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# Mobile Applications for Agricultural Online Portals – Cross-platform or Native Development

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## Anotace

K vývoji aplikací pro mobilní zařízení existuje několik možných přístupů. Článek se zabývá možnostmi vývoje nativních aplikací pro mobilní zařízení. Analyzuje základní ekonomické aspekty pro dva přístupy - vývoj nativních aplikací pomocí nástrojů pro jednotlivé platformy (Windows Phone, Android, iOS) a vývoj nativních aplikací pomocí multiplatformních nástrojů, který představuje nástroj Xamarin. V článku jsou definovány základní proměnné a vzorec pro výpočet nákladů. Závěry ukazují, že použití multiplatformního nástroje Xamarin může přinést výraznou úsporu. Je však nutný další výzkum především v oblasti složitosti vývoje multiplatformními nástroji a splnění požadavků na UI a UX..

## Klíčová slova

Mobilní zařízení, aplikace, Android, iOS, Windows Phone, Xamarin, náklady.

## Abstract

There exist several possible approaches to the development of mobile applications. The paper treats the options of native applications for mobile devices. It analyzes economic aspects of two approaches - native applications development with the help of tools for individual platforms (Windows Phone, Android, iOS) and native applications developed by cross-platform tools represented by the tool Xamarin. In the paper basic variables and a formula for costs calculation are defined. The conclusions show that the utilization of the cross-platform tool Xamarin can lead to significant costs reduction. However, further research is needed mainly in the area of both the complexity development by cross-platform tools and meeting the requirements on UI and UX.

## Key words

Mobile devices, applications, Android, iOS, Windows Phone, Xamarin, expense.

## Introduction

Our contemporary society has been characterized not only by a permanently growing number of information sources but also by an access to these sources from various client devices and platforms. An enormous growth has been recorded especially in the area of single-purpose or multi-purpose mobile devices. There exists an inexhaustible number of mobile devices using several platforms from which users connect to the server sources of information. Sales of smart phones have been higher than those of classic notebooks even though a slight decline of growth in 2015 has been proposed (Gartner, 2014).

Owing to the development of mobile devices and mobile and wireless access to the Internet, the number of accesses not only to web portals with the use of mobile devices has been rising. The situation seems to be the same in the area of agriculture, forestry, water supply and distribution, countryside, food industry etc. There exist several approaches how to make this access simpler for users. The first approach is the optimization of web pages with the utilization of responsive design with the help of module media queries in CSS3 (Nebeling 2013). The second approach means the creation of own applications for these devices. In the market with the mobile operational systems there exist three most

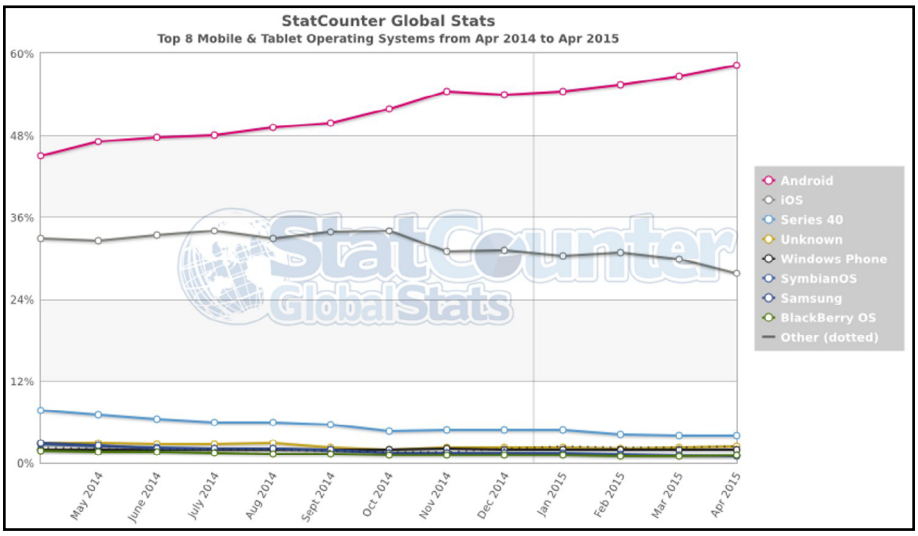
widespread platforms - Google Android, Apple iOS a Microsoft Windows Phone. The statistics of accesses to web pages can be seen in Figure 1. You can see here Series 40 item, too. That primarily belongs to older devices Nokia with the operational system Symbian S40. These devices have already been in decline and this operational system is no longer developed or supported.

