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Mobile accessibility expense analysis of the agrarian WWW portal

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Abstract: The article analyses the potential expenditures that would be required in order to make the agrarian web information source (the areas of agriculture, food industry, forestry, water management) accessible from the mobile devices. The following approaches were analysed: creating of the responsive layout for mobile web browsers, creating a native application for the Android platform, and creating three native applications in the cross platform environment for the Android, iOS and Windows Phone. The experimental evaluation was performed using the Agrarian WWW portal AGRIS (www.agris.cz), which is one of the most visited online information source in the Czech Republic for covering the areas of agriculture, regional, and countryside development.

Keywords: agrarian sector, information source, mobile access, mobile device, native application, web application

In the recent history, there was a surge in the number of online information sources and alongside with it, a rapid increase in variety of the access types, client devices and different platforms. The industry is increasingly information based and dependent on the network connectivity with the Internet playing the pivotal role. The digital agenda of the European Strategy 2020 also mentions the importance of a broadband connection infrastructure for both the line and wireless networks (European Commission 2010) in order to increase the end user connectivity speed.

These trends force the web application developers to seek efficient and cost effective ways to enable the access to their information source from as many end user platforms and devices as possible. The three most common approaches are:

– developing a responsive layout,
– developing a native application for each platform,
– developing native applications in the cross platform environment.

Web browsers that are installed by default on most of "smart" mobile devices are usually capable of displaying the web page contents, but without regard to the specific user visual output needs (Sunkara et al. 2014).

Developing individual native applications can increase the costs, work effort and time required drastically (Chang and Oh 2015). However, after dealing with the complex synchronization issues (Miravet et al. 2015), the native application can provide the best comfort and most work effective environment for the end users (Adinugroho et al. 2015). Cross platform applications can potentially reduce the expenses, but also come with serious drawbacks and can only work on the reduced level of abstraction (Heitkotter et al. 2015). In order to create secure a high quality mobile application, it is often necessary to employ engineering principles of software development and use specialized development environments and kits (Alamri and Mustafa 2015), but that can often have a detrimental effect of the resulting native application performance (Acosta and Almeida 2014). Another option is to provide a web application for mobile devices within the software and service scope of cloud computing (Colombo-Mendoza et al. 2014).

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Another important factors, while developing mobile applications, are the demographic and geographic ones (Gurtner et al. 2014), as well as the user experience and habits. The same applies for providing mobile accessibility to already existing information sources and web applications in the agrarian sector (agriculture, food industry, forestry, water managements) and rural development sector.

MATERIAL AND METHODS

The accessibility of web applications for mobile devices is one of the long term scientific endeavours of the Department of Information Technologies at the Czech University of Life Sciences Prague. The possible approaches to providing such access were experimentally evaluated in the case of the Agrarian WWW portal AGRIS. This portal's main purpose is to serve as the integrated web information source for the areas of agriculture, food industry, forestry, water management and rural development. The target user groups of this portal are company managers, the government administration, the local administration, students, food consumers and citizens living in the countryside. The main benefit of the portal is its convenient accessibility and the presented information utilization.

Between 2010 and 2011, the current version of the agrarian portal web application was developed and launched. It was created according to modern trends as highly flexible and robust web application

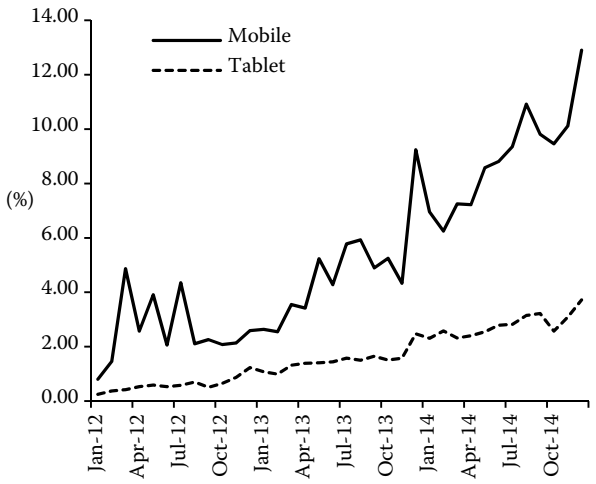

Figure 1. Progression of the mobile device access to the Agrarian WWW portal AGRIS

