A Research Agenda for Mobile Systems Evaluation

Tamara Högler
CyberForum e.V., Haid-und-Neu-Str. 18, 76131 Karlsruhe, Germany

Keywords: Research Agenda, Mobile Systems, Evaluation, Information and Communication Systems.

Abstract: The present work shows the necessity of an economic evaluation model that is based on singularities of mobile systems and that takes into account the interdependencies of