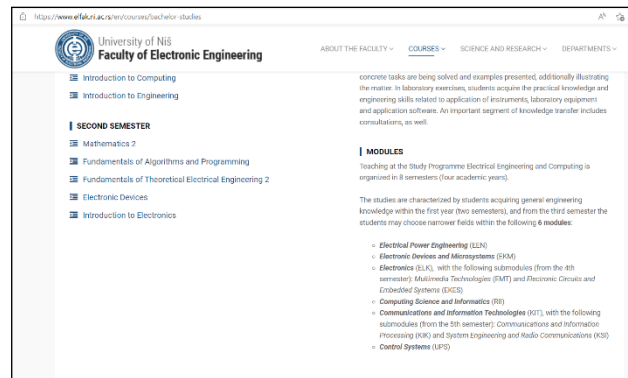
In analysis presented in this paper, both Serbian and English versions of these web portals were analyzed. Examples of web pages from university schools' web portals, that present information about IT-related study programmes are presented at Figures 3-8.



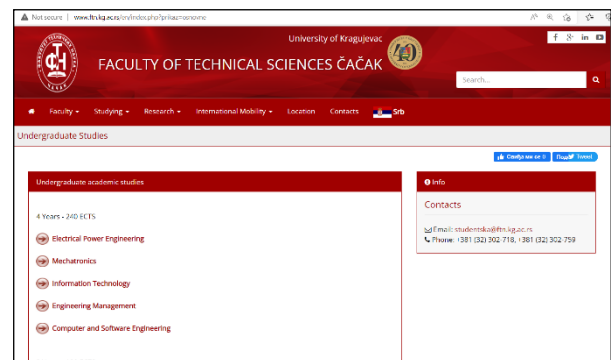
**Figure 3.** IT-related study programmes at [17] (English version page)



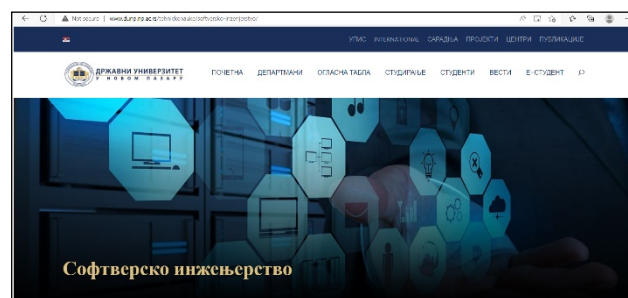
**Figure 4.** IT-related study programmes at [18] (English version page)



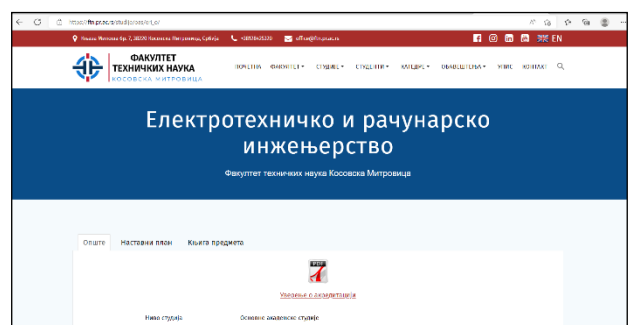
**Figure 5.** Undergraduate study program modules at [19] (English version page)



**Figure 6.** Study programmes including the IT-related at [20] (English version page)



**Figure 7.** Software Engineering Study Programme at [21] (Serbian version page)



**Figure 8.** Study programme in electrotechnical and computer engineering at [22] (Serbian version page)

## 5. RESULTS AND DISCUSSION

Analysis of user-experience design has been performed according to the proposed evaluation model (presented at Figure 2), upon the sample web portals of Serbian state-owned technical

faculties and the results are presented in following tables. First column at each table represents sample item number, while the rest columns are related to particular most important elements and characteristics at sample web portal pages.

**Table 2.** Content accessible from the first page

Sample item No.	News	Management, departments, services offices	Accreditation	Study programmes, enrollment	Scientific conferences, projects, technical solutions and publications	Documents legislation public procurements	Mobility	Stud. organizations	Jobs, Internships
1	GAC	DDM	DDM	SP, E	no	D	yes	no	J, I
2	LA	DH	DH	SP, E	C, Pub	L, PP	yes	yes	J, I
3	PAN	DDM	DDM	SP, E	no	DDM	no	no	no
4	G,UT	DDM	DDM	SP, E	DDM	D, L	no	yes	J, I
5	PAN	DDM	no	SP, E	Pro, Pub	L	yes	yes	no
6	PAN	DDM	DDM	SP, E	no	D, L	no	yes	no

News at first page are at some portals categorized to: general news, announcements and contests (GAC). Sometimes news are prioritized (very important/all news (PAN)) or categorized as latest and archive (LA), while at some portals news are categorized as general (G) and by user types (UT) (students, teaching staff).

Regarding organization of the institution, it has management, services offices and scientific-educational departments and their data are usually accessible via drop down menu items (DDM) or via direct hyperlinks (DH) at first page.

At most web portals, accreditation data and documents are provided within separate pages, not directly from the first page. Study programmes and enrollment data are available at all web portals. Scientific conferences, project, technical solutions and publications are insufficiently present at the first (home) pages. Documents and legislation are mostly reachable from the first pages, while public procurement is directly accessible from only one web portal. Mobility, jobs/internships contests and students' organizations are partially present.

**Table 3.** Functionality

Sample item No.	Online enrollment registration	Enrollment preparation and news registration	Log In joined	Separate student portal	Separate employee portal	Web portal search	Address book	E-mail service
1	yes	yes	No	yes	Yes (E)	no	yes	yes
2	yes	no	No	yes	Yes (TS)	yes	yes	yes
3	yes	no	Yes (FS, S, TS)	no	no	no	no	yes
4	yes	yes	DIR	yes	Yes (E)	yes	Yes (DDM)	no
5	no	no	No	No	No	yes	no	no
6	yes	no	No	No	No	yes	no	yes

FS – future student, S- students TS – teaching staff, E – employee – DIR – joined login form, but with subform for students, DDM – available from drop down menu

Regarding functionality, it could be concluded that most of faculties have online enrollment registration (registration for applying to enroll for the study admission), while only two faculties have enrollment preparation registration online forms. At only one faculty there is joined log-in page for future students, students and teaching staff, while

most faculties have separate log-in forms for students and employees/teaching staff. These separate log-in forms enable entry to separate web portals for students and employees/teaching staff. Web portal search, web email service and address book are available at most portals.

**Table 4.** Interaction and accessibility

Sample item No.	Languages	Hiperlink type	Image slider	User types categorization of content	Accessibility - graphical settings	Accessibility - reading (audio) content	Cookies	User feedback	Mobile version applied
1	S, Ch, E	T, I, Im, A	Au, Ar, P	Sm, Em, Gm	no	no	no	no	yes
2	S, Ch, E	T, I, Im, B	Au, Ar, P, T, H	no	no	no	no	yes	yes
3	Ch, E	T, I, Im, B	Au, B	no	no	no	no	no	yes
4	Ch, E	T, I, Im	Au, Ar, P, T, H	Sn, En, Gn	no	no	yes	no	yes
5	Ch, E	T, I, Im, B	no	No	no	no	no	no	yes
6	Ch, E	T, I, Im, B	Au, B	no	no	no	no	no	yes

Languages: S – Serbian Latin, Ch –Serbian Cyrillic, E-english; Hiperlink types: T-text, I- icon, Im- image, A-area, B - button; Image slider: Au – automated, Ar- arrows, P – progress bar T – text, H – hyperlink, B – button; User categorization: S E G m/n – students/employees/general menu-news;

As for interaction and accessibility, all web portals have English version, as well as Cyrillic Serbian version, while two have also Serbian Latin versions of pages. Hyperlinks are regularly texts, icons and images, while most of web portal use also buttons and only one uses area as a hyperlink (i.e. click on the area invokes animation). All except one web portal have automated image sliders, where most of them have arrows, progress bar, but also buttons, hyperlinks and text above images. Only two web portals have explicit user types'

categorization regarding offered content. None of the web portals offer accessibility adjustments (settings for users to adjust colors, contrasts) or other accessibility options (such as audio content – reading of the web site content). Only one web portal offer using cookies and only one web portal enables users to leave their comments on the usability (user feedback). All web portals have mobile versions, which are automatically adjusted when user screen shrinks or it is loaded at mobile devices.

**Table 5.** Navigation

Sample item No.	Dropdown menu	DDM fixed	Site map	Site map location of page	Separate menus	Multiple menus at first page	Home	On Top icon	Menu at mobile version
1	ST, 2C, SIp	no	no	yes	yes	Left, top (DDM)	icon	no	H, l, C, Op, A, Lo
2	2C, S	no	yes	No	yes	Left, top (DDM), right	icon	No	C, T
3	2C, SIr	yes	no	no	no	top (DDM)	Word	hover	H, r, O, C, A
4	2C, S	no	no	yes	yes	top (DDM), collapsible right	icon	hover	H, r, To, C, A
5	2C, SIr	yes	no	no	yes	top (DDM), right	Word	no	H, r, Op, C, Ro, A
6	2C, SIr	yes	no	no	yes	top (DDM), down (footer)	Word	no	H, r, C, Op, Ro, A

Dropdown menu (DDM): ST – semitransparent, 2C – two colored items, SIp – sub items popup, S – simple (no subitems), SIr – with subitems opened right, Mobile menu: H- hamburger menu, C - collapsible with subitems, r – right position, l – left position, T- top position, To – top position when opened, O – over content, Op – partially over content, Lo – Left position when opened, Ro – right position when opened, A – animated appearance when opened

When navigation is concerned, it could be concluded that half of web portals have dropdown menus fixed, most of them have DDM with sub-menus, which appear right, two of them have simple dropdown menus without sub-menu items. Most of them are two-colored for the items background, while only one applied semi-transparency as well. Only one web portal has site map and only two has site map position displayed at the top of pages that are loaded. Most web portals have separate menus presented out of

dropdown menu – some at left position, some at right and some at footer. Back to home is mostly by word in dropdown menu, while in two cases a house icon is used. Back to top is applied only in two cases, when the icon of an arrow hovers while content is scrolling. Most web portals have right positioned hamburger menus (only one does not have), whose content appear with animation and have items that are collapsible (enabling to open sub-items).

**Table 6.** Interface organization

Sample item No.	Appearance type at first page	Simlicity (minimalist design)	Content columns	Collapsible content	Tabs at first page	Tabs at other pages	Mobile version outline
1	columns	3	3	no	No	no	Sm, Im, 1c
2	columns	4	5	no	No	no	C, Im, 1c
3	image	1	3	no	No	yes	F, Im, 1C, T
4	columns	2	2	yes	yes	no	Im, 1c, 2c
5	image	1	3	no	No	no	Sm, Im, 1c
6	image	1	4	no	No	yes	Im, 1c

Mobile: Sm – separate menus, Im – images, 1c – one column content, C – collapsible, F- fixed baner with menu, T- on top icon

Interface organization could be presented with respect to desktop and mobile version. As for desktop version of web portals, half of web portals have one-image appearance at first page, having the rest of first-page content accessible after scrolling, while other half has column-arranged content of first page, having separate menus, texts and images organized in columns. Three of six web portals have a 3 columns interface organization (as a rule, middle column is broader). Others have 2, 4 and 5 columns organization of content. Only one of portals have collapsible content and three institutions are using tabs to present similar content at first and other pages (categorized by

types of users, types of documents, organizational structure elements etc). According to elements that are present at first page, estimated simplicity (minimalist design level) of web portals are: half (3 od 6) have level 1 (minimalist), while one has level 2, one 3 and one level 4 (the most complex).

As for mobile version outline, most content is presented in a one column style and using both text and images. One institution presents content in 2 columns at non-first page, one has both hamburger as a main menu and also separate menus, one has collapsible content and one has "on top" icon provided.

**Table 7.** Media

Sample item No.	Dominant background color	Back-ground colors of DDM	Font colors	Images color effects	Banner image	Icons	Images	Video	Animation (other than image slider and hamburger menu)
1	white	Yellow, brown	Black, white, orange	Colorized baner	Colorized photo	H, Sp, Ep, We, Ad, Sp, Ep, D, Cal, Con, M, ST, Di, Pw, PP, Pd, Emp	Small, Middle	yes	Dropdown list fade in, dropdown subitems appearance
2	white	Orange, light gray	Black, blue, white	Dark edges of image on mouse move	no	H, La, S, Os, E, N, A, SN	Small, Middle	yes	no
3	white	Light gray	Black, gray, blue, white	Colorized photos	no	L, C, Lo, We, SN	Small, Middle, Large	yes	dropdown item mouse move underline, page loading progress animation
4	white	Red, light gray	White, red, light gray, black	no	Abstract stylized	Sn, S, Lo, H, La, Tn	Small, Middle, Large	yes	Logo, link images in strip, enrollment icon fade in
5	white	Gray	Dark blue, black, orange	Linear gradient of photo with color	No	La, S, SP	Small, middle	no	dropdown item mouse move underline
6	white	Light gray	Black, blue, white, red	Colorized photos with animated gradual lighting fade in	no	L, SN, C, La, SP, Se, St	Small, middle	yes	no

DDM – dropdown menu; Icons: L – location, SN – social networks, C – contact, La- Languages, SP – study programmes, Se – services, St – statistics, S – search, H – home, Lo – login, Tn – types of news, We – web email, Os – organization structure, E – employees, N – news, A – archive, Ad – address book, Sp – students portal, Ep – employee portal, D – documents, Cal – calendar, Con – contests, M – mobility, ST – online teaching service, Di – diploma lists, Pw – public view, PP – public procurements, Pd- public defending of theses, Emp – employment contests

As for the media category, it could be concluded that all web portals have a dominant white as a background color. Gray is mostly used as a background color for dropdown menu items, together with yellow, orange and red. Font colors are mostly black, white, orange, blue and red. Most web portals do not have a banner image, but when it is present, it is stylized abstract or colored photo. Images are mostly adjusted for fast loading and they are mostly small or with middle size, rarely large. Images are processed with colorization, gradient with colors or dynamically changed on mouse move (animated gradual lighting to fade in or change lighting at borders). Icons are minimally used for most common purposes, such as languages, login, search, contact and social networks, while sometimes they are present in the content to illustrate study programmes, organization, statistics etc. Video is present at almost all web portals. Animations are used for special effects with loading pages, dropdown lists, image sliders, appearance of hamburger menu at mobile version, but also for animated logo and important links emphasis with fade in effect (such as enrollment news) etc.

## 6. CONCLUSION

The aim of this paper was to conduct comparative analysis of educational institutions' web portals, with special emphasis on university schools of technical sciences. The sample for this empirical research was chosen to be Serbian faculties of technical sciences that are affiliated to state-owned universities.

Results of this research are twofold. First result is an evaluation model for university schools' web portals, based on categories of user experience design and cumulative approach of extraction of contents, elements and characteristics of analyzed web portals. Second results are analysis data that are obtained according to previously created evaluation model and conclusions that could be drawn regarding the empirical research sample.

It could be concluded that the evaluation model has been successfully created and applied upon the web portals in the sample. Analysis data regarding application of the evaluation model show that most of the analyzed web portals have similar content, functionality and interface design.

Results presented in this paper could be beneficial in two aspects. First aspect is related to the formulated evaluation model for user experience assessment of university schools' web portals. Second aspect is related to the elements and design characteristics that are integrated from multiple sources (different web portals) and could be used in directing future development of new or improving existing education institution web portals.

Limitations of this research are related to: a) the formulation of the evaluation model, which takes certain aspects of user experience design and cumulative approach of extracted elements and characteristics from the sample; it should be based on detailed related work in this area and their results integration and it should take all necessary aspects, elements and characteristic into account; b) sample for application of this empirical research is limited to 6 items, i.e. web portals; there should be a broader sample of more items to be analyzed to draw statistically-valid conclusions; c) in some of particular analysis, only first page was analyzed or randomly selected other pages; detailed analysis of all pages, or most of them, should be conducted in aim to get more precise results; d) web technology change, so this evaluation model is applicable in near period of time; it would be beneficial to make an universal evaluation model, but this way granularity (i.e. preciseness) of the evaluation model will be lost, so appropriate optimization between general setting and preciseness should be accomplished in future evaluation model proposals.

Future work could be directed towards creating evaluation models for university web portals that are based on standards and different approaches and methods of software evaluation. Such models could be applied to larger sample and include university schools web portals from different countries. New web portal evaluation models should consider application area, but also a proper trade-off between general setting and preciseness of elements and their characteristics to be evaluated.

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