Source: Google Analytics

to be used primarily by the PC users. For the identification, sorting, management and distribution, each hosted article has associated metadata in the DC format (Dublin Core) and the VOA3R Metadata AP format (Virtual Open Access Agriculture and the Aquaculture Repository Metadata Application Profile), which was developed specifically for the agriculture data (Šimek et al. 2013).

The increase in mobile device usage when accessing information sources can be traced to the agrarian sector using the Agrarian WWW portal AGRIS access statistics (Figure 1). While in January 2012 the portion of the mobile access was around 1%, in December of the same year it was almost 4% and in January 2014 it was over 9%.

Following the trend of the increased mobile device usage, the contents of the Agrarian WWW portal AGRIS were made accessible from such devices during the years 2014 and 2015. Due to the lack uniform field specific approach for the agrarian sector, the entire process of providing access was divided into three parts which were then analysed and evaluated. Those were:

– developing responsive design for mobile device web browsers,
– developing native application for the Android platform,
– developing native applications in the cross platform environment for iOS, Android and Windows Phone 8 platforms.

The results of the responsive design development were further elaborated in the article "Cross-Platform User Interface of a Web Application in Agrarian Sector" (Šimek et al. 2014a). The possibilities of hybrid applications are introduced in the article "Mobile Access to Information in the Agrarian Sector" (Šimek et al. 2014b). The development of the native application is depicted and evaluated in "Mobile accessibility of information sources in the areas of agriculture, forestry, water management, food industry and rural development", which was presented in the paper at the conference Agrarian Perspectives 2015.

The occupation of personnel for developing various parts of the accessibility features for the Agrarian WWW portal AGRIS was overlapping, but for the purposes of the economic evaluation, the roles of employees were temporarily separated (Figure 2). All the work was done by academic employees, technicians and students as a part of scientific research at the Department of Information Technologies at the Faculty of Economics and Management of the CULS

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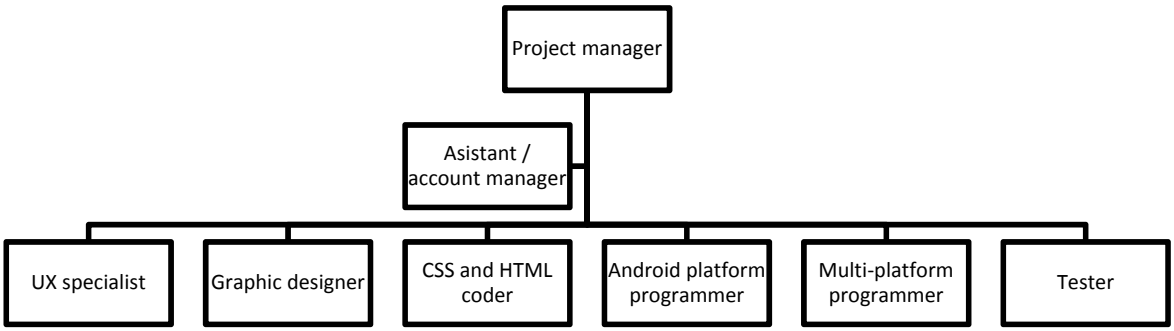

Figure 2. Organizational structure of the involved personnel

Source: Author

Prague (Czech University of Life Sciences). For the approximation of economic expenses, the average salary in the field taken from the Czech Statistical Office was used. In order to calculate the actual costs for a non-scientific employer, the mandatory 34% tax would have to be added (figures shown in Tables 1–3 are without the tax).

