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A.A. Mirolubov, Ju.A.S. Mäkiö

MOBILE TECHNOLOGY IN SUPPORTING E-BUSINESS – CHANCES AND CHALLENGES

А.А. Миролюбов, Ю.А.С. Мякио

МОБИЛЬНЫЕ ТЕХНОЛОГИИ ДЛЯ ПОДДЕРЖКИ ЭЛЕКТРОННОГО БИЗНЕСА – ВОЗМОЖНОСТИ И ВЫЗОВЫ

Paper discusses the chances and challenges of contemporary e-business mobilization process. Mobile applications are characterized as an applications running in various mobile devices. In the business context, mobile applications usually have an over Internet into back-office systems. Because of the lack of the computing power and slow wireless connections, the calculations of the presented data is done on the back-end and the presentation is done on the mobile device. Paper explains that correct choice of mobile apps is a promising approach to improve the efficiency of business processes and to reduce operative expenses in organizations.

MOBILE TECHNOLOGY. E-BUSINES. MOBILE CUSTOMER APPLICATIONS. MOBILE BUSINESS APPLICATIONS. FRONT-END DEVICES. COMPUTATION POWER. PORTABILITY

Обсуждаются возможности и вызовы современного процесса мобилизации в электронном бизнесе. Мобильные приложения представляют собой программные приложения функционирующие в различных мобильных устройствах. В контексте современного бизнеса, мобильные приложения, соединяются через Интернет с традиционными бэк-офисными приложениями. Однако вследствие ограничений по вычислительной мощности и низкой скорости беспроводной связи, все необходимые расчеты с данными выполняются на сервере и представляются на мобильном устройстве. В статье показано, что правильный выбор мобильных приложений является условием повышения эффективности бизнес-процессов и сокращения оперативных затрат в условиях организации.

МОБИЛЬНЫЕ ТЕХНОЛОГИИ. ЭЛЕКТРОННЫЙ БИЗНЕС. МОБИЛЬНЫЕ ПРИЛОЖЕНИЯ ПОЛЬЗОВАТЕЛЬСКОГО КЛАССА. МОБИЛЬНЫЕ ПРИЛОЖЕНИЯ ДЛЯ БИЗНЕСА. УСТРОЙСТВА КОНЕЧНОГО ПОЛЬЗОВАНИЯ. ВЫЧИСЛИТЕЛЬНАЯ МОЩНОСТЬ. ПОРТАТИВНОСТЬ.

Introduction. In recent years the development of mobile communication technologies and devices have improved and dramatically changed the way people communicate in private and in the business. The new mobile technology based possibilities of communication have opened new ways to exchange information at anytime and anywhere. Especially this can be seen in the business where knowledge and information are understood increasingly as production factors enabling the sink of process costs and the improvement of business processes. A real-time access into the knowledge and information are preconditions for improved processes and for more efficient use of the work schedule.

The possibility to communicate by means of electronic communication devices, causes the development of new or improvement of existing technologies and vice versa. At the same time to the improvement of the technical possibilities, companies are facing the challenges of their useful application in all fields of the everyday business. The use of mobile phones is not anymore limited to the communication and interaction between peoples. E-mail, SMS and instant messaging have become a standard communication medium. The recent improvements of mobile communication devices and communication technologies have enabled the mobilization of classical IT systems in business. The number of remote and mobile working employees is increasing as they more and more work remotely or they are required to be accessible outside of the office times.

The globalization of the business is understood as one of the deciding factors a corporation needs to utilize to survive in the market. The changes caused and enabled by the mobile technology may improve the efficiency of the whole economy. From a single company the question is not anymore, whether they should utilize mobile technology in their business but for which purposes and where the mobile technology shall be utilized.

Not with standing technical possibilities of the mobile technology, its limitations narrow its application area. Therefore, companies are facing the question of the profitable use of the mobile technology in their everyday business. New changes are raising new challenges. The meaningful and beneficial use of mobile technology requires careful analysis and realistic planning considering all its drawbacks, limits on the one hand and possibilities on the other hand.

This work focuses the chances and challenges of the use of mobile technologies in business. In the following sections the mobile technology and identify some typical characteristics and challenges are discussed. After that a closer insight into the e-Business in respect of mobilization is delivered. Additionally some critical factors for the use of mobile application in business are presented and discussed. By means of two examples the mobilization benefits of e-Business are demonstrated.