There exist three types of approaches to the development of own applications for mobile devices - native applications development, hybrid applications development, native applications developed by cross-platform tools. In the case of a Native mobile application there is the need of development for each platform separately - using various tools and technologies including the creation of updates. The orientation of native applications to concrete platforms puts serious obstacles in the path of the utilization of different development environments, technologies and API which inevitably leads to waste of time and effort including higher expenditure on maintenance (Xanthopoulos and Xinogalos, 2013). The advantages of hybrid applications lie in the fast development, fast updates and relatively easy extension of application. The opposite could be a non-optimum result in terms of UI (User Interface) and UX (User eXperience). According to Amatya (2013) this approach is the best one for the development of cross-platform applications. Nevertheless, another approach has recently appeared - native applications developed by cross-platform tools. This approach combines advantages of the previous two approaches. The most powerful representative in this area is the tool Xamarin. Its disadvantage is the higher price of licenses for development tools. According to Seung-Ho (2015) there are two key factors in the development of mobile applications – one is a user interface design, and the other one is an efficient utilization of device capabilities such as various sensors, cameras, network interfaces. Both these factors are met by this tool in the same way as native applications.

One of the most frequently visited information sources of the agrarian sector in the Czech Republic is the agrarian WWW portal Agris. The main aim of the agrarian WWW portal Agris is to create a unified on-line information space on the Internet for the area of the agrarian sector (agriculture, food industry, forestry, water supply and distribution) and rural areas. The task group of users consists of enterprises' managers, managers from state and local administration, students, all consumers of food and inhabitants of rural areas.

The area of the agrarian sector and portal task groups brings a number of special characteristics and requirements for these applications.

- Possibility to store articles offline
  - In rural areas in the Czech Republic there occur problems with the cover by mobile networks, especially data services and their quality
- Simplicity and intuitiveness of the application
  - It should comply with well-tried standards for the respective platform
  - Hybrid applications don't meet this requirement




Source: http://statcounter.com

Figure 1: Mobile operating systems statistics.

- Adequate demands on the mobile device performance
- The use of similar applications is expected in the sector where wages and salaries are on a lower level. There we can expect the use of older and less efficient devices.
- The assumption of limited funds for the development of the application is closely connected with the previous point

Within the framework of research projects at the Department of Information Technologies (Faculty of Economics and Management, Czech University of Life Sciences Prague) several applications for the agrarian portal have been developed: a web mobile application, a native application with the help of cross-platform tool Xamarin and simultaneously an application for OS Android with the use of native development tool Android Studio.

The aim is the analysis of possibilities of native applications (for mobile devices) development. Basic economic aspects for two different approaches have been analyzed: a) the development by means of native development tools for an individual platform (Windows Phone, Android, iOS) and b) the cross-platform tool Xamarin. The analysis should provide an answer to the basic hypothesis whether it is economically favourable to develop applications with the help of this tool or not.

## Materials and methods

In the case of native mobile applications there is the need of development for each platform separately - using various tools and technologies including the creation of updates. With the increasing number of platforms the length of needed time grows, too; and so do the costs of mobile applications' generation and maintenance. Nevertheless, there is the advantage of an optimum result in the form of stable and fast mobile applications with a possibility to work off-line. To utilize these advantages, tools for the development of native applications by means of cross-platform tools are being created (for all the platforms at the same time).

### Android

The operational system Android is the most open platform. The native development proceeds in the JAVA language and development environment (IDE) Android Studio which is based on IntelliJ IDEA. Nevertheless, the resulting applications do not use JAVA Virtual Machine, but an own solution in the shape of Dalvik, or from Android 5.0 ART (Android Open Source Project, 2015).

From the point of view of costs, the developmet for this platform only requests the payment for the developer account amounting to $25 (Android Developers 2 2015). This is a lump sum and thereafter it is possible to publish an unrestricted number of applications.

### iOS

For the development of applications for this platform the IDE Xcode is used. For the programming itself languages Objective C and Swift are utilized (Apple 2015). For a completely functional development, and for the application testing in particular, it is necessary to build applications on Apple devices (Macbook, iMac, etc.). The license for the developer account is subject to a fee amounting to $99 annually. Development tools are provided free of charge.