RESULTS AND DISCUSSION

All three parts of the mobile device access of the agrarian WWW portal AGRIS were one by one realized, utilizing the knowledge of the portal usage by the end users. The responsive design was developed using the MediaQueries technology in the CSS3 (Cascading Style Sheets 3), which allows an adaptable display of output depending on the end user device parameters. The following is taken into account:

– web browser of the device,
– size and resolution of the device display
– device orientation (portrait vs. landscape).

During the final steps of the development, the tools and technologies such as the BootStrap, jQuery Mobile, the CSS pre-processor Sass, the Kickstrap and the YUI were used. The result brings an optimal layout of the control features and the information content for the end user and allows for easy and quick modification by the developer in the future.

The total extent of the process was estimated at 432 man-hours among all the team members. In reality, the process was completed in 333 hours. This makes this approach the fastest and the cheapest of all three. All used tools and technologies are free and do not require any purchases, therefore the expenses are only for the workforce. The expenses shown in Table 1 do not include those for the personnel responsible for the extensive UX testing (only the main tester and UX specialist are included).

The responsive layout of the Agrarian WWW portal AGRIS was deployed in mid-2014 and helped to propagate the trend of the increasing mobile device access using web browser (Figure 3). It proved to be an effective extension of the already existing web application. The downside is that the end users need to be connected to the Internet all the time in order to be able to use the portal.

The development of the Agrarian WWW portal AGRIS native application for the Android platform was more complicated. It was designed to allow for an easy

Table 1. The responsive layout development personnel work hour distribution

Position	Average monthly salary (CZK)	Planned		Real	
		hours	result (CZK)	hours	result (CZK)
Project manager	47 821.00	64	19 128.40	54	16 139.59
Assistant	16 804.00	64	6 721.60	55	5 776.38
UX Specialist	47 821.00	64	19 128.40	41	12 254.13
Graphic designer	47 821.00	16	4 782.10	13	3 885.46
CSS and HTML coder	47 821.00	192	57 385.20	134	40 050.09
Tester	47 821.00	32	9 564.20	36	10 759.73
Total		432	116 709.90	333	88 865.36

Source: Author and CSO (2015)

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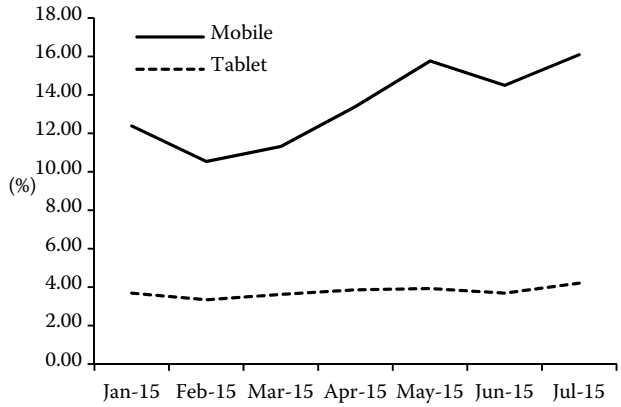

Figure 3. Mobile device access to the Agrarian WWW portal AGRIS - mid-2015

Source: Google Analytics

use and to be visually similar to the web responsive design. The requirements for the application followed the guidelines of security, functionality, reliability, quality, usability, maintainability and transferability (Vaníček 2000; 2006). The most emphasis was then given to functionality, because the application had to provide the desired services for the end users.

The native application was developed in the Android Studio, which is based on the IntelliJ IDEA and is the official IDE (Integrated Development Environment) for developing applications within the Android platform. It was designed for the Android 4.0 Ice Cream Sandwich and higher versions and it is optimized based on the mobile device type (smartphone vs. tablet) and its display size, resolution and orientation (portrait vs. landscape).

The projected hourly input from all workers was 592 hours total across the team, but it actually took only 449 hours (Table 2). The used tools and technologies were free of charge. Therefore, only the expenses for personnel (excluding the extended circle of testers) and the application maintenance were necessary. Additional costs included the process of uploading the application to the Google Play in order to make it easily available for the public.