Mobile technology

Faster access to information is today in the business more important than ever before. Founded decisions may be made only based on valid and up-to-date information. The place where the information is saved does not play a role. The quality of the information and the accessibility are more important. The information access is enabled by a front-end device.

Fig. 1 depicts the development of communication devices since 1960s till today. The considered period of time is subdivided into three generations. For each generation the technology development, enterprise demand, vendor response, and features are considered. During the first period the technology developed was based on the voiceonly mobile-communication. This technology was because of high costs and missing infrastructure not wide spread. For the enterprises the technology was not yet secure and enough and the performance was too low. At the end of this era the first digital cellular phone was published. The second generation from 1990s-2000s was based on the use of the cellular phones and its new features in the communication. Communication devices in this generation supported already e-mail and calendaring functions and possessed already some



Fig. 1. Development of communication devices according to [1]

implemented security standards. The 3rd generation beginning at the end of the first decade of 2000 brought a novel application centric phones with integrated touch screen and camera, high performance processors and large memory. The 3rd generation devices are the precondition for the mobile business.

The number and diversity of various front-end devices that are used in e-Business applications is continuously increasing. To be applied to the e-Business, the use of various front-end devices should be profitable and the devices should fulfill the various needs of business, like adaptability and usability in business processes as well as various user habits. The fulfillment of various kinds of needs requires the knowledge about the challenges and their solutions as well as about the mobile devices and their limitations.

First we present various typical front-end devices and discuss their properties. After that we are given a closer look into the similarities and common characteristics of e-Business applications and compare the fulfillment of the needs of e-Business application by front-end devices. After that we will consider challenges from the hardware, software, and organizational points of views. We are focusing on mobile devices and on solutions for specific problems arising from the use of mobile devices in e-Business.

Mobile devices may be classified in multiple ways, for example by purpose of use, by used technique or supported technologies, or by user interfaces. In this work front-end devices are classified by the device class.

The class laptop

Laptop computers, also known as notebooks, are portable computers that you can take with you and use in different environments. They include a screen, keyboard, and a track pad or trackball, which serves as the mouse. As laptops are meant to be used on the go, they have a battery allowing them to operate up to 12 h without being plugged into a power outlet. Laptops also include a power adapter that allows them to use power from an outlet and recharges the battery. Because of the portability of laptop computers, the hardware components used in laptops are designed to use less electric power than those in PCs. Laptops are more expensive than PCs with an equivalent computational power. Laptops are capable to access wireless into a network and onto the Internet via WLAN or UMTS.

The most significant difference between a PC and laptop is the smaller screen size of laptops and lower resolution. Laptop computers are further classified according to the screen size. Subnotebook are laptops with screen size between 11»and 15». Netbooks are laptops with screen size smaller than 12». The borders between these subclasses are not exact.

The class mobile phone

A mobile phone is first of all a telephone that may be used location-independently. Beyond the telephone functionality, modern mobile phones have additional features such like MP3-player, camera, SMS and MMS messaging. A shorten keyboard, «T9» – text on nine keys, is used for textual input, i. e. One and the same key is used to input multiple characters. The computation and graphic power of mobile phones is low and the use of the Internet is limited. The screen diagonal is only a couple of cm long and the screen has a low resolution. For example, the resolution of Nokia E52 is 240px x 320px, whereby it is one of the highest resolutions in its class.

The class smart phone

A smart phone combines a mobile phone with a PDA (Personal Digital Assistant). A smart phone provides a number of various functionalities. A smart phone has in most cases a multipoint-touch screen and a virtual keyboard. Commonly a smart phone has a screen that is usually nearby as large as the device itself. In most smart phones there are only one or few physical buttons. The computational power of smart phones is larger than in mobile phones. Typically, modern smart phones have a high resolution display up to 768x1280 pixel and screen size up to 4.5 inches. The functionality of a Smartphone can easily be widened by so called mobile apps that are software applications designed to run on smart phones, tablet computers and other mobile devices.

The class tablet computer

A tablet computer (or tablet) is a small computer similar to laptop designed primarily for the mobile use. Tablets are operated by touch screen whereby the user's finger functions as a mouse and cursor. Tablets use a lightly modified operation system versions like Windows or Linux. Additional hardware, like keyboard, and the Internet connection may be adapted via wireless connection. Tab. 1 sums up the various front-end devices discussed above. The classification is done according to the device type.

Challenges and solutions with hardware

This section deals with the challenges bounded with the hardware of front-end devices as well as with their solutions.