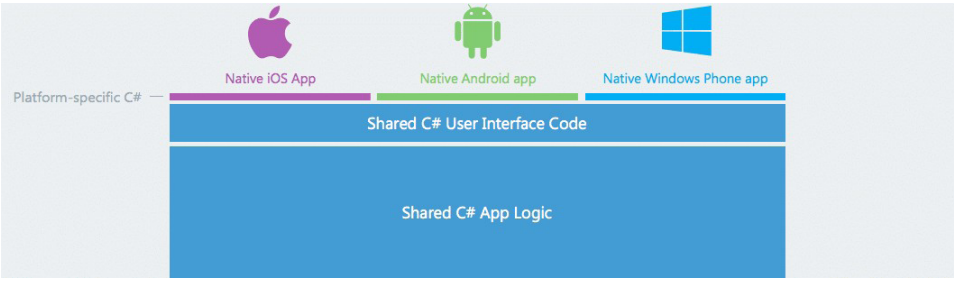
### Windows Phone

For the development of applications for the operational system Windows Phone (Windows 10 in the future) development environment (IDE) Visual Studio is used. This environment exists in several variations. The development is possible in variations such as Community, too. And these variations are free of charge. The development itself proceeds under the platform of the framework .NET (it is possible to use languages C# or Visual Basic) (Microsoft 2015).

From the point of view of costs, it is again necessary to pay a lump sum for the developer account. Here Microsoft offers two rates. The Individual account variation (for individuals or small unincorporated groups) costs $19. The Company account variation (for businesses, mobile operators or OEM) the fee amounts to $99 (Windows dev center 2015). The latter provides authors and developers with more opportunities.

### Xamarin

Xamarin is a set of tools for a cross-platform development. It facilitates the developing of native applications which share the same code across platforms (Xamarin 2015). The situation is shown in Figure 2. Applications thus do not have the disadvantages of hybrid applications in the form of nonstandard user interface. As a development tool it is possible to use special Xamarin Studio or Microsoft Visual Studio (for some licenses only). The development then proceeds with the help of programming language C#.




Source: http://xamarin.com/platform

Figure 2: The chart of the shared code for applications developed with the help of the Xamarin tool.

This tool also facilitates - in contrast to hybrid applications – an access to nearly all native API individual platforms. Xamarin (2015) writes bluntly: „Xamarin apps have access to the full spectrum of functionality exposed by the underlying platform and device, including platform-specific capabilities like iBeacons and Android Fragments." Thus it is possible to use all functions of mobile devices such as cameras, sensors, print readers etc.

From the point of view of costs, Xamarin already requests payments for licenses and offers four basic variations. In principle, all licenses are bound to one developer, platform and year. The payment is needed for iOS and Android, but Windows platform is free of charge. More detailed price list is shown in Figure 3.

Variations of licenses differ in opportunities which they provide to developers.

1. Starter Edition
   - 1.1. The development with the help of Xamarin Studio
   - 1.2. Free of charge, for small applications, development testing, deployed only to devices only
2. Indie
   - 2.1. The development with the help of Xamarin Studio
   - 2.2. Designed for individual developers or companies with up to 5 developers
3. Business, Enterprise
   - 3.1. The opportunity to use MS Visual Studio
   - 3.2. For companies with more than 5 developers
   - 3.3. Business features and other opportunities such as e-mail support, tuition, etc.

## Costs of development

Costs spent on the development of applications for individual platforms belong to key criteria as to the determination which approach to the development to choose. Total costs include several items. Above all, it concerns the price of programmers' / developers' work. Furthermore, it is necessary to include the payment for the license of the development tool and price for publications. Native development tools for individual platforms are provided free of charge. With the cross-platform tool Xamarin there is the need to pay for the license. Prices are calculated per a developer and a platform for which it is possible to develop, with the exception of Windows Phone which is always free of charge. For individual developers the price is $538.2 for all the platforms. In the case of applications development it is necessary to calculate with a license for organizations which amounts to $1,798.20 for all the platforms. On top of that, there is the need to include the fees connected with publishing in respective application shops. Total costs are shown in Table 1.

For publishing in the Google Play shop a lump sum of $25 is paid. Such a lump sum must be paid in the case of Microsoft Store, too. Nevertheless, price policy here is divided into individual accounts and accounts for organizations. In the case of the iOS platform the payment for a developer account amounts to $99 annually.

Furthermore, there is the need to include personal costs for developers, e.g. their wages or salaries. In the case of the development for individual platforms it is necessary to allow for three developers, or for one developer only, but with triple time needed for the development. From the point of view of the costs calculation, it is the same. In the case of cross-platform development it is not possible to divide the time simply by three. It is necessary to take into consideration individual

Source: http://xamarin.com/platform

Figure 2: The chart of the shared code for applications developed with the help of the Xamarin tool.

| | Xamarin Individual | Xamarin Organisation | Native Development | Native Dev. (Individual) |
|---|---|---|---|---|
| **IDE** | $538.2 per year | $1798.2 per year | 0 | 0 |
| **Google Play** | $25 once | $25 once | $25 once | $25 once |
| **iOS Appstore** | $99 per year | $99 per year | $99 per year | $99 per year |
| **Microsoft Store** | $19 | $99 | $19 | $99 |
| | once | once | once | once |
| **Total $** | **681.2** | **2021.2** | **138** | **223** |

Source: own processing

Table 1: Expenses for application stores and IDE licenses.

adjustments for individual platforms.