The main advantages of the Android platform specific application are its speed and ability to be operated in the offline mode, where the application downloads all current content from the portal server and does not require the Internet connection from that point. The next actualization and synchronization will be done upon reconnecting to the Internet or on the user request. The content is only downloaded in the text format, so the requirements for the connection speed and download capacity are low, therefore even the GPRS is sufficient, which is available alongside the mobile signal.

The hardest to put into place were the native applications for the Android, iOS and Windows Phone 8 in cross platform environment. The development itself was performed in the Xamarin environment for all the applications which were then exported to their respective platforms, but most of time and effort were taken by the testing and optimization that followed.

Overall, it was planned that it would require 832 work hours to complete this task, but in reality, it took more than 900 hours. Alongside the expenses for personnel (Table 3; only main tester and UX specialist included, not additional testers), there were the costs associated with obtaining the Xamarin development environment which cost 999 USD (Xamarin 2015) per year, and the MS Visual Studio which cost 1286.65 EUR (Visual Studio 2015). Higher monetary and time expenses can be also expected when maintaining the resulting applications and keeping them updated (Xanthopoulos and Xinogalos 2013; Miravet et al. 2014; Chang and Oh 2015).

Thanks to optimization, the platform specific applications are usually very fast, but they are commonly plagued with problems in the implementation pro-

Table 2. Work hour distribution for the development of the Android native application

Position	Average monthly salary (CZK)	Planned		Real	
		hours	result (CZK)	hours	result (CZK)
Project manager	47 821.00	96	28 692.60	75	22 416.09
Assistant	16 804.00	96	10 082.40	75	7 876.88
UX Specialist	47 821.00	96	28 692.60	58	17 335.11
Graphic designer	47 821.00	16	4 782.10	15	4 483.22
Android platform programmer	47 821.00	192	57 385.20	158	47 223.24
Tester	47 821.00	96	28 692.60	68	20 323.93
Total		592	158 327.50	449	119 658.46

Source: Author and CSO (2015)

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Table 3. Work hour distribution for the development of multiplatform applications (Android, iOS, Windows Phone 8)

Position	Average monthly salary (CZK)	Planned		Real	
		hours	result (CZK)	hours	result (CZK)
Project manager	47 821.00	144	43 038.90	142	42 441.14
Assistant	16 804.00	144	15 123.60	140	14 703.50
UX Specialist	47 821.00	96	28 692.60	101	30 187.01
Graphic designer	47 821.00	16	4 782.10	28	8 368.68
Multi-platform programmer	47 821.00	288	86 077.80	322	96 239.76
Tester	47 821.00	144	43 038.90	186	55 591.91
Total		832	220 753.90	919	247 531.99

Source: Author and CSO (2015)

cess (Miravet et al. 2014). One of the approaches of developing native applications in the cross platform environment involves using the shared code base, but that cannot be done in every situation and scenario (Klima and Selinger 2013). The results of experimental evaluations conclude that in the agrarian sector, the cross platform tools are suitable for the deployment in order to provide accessibility to the web information source (Figure 4). This was also confirmed in the article "Mobile Applications for Agricultural Online Portals – Cross-platform or Native Development" (Masner et al. 2015). The responsive output of the web application content can become costly when the variety of mobile device web browsers and user habits for each platform are taken into consideration. The web access, unlike native applications, is also usually full of compromises (Harrington et al. 2013).

CONCLUSION

In 2014 and 2015, three approaches to providing mobile accessibility to the web information source in the agrarian sector were experimentally implemented and economically and technically evaluated. Those were:

– developing the responsive design for mobile device web browsers,
– developing the native application for the Android platform,
– developing native applications in the cross platform environment for the iOS, Android and Windows Phone 8 platforms.

All the work was executed by experienced members of the Department of Information Technologies realization team at the Faculty of Economics and Management of the CULS Prague. The team consisted of the following members: a project manager, an assistant/account manager, a graphic designer, a UX specialist, a HTML a CSS coder, two android platform programmer, two multi-platform programmer and a main tester.