The first challenge is the different screen sizes of front-end devices. Screen sizes vary between 3.5" of smart phones to 14-15" in laptop PCs to over 20» in desktop PCs. Consequently, the characteristics of the various front-end devices must be taken into account during the design of the user interface. Additionally, the usability of the application has to be carefully designed because of differences of front-end devices.

As an example, Fig. 2 illustrates the screenshot of the Lufthansa portal. The site is optimized for mobile devices. However, the mobile version is limited to the most essential functionalities. The scroll function is restricted to the horizontal direction and supports them visually through the half visible «Miles & More» button. Even more significant is the difference between a desktop PC a mobile phone, because of the display size of only 1.5–4.5 inches diagonal. It is therefore necessary to adjust the screen content for the device. The limitation of the screen size is difficult to correct for devices using the traditional technology. Current research work is done on roll able displays. These displays may improve the difficulties of today. A further approach is to integrate a small projector into a mobile device. The projection can be done onto any ground and functions analog to a touch screen. For example, the current time may be projected onto the hand of the user. By using a projection as a screen would eliminate the limitations given by the screen size.

In order to support users, it is important to adapt the monitor content on the devices. For web pages and web portals the adaption may be done by using special style sheets. However, it is important to note whether a Web view of 1:1 is needed for the mobile device. In complex cases it may be better to write special Apps (small applications for mobile devices), because by doing so all functionalities of the mobile device may be used. The drawback in apps is the heterogeneity and missing compatibility of various mobile platforms. In some cases code generators and cross-compilers may be used for the development of apps. For example, the cross-compiler developed by the Cross-Compiling Project XML VM generates from the byte code of an Android-App iOS-App (Objective-C). (Java) an Additionally, the XML VM supports .NET, Ruby and Java script. The support for further languages is planned.

Table 1

Device type /	Screen-	Computation-	Network-	Data input	Talk	Internal
Challenge	diagonal, inch	power, GHz	function	Data Input	time, h	memory, Gb
Mobile phone	ca. 2.4	< 0.6	GSM	Keyboard (T9)	6-8	≤ 16
			UMTS			
			WLAN			
Smart phone	3-4.5	> 0.5	GSM	Qwerty keyboard,	6-14	32
_			UMTS	virtual keyboard		
			WLAN			
Tablet	7-10, 11-15	1, 2×1.4	WLAN	Qwerty-keyboard,	10-16,	64, 120
(Slate,	-		UMTS	virtual keyboard	2-6	
Convertible)			GSM			
,			LAN			
Netbook	10-12	1.2	LAN	Qwerty-keyboard	2-11	160
			WLAN			
			GSM			
			UMTS			
Laptop	13-18	2×2 GHz	LAN	Qwerty-keyboard	1.5-9	250
			WLAN			
			GSM			
			UMTS			

Classification of mobile devices



Fig. 2. Adaption of the Lufthansa portal for mobile devices

Another possibility is the slicing – tree based web page transformation. In the first step, only a thumbnail of the web page is displayed. This thumbnail is linked to various fields. The thumbnail is used to navigate through the content page displayed which is processed in a tree structure. The advantage here is that no zooming or scrolling is necessary. The drawback is that this mechanism requires an additional proxy server to perform the processing of the Web sites.

A further challenge is the not uniform and relatively low computing power of mobile devices. Therefore, computationally intensive applications on mobile devices are currently not practicable. This could be improved by virtualization of applications. In the case of virtualization calculations would not run on the device that is used for the data presentation only. The computation is parameterized by the mobile device. The calculation results will be shown on the screen of the mobile device.

The differences in the performance of the underlying network may hinder the broad use of mobile solutions it the business. In Tab. 1, the transfer speeds are listed. The mobile providers in Germany support almost everywhere the slower GSM standard, GPRS and EDGE. A transmission rate of up to 236.8 kBit/s downstream (from the network to the mobile device) is possible. UMTS and HSPA (High Speed Packet Access, Update for UMTS) is mostly available in urban areas and offers transfer rates of up to 14.4 Mbit/s HSPA (Release 6). Without HSPA release 6 only 384 kBit / s transfer rate is possible. There are other UMTS