Overall, it is possible to set several key variables for the calculation of total costs.

**ide** - Price for development tools (IDE). This variable can be taken into consideration only with the development tool Xamarin where there is the need to pay for the license.

**google, apple, ms** - Prices for publications of applications in respective application shops (Google Play, Apple Appstore, Microsoft Store). This price is paid for a development account which can publish an unrestricted number of applications.

**gAppN, aAppN, mAppN** - Numbers of applications published in individual shops among which it is necessary to divide the costs for a development account.

**devE** - Monthly costs for one developer.

**devL** - The length of application development in months.

**devN** - Key factors are the number of developers and the length of development.

## Results and discussion

In previous chapters there have been indicated analyses of possible native applications development for mobile devices. Based on established cost items, key variables have been set. Thus it was possible to put together a formula for the general calculation of total costs for the development of an application.

$$Total\ costs = \left(ide \times devN + \frac{google}{gAppN} + \frac{apple}{aAppN} + \frac{ms}{mAppN}\right) \times \frac{devL}{12} + devE \times devN \times devL$$

For a model calculation a beginning company (Startup) was considered. The given application will be developed by one developer in the case of the tool Xamarin utilization. For native development environment three developers will be considered. The length of the development was set at 6 months for the utilization of the Xamarin tool, 4 months for a native development. Calculation values can be seen on Table 2.

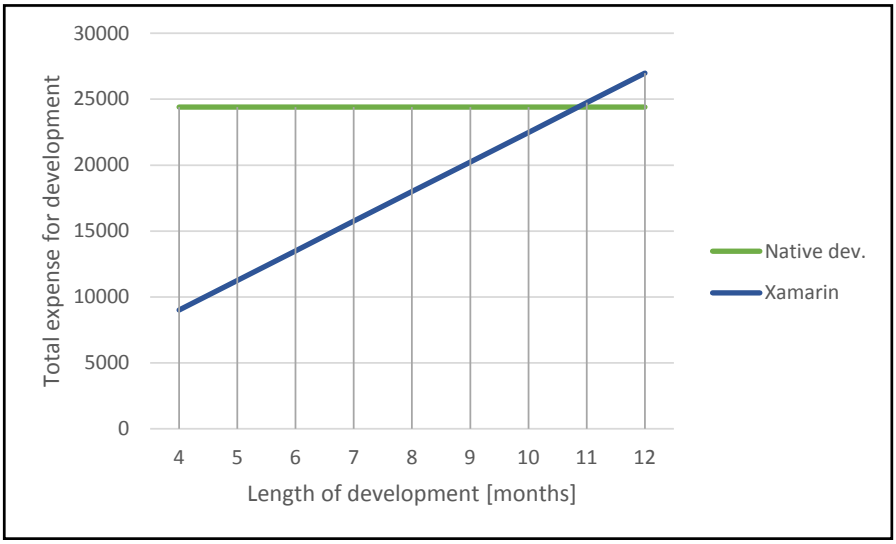
From the calculations it is clear that the key factors are the length of the development and the number of developers. For the development by means of native tools it is necessary to employ 3 developers, especially because of time demand. When choosing the approach to application development, the most important factor is the length of application development and thus the complexity of the development with the use of the cross-platform tool Xamarin.

Based on the above stated formula, it is possible to deduce the requirements of the development

| | Xamarin Individual | Xamarin Organisation | Native Development | Native Dev. (Organisation) |
|---|---|---|---|---|
| **IDE + Publication** | 340.6 | 1010.6 | 46 | 74.33333333 |
| **Developer per month** | 2000 | 2000 | 2000 | 2000 |
| **N° of developers** | 1 | 1 | 3 | 3 |
| **Length of dev.** | 6 | 6 | 4 | 4 |
| **Developers exp.** | 12000 | 12000 | 24000 | 24000 |
| **Total** | **12340.6** | **13010.6** | **24046** | **24074.33333** |

Source: own processing

Table 2: Total expenses for development.