The process of providing the mobile device accessibility to the web information source was economically evaluated. Firstly, a qualified estimate of the hourly distribution was made. During the implementation, each member carefully recorded the actual spent time into a timesheet. For the financial evaluation,

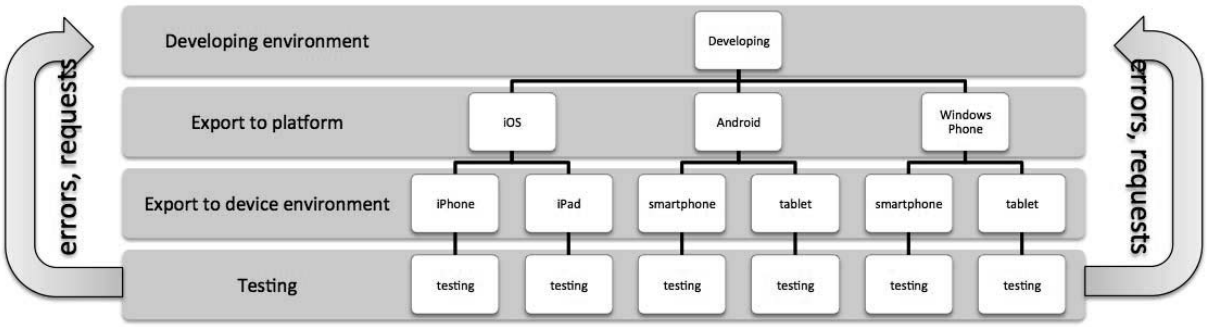

Figure 4. The process of development and testing of the multiplatform application

Source: Author

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the average salaries of employees in the field were used (provided from the Czech Statistical Office). The resulting expenses do not include the potential 34% tax that a non-scientific organisation would have to pay for their employees. The projected expenses also did not include the costs for the extensive UX testing (10 users), maintenance costs and the expenses for the used hardware and software.

The implementation of the web application responsive design for the Agrarian WWW portal AGRIS was projected to take 432 working hours, but actually it took only 333 hours. This approach was the fastest, cheapest and also not dependent on the end user mobile platform. Downsides of this approach are the necessity for the constant Internet connection and also the possible issues with old web browsers.

The native application for the Android platform was estimated 592 hours to make. The actual time investment was 449 man-hours. The resulting application is very fast and highly optimized for both smartphones and tablets. It allows for the offline usage via the system of actualization and synchronization. Additional costs for this method include publishing the application in the Google Play.

The last approach is developing the application in the Xamarin environment and then exporting it onto three target mobile platforms. This was the most complex and also expensive of the three methods. The real work took 919 hours (while only 832 were estimated). This was due to the complicated testing and debugging for each platform. However, still this approach is almost three times faster and less expensive than developing the application for each platform separately. Additional costs of this approach include payments for the software licenses (for instance the Xamarin) and costs for publishing in each individual application store (Google Play, App Store, Windows Phone store etc.).

It is necessary to take the end user group and its needs into account when implementing the mobile access for an information source. Another important thing is securing the appropriate workforce for the task. If a subject does not employ the proper workers already, it is unfeasible to hire an entire team just for this task alone. Therefore, it is most efficient to hire the employees for a short time from a specialized agency or to outsource the whole project to a company that already has the required employees. The responsive layout provides accessibility for all mobile users regardless their platform. This can be followed by either the multiplatform application development or the specialized native application for the selected platforms based on the analysis of user preferences. To determine the user needs and habits, a qualified survey has to be held, or in some cases, the analysis of information from the web analytics such as the Google Analytics is sufficient.

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REFERENCES

Acosta A., Almeida F. (2014): Android (TM) development and performance analysis. Journal of Supercomputing, 70: 649–659.

Adinugroho T.Y., Reina, Gautama J.B. (2015): Review of multi-platform mobile application development using WebView: Learning management system on mobile platform. Procedia Computer Science, 59: 291–297.