Table 2

	GSM	GPRS	EDGE	UMTS	HSPA Rel. 5&6
Transmission	Leitungs-	Packet-	Packet oriented	Packet oriented	Packet oriented
method	vermittelnd	oriented			
Transmission rate	9.6 kBit/s	171.2 kBit/s	Downlink: 236.8 kBit/s	Downlink: 384 kBit/s	HSDPA: 3.6 MBit/s
(Theoretical)			Uplink: 118.4 kBit/s	Uplink: 64 kBit/s	HSUPA: 1.44 MBit/s
Transmission rate	~9 kBit/S	~40 kBit/s	Downlink: ~170 kBit/s	Downlink: 360 kBit/s	
(in the practice)			Uplink: ~95 kBit/s		
Always-On	No	Yes	Yes	Yes	Yes
Availability	Since 1992	Since 1999	Since 2006	Since 2004	Since 2007

Comparison: transmission rates

releases providing even higher rates. However, the providers have refrained, as it requires large investments in infrastructure, and a successor to UMTS is already known. The successor of the UMTS is the LTE (Long Term Evolution). LTE enables transfer rates up to 1 GBit/s. This speed is theoretical because, depending on the WLAN standard, IEEE-transmission speeds of 2 MBit/s to 100 MBit/s for mobile devices are currently possible. Because of the in the practice significantly lower transfer rate it is important to know in advance how much data is transmitted and whether this is possible with the underlying infrastructure.

Challenges and solutions with Software

In respect of the software, the highest relevance is in the appearance of Web pages in different browsers and devices. The challenge may be met already by desktop PCs or laptops when presenting one and the same site in different browsers. The problem here is that the browser, the HTML tags represents different. Even more difficult is it if the Flash or JavaScript is disabled in the browser but they are used on a web site. Here it is difficult to find a solution. One way is to define corporate wide guidelines. The aim of the HTML5 standard is to ease this problem. This standard is currently in development by the W3C and is expected in 2012. Currently the browser vendors are trying to implement the new standard. By HTML5 in combination with CSS 3, interactive Web applications are created that are very similar to a native application. The HTML5 standard will likely ease the creation of cross-platform websites.

Another challenge is the portability of applications and platforms. The adoption of applications for other platforms is on the current state of the technic in most cases challenging. One approach here is the so called multi-channel development focusing the diversity of end devices. Multi-channel development is based on an extensive middleware that substitutes real devices and thus limits the use of device specific functions. Therefore the platform optimizations for typical user experience are not focused. An alternative is Mobile AJAX (Asynchronous JavaScript and XML). AJAX allows the reduction of the transferred amount of data to the mobile device. The advantage of AJAX is that not the entire page must be reloaded, but that individual side parts are updated asynchronously. However, the AJAX engine requires more processing power, so battery life is claimed. The Xfce-engine is a lightweight alternative to mobile AJAX with some functional limitations for example, regarding the selection of tags. The Xfce-engine requires fewer resources and is accordingly well suited for mobile devices.

Organizational Challenges & Solutions

The use of private devices makes it difficult to get an overview of devices that are used in an organization. The devices differ in terms of security and the application area. In some cases the use of private devices may be allowed. However, for security reasons the use of private devices may also be forbidden. Thus, a company should clearly define which devices are for what purpose supported. For example, the e-mail functionality for private devices may be allowed. Because of the high costs, the technical support would be available for few device types only. Equally important question is what happens in case of loss or theft of a device. For this case mechanisms to delete the data in the device remotely should be enabled. As the number of different devices is large and the capability of a company to support many different kinds of devices is limited, it is essential for a company to establish clear rules on what devices are supported and how to proceed with the devices.



Fig. 3. Relationships of the requirements

Fig. 3 sums up challenges related to front-end devices are placed directly in a relationship.

From the business perspective it is important to define policies and rules for the selection of front-end devices that are supported. The most promising approach to solute the challenges seem to be the HTML5 standard, as it stresses the adoption of web applications to multiple platforms and covers a wide range of functions necessary for e-business applications.

E-Business Applications

E-Business is the integrated application of information and communication technologies (ICT) in support of all the activities of business and execution of automatized business processes of a company. This means that any software program that is used in a company for the process execution having interfaces for data exchange is an e-Business application.

Initially, all e-Business applications provide in most cases some kind of graphical user interface (GUI). Typically the GUI contains control elements (input fields, buttons, check boxes, ...) allowing the application control. Also interfaces between applications are possible. These interfaces are configurable and in one or in other way controllable by the user. Typically e-Business applications allow and enable a data and information exchange (reading and writing). The following section discusses the use of mobile devices in e-Business.