Source: own processing

Graph 1: Native and Xamarin development comparison.

and the critical value when it is worthwhile to use cross-platform development environment Xamarin. First, the costs per one month of development with the use of formula XX were calculated. Variables set up in the previous chapter were used. To simplify the calculation, costs for development account Google Play and Microsoft Store were removed. These are lump sums and from the previous formula it follows that their influence is not that big.

$$Monthly\ costs = apple + devN \times ide + devN \times devE$$

After the substitution into the formula, monthly costs for native development amount to $6,099. For the tool Xamarin they amount to $2,248.85. From these data we can define the complexity coefficient of mobile applications development, which is in this case 2.71. If the native development lasts 4 months, the multiplatform development must not last longer than 10.84 months. This relation is presented in Graph 1.

## Conclusion

The paper primarily treats the economic aspects of the choice of approach to the development of a native application for mobile devices. The given formula for the calculation of costs for development can be utilized in general. From the formula it is clear that the key factor is the time demand - the length of application development. Fixed costs for development environment and applications publication are - from the long-term point of view - less important. As assumed, the highest cost items are developers' salaries.

The performed analysis for the setting of exact economic indicators should be more detailed. However, it is sufficient for the purpose of our basic aim and research questions. It shows that the cross-platform development of native applications with the help of the tool Xamarin could significantly reduce costs and thus increase profit.

For the subsequent research it is possible to formulate some conclusions and solutions.

There is the need to set up the complexity coefficient of applications development with the use of the Xamarin tool. To maintain cost effectiveness, this coefficient should not be higher than 2.7. From the existing research it seems to be substantially lower. In the subsequent research it is necessary to set up this coefficient. Even though this requirement is unfeasible on general level, it seems to be feasible for the purpose of specific types of applications (for example for news portals such as Agris.cz).

It is also necessary to assess if the application created with the help of the Xamarin tool meets the requirements on user interface, especially in the area of applicability and User Experience (UX) of the respective platform. Possible adaptation could lead to a disproportionate increase of the complexity coefficient. This tool enables the creation of user interface natively for each platform separately. However, a question arises whether this approach is useful or not.

A more detailed analysis and the creation of relevant economic or econometric modules could help with setting the limits of cost effectiveness in key aspects (the length of development, complexity coefficient, number of developers, costs per a developer).

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## References

[1] Account type. Windows Dev Center. 2015, [Online] Available: https://appdev.microsoft.com/StorePortals/en-US/Account/Signup/SelectAccountType [Accessed: 11 March 2015].

[2] Amatya, S., Kurti, A. Cross-Platform Mobile Development: Challenges and Opportunities. Advances in Intelligent Systems and Computing. 2013, Vol. 231, p. 219-229. ISSN 2194-5357. [Online] Available also: http://link.springer.com/10.1007/978-3-319-01466-1_21 [Accessed: 16 May 2015].

[3] Android Developers. Android Studio Overview. 2015, [Online] Available: http://developer.android.com/tools/studio/index.html [Accessed: 11 May 2015].

[4] Android Developers. Get Started with Publishing 2015, [Online] Available: http://developer.android.com/distribute/googleplay/start.html [Accessed: 10 May 2015].

[5] Android Open Source Project. ART and Dalvik 2015, [Online] Available: http://source.android.com/devices/tech/dalvik/index.html [Accessed: 10 May 2015].

[6] APPLE. Developer. 2015, [Online] Available: https://developer.apple.com/ [Accessed: 28 May 2015]

[7] Gartner Says Sales of Tablets Will Represent Less Than 10 Percent of All Devices in 2014. Gartner. 2014, [Online]. Available: http://www.gartner.com/newsroom/id/2875017 [Accessed: 25 May 2015].

[8] LIM, Seung-Ho. Experimental Comparison of Hybrid and Native Applications for Mobile Systems. International Journal of Multimedia and Ubiquitous Engineering. 2015, Vol. 10, No. 3, p: 1 - 12. DOI: 10.14257/ijmue.2015.10.3.01.

[9] MICROSOFT. Windows Dev Center. 2015, [Online] Available: https://dev.windows.com/en-us/home. [Accessed: 11 May 2015].

[10] Nebeling, M., Norrie, M. C. Responsive Design and Development: Methods, Technologies and Current Issues. p. 510. DOI: 10.1007/978-3-642-39200-9_47. [Online] Available also: http://link.springer.com/10.1007/978-3-642-39200-9_47. [Accessed: 15 May 2015].

[11] XAMARIN INC. Xamarin Platform: BUILD BETTER APPS. 2015, [Online]. Available: http://xamarin.com. [Accessed: 11 May 2015].

[12] Xanthopoulos, S., Xinogalos, S. A comparative analysis of cross-platform development approaches for mobile applications. Published in Proceedings of the 6th Balkan Conference in Informatics. 2013, p. 213 - 220. ISBN 978-145031851-8.