Alamri H.S., Mustafa B.A. (2015): Software engineering challenges in multi platform mobile application development. Advanced Science Letters, 20: 2115–2118.

Chang Y., Oh S. (2015): A study on the development of one source multi use cross-platform based on zero coding. Multimedia Tools and Applications, 74: 2219–2235.

Colombo-Mendoza L.O., Alor-Hernandez G., Rodriguez-Gonzalez A., Valencia-Garcia R. (2014): MobiCloUP!: a PaaS for cloud services-based mobile applications. Automated Software Engineering, 21: 391–437.

Český statistický úřad (2015): Zaměstnanci a průměrné hrubé měsíční mzdy podle odvětví CZ-NACE. Available at https://vdb2.czso.cz/vdbvo2/faces/cs/index.jsf?page=statistiky&filtr=G%7EF_M%7EF_Z%7EF_R%7EF_P%7E_S%7E_null_null_&katalog=30852

European Commission (2010): A Digital Agenda for Europe (DAE). Available at http://ec.europa.eu/digital-agenda/digital-agenda-europe

Gurtner S., Reinhardt R., Soyez K. (2014): Designing mobile business applications for different age groups. Technological Forecasting and Social Change, 88: 177–188.

Heitkotter H., Kuchen H., Majchrzak T.A. (2015): Extending a model-driven cross-platform development approach for business apps. Science of Computer Programming, 97: 31–36.

doi: 10.17221/313/2015-AGRICECON

Harington N., Zhuang Y., Yazir Y.O., Baldwin J., Coady Y., Ganti S. (2013): Beyond user interfaces in mobile accessibility: Not just skin deep. In: 14th IEEE Pacific Rim Conference on Communications, Computers, and Signal Processing, Rome, Aug 27–29, 2013: 322–329.

Klima P., Selinger S. (2013): Towards platform independence of mobile applications metamorphosing android applications for the web. Lecture Notes in Computer Science, 8112 LNCS: 442–449.

Masner J., Šime, P., Jarolíme, J., Hrbe I. (2015): Mobile Applications for agricultural online portals – cross-platform or native development. Agris on-line Papers in Economics and Informatics, 7: 47–54.

Miravet P., Marin I., Ortin F., Rodriguez, J. (2014): Framework for the declarative implementation of native mobile applications. IET Software, 8: 19–32.

Sunkara S., Tetali R., Bose J. (2014): Responsive, adaptive and user personalized rendering on mobile browsers. In: 2014 International Conference on Advances in Computing, Communications and Informatics, ICACCI 2014, Delhi, India, Sep. 24–27, 2014: 259–265.

Šimek P., Jarolímek J., Masner, J. (2014a): Cross-platform user interface of a web application in agrarian sector. Agris on-line Papers in Economics and Informatics, 6: 155–160.

Šimek P., Stočes M., Vaněk J. (2014b): Mobile access to information in the agrarian sector. Agris on-line Papers in Economics and Informatics, 6: 89–96.

Šimek P., Vaněk J., Jarolímek J., Stočes M., Vogeltanzová T. (2013): Using metadata formats and AGROVOC thesaurus for data description in the agrarian sector. Plant, Soil and Environment, 59: 378–384.

Vaníček J. (2000): Měření a hodnocení jakosti Informačních systémů. ČZU PEF Praha in CREDIT Praha, Prague.

Vaníček J. (2006): Software and Data Quality. Agriculture Economics – Czech, 52: 138–146.

Visual Studio (2015): Koupit předplatné Visual Studia a MSDN. Available at https://www.visualstudio.com/cs-cz/products/how-to-buy-vs.aspx

Xamarin (2015): Pricing. Available at https://store.xamarin.com/

Xanthopoulos S., Xinogalos S. (2013): A comparative analysis of cross-platform development approaches for mobile applications. In: Proceedings of the 6th Balkan Conference in Informatics, Thessaloniki, Sept 19–21, 2013: 213–220.

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