Business applications

Business applications are mobile applications used in the business context and which are developed for smart phones. The programming of business apps may be a challenging task because of the very specific mobile environment where they are supposed to be used. Thus, the specific situation has to be taken into account, when designing and developing of business apps.

According to Julian Von der Neyen [2], mobile applications may be subdivided into two categories. The first category consists of so- called «Mobile Customer Applications» (MCA) focusing the communication and interaction between a company and its clients using mobile devices. MCAs are used in order to improve the communication by personalization and by delivering the required information faster to the customer. The second category, called «Mobile Enterprise (Business) Applications» (MBA), focuses the simplification of company's internal

Increasing need of mobility	High dynamic of the market						
Flexible organizations need mobile employees Shorter processing times becomes as a critical success factor The use of private devices require a novel approach for mobile devices The consolidation of the IT leads to standardized solutions	The computing power and the functionality of mobile end devices are increasing by sinking costs «Battle» of platforms at the system level and focus on the services and applications Increasing qualityand reliability of mobile networks by lower operational costs Cloud Computing opens chances for new offers						
New Generation of mobile solutions							

Fig. 4. Driving factors of Enterprise Mobility according to [3]

business processes. MBAs improve business processes for example by providing employees an access to the data from anywhere at any time. MBAs may thus make the execution of business processes more efficient and increase the productivity of the employees.

As business apps are per definition used in the business context, they have to be capable to support existing business processes. Therefore, the application of mobile apps means total or partial mobilization of business processes requiring occasionally their redesign and reorganization. Simultaneously the environment for their meaningful application needs to be created. This in turn leads to investments for a working mobile ecosystem that supports the mobilization of business processes. On the one hand business apps are the precondition for the mobilization of business processes and for an effective use of production resources. On the other hand business processes need to be modeled and defined in such a way that they may be implemented for mobile devices.

As business apps are used in mobile devices, their limitations and possibilities have to be carefully taken into account during the planning and implementation. Depending on the used mobile device, the main limitations are given by the limited screen size of the mobile device, the low network capacity, the reduced computing power compared with typical personal computers, and limited memory resources of the mobile devices. Never the less, the pros of mobile apps are often bigger than their cons or the challenges that are coupled with them. Having an Internet connection, they enable the supply of just in time personalized information for employees independently of the localization, time or other physical restrictions. For instance, outdoor stuff, when making an on-site visit by a customer, may get from anywhere and anytime an access to the relevant information.

Criteria for the Integration and Use of Business Apps

Mobile apps are used basically in order to increase the efficiency of business processes. The business process is defined as «a specific ordering of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs» [4]. Work activities are carried out by «business process actors» that are employees, customers, or systems.

It is note worthy that not every business process and not every business environment may be successfully supported by mobile devices. The success depends on multiple factors that are to be considered and taken into account when planning the application of mobile apps in the business. Facing the question about a successful and economically meaningful application of business apps, turns to the question about the suitability of the process, of the business environment, and of the employees involved. A company considering and planning the application of mobile apps to support their business processes shall consider the critical criteria for their integration and use in business.

For the successful implementation of business apps (i.e. mobilization of business processes) depends on the environment where they are planned to be implemented. The environment consists of factors like information technology (IT), organization, and stakeholders.

Prior to the mobilization of business processes, the organization shall investigate the currently used IT in respect of data security, range and availability of the wireless connections, mobile end devices, and their capability of being planned integrated into the or existing infrastructure. Besides the infrastructure also the variety of supported mobile devices shall be first analyzed and defined. As in the market there are a number of different kinds of mobile devices available that are not compatible with each other and possible not compatible with the existing IT environment, the organization shall determine the types of various kinds of mobile devices that will be supported by the environment. To minimize operating costs, the number of various systems shall be kept as small as possible. The lack of standards and the rapidly developing mobile technology complicate the planning at the technical level. At the business level the dynamic nature of the telecommunications market makes the business mobilization difficult [5].

If the organization is not prepared for the introduction of mobile apps, the introduction will most probably be not successful. Especially the top management shall know where and for what reason mobile apps are introduced in the company. Thus, for the introduction of mobile business in an organization the participation of the top management is one of the critical factors. Bearing this in mind Basole states that «leadership needs to ensure that the mobile strategy fits their way of doing business rather than changing their ways of doing business to fit the strategy» [6].

The most significant factor for the mobilization of business processes are their mobilization abilities. The mobilization abilities may be determined by process characteristics. If a process may be executed independently from the time, location, or some fixed context, it has a high potential to be mobilized.

The benefits of the mobilization may be considered from several points of views, as stated by [7]. According to the authors «the benefits of mobile technology are related to the opportunity costs of not being able to coordinate during the time when actors are difficult to locate». Business processes are a lot of about coordinating single tasks in order to reach some result. For the coordination various mechanisms and systems are available. The advantage of the mobile technology compared with an alternative one may be measured by comparing the benefits of the mobile technology with an alternative technology.

Examples for Use of Mobile Applications

This section presents shortly two case studies about the use of Mobile apps. The first case study is about the use of a mobile app in the after-sales service of one big German company in automotive industry (case A). The second case study presents the use of mobile apps in an ordering system for computer industry (case B). Case B is still under development. Thus in that case only the first results are presented.

The goals of the case A were many folds. The company wanted to make a feasibility study about the development and usage of mobile apps. From the technical point of view the goal was to compare different development approaches and platforms in order to define companywide guidelines for the development of hybrid mobile apps for three different end platforms: iPhone, Blackberry and Android. Hybrid mobile apps are combinations of native code and usual web code, like HTML. From the business point of view the major goal was to study the usability and the benefits of mobile apps in the after sales.

During the case study could be demonstrated that the use of mobile apps could increase the productivity in the after sales about 20 % – 30 %. The app allowed the employees to access directly to back office systems of the company. This allow them to read and write in the real time the data relative to the case they were working on. The paper work could be eliminated totally. Thus, the failure rate caused by the transfer from paper slides to the IT system disappeared. The client's satisfaction degree could be increased significantly after the introduction of the system. The clients could get informed about their case in the real time. So they got the feeling that somebody really takes care of them. No need for the staff education in the usage of the app was reported. This is because of the intuitive usability of the application and because the application basically had the same functionality as the traditional application on their working place.

In the future, it is planned to provide an access also for the clients so that they get

informed about their case remotely. Therefore the IT environment needs to be analyzed more in detail respective security and bandwidth. In the first step the access will be given to a group of preselected clients. Based on the collected experiences, the application may be widened for entire clients.

In the case **B** a company (let call it **C**) selling costly IT products to business clients enlarges its selling software with mobile components. The clients should get an access for mobile devices. Additionally the C wants to widen the functionality of the selling software by an authorization process component that checks the maximum available budget of the purchasing agent. Prior to the mobile introduction of the solution. the authorization process takes approximately 37 hours. This is caused by the timely double checking that is implemented in the process that takes 19.5 hours. For security reasons the authorization has a validity of a short time. Because of expired authorization C loosed orders that could have taken place if the process had been faster. The new mobilized solution shall additionally enhance to the satisfaction degree of the clients by delivering them a possibility any time and any place to follow the state of their orders.

Prior to the development of the mobile app, the business case was analyzed, benchmarks to measure to change have been developed, and both functional and non-functional requirements of the app ware collected.

Approximately the average value of each order in the considered time period of one year was 1136.65 Euro. The total value of the orders was over 16254 orders more than 18 mln. Euro. About 6 % of the total number of orders was processed through the authorization process, total cost was about 1 mln. Euro. As a rule an order will be cancelled, when will not be responded within 96 hours. During the considered period of time more than 600 orders with a total value of almost 700.000 Euro were cancelled.

After the implementation and first experiences from the practice the results seem to be promising. The processing time of the orders could significantly be shortened. As the testing phase is not yet ended, it is too early to say, in which amount the order cancellation rate is reduced.

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MIROLUBOV, Andrei A. – Saint-Petersburg State Polytechnical University. 195251, Politekhnicheskaya str. 29. St. Petersburg. Russia. E-mail: amirolubov@yandex.ru

МИРОЛЮБОВ Андрей Анатольевич — доцент кафедры международного бизнеса Инженерно-экономического института Санкт-Петербургского государственного политехнического университета, кандидат экономических наук.

195251, Россия, Санкт-Петербург, ул. Политехническая, д. 29. E-mail: amirolubov@yandex.ru

MAKIO, Juho A.S. – Emden Leer University of Applied Science. 26723, Constantiaplatz. 4. Emden. Germany. E-mail: juarsa@web.de

МЯКИО Юхо Арви Сантери – профессор Университета Прикладных наук Эмден Лир, доктор наук (информатика).

26723, Германия, Эмден, Константияплац, д. 4. E-mail: juarsa@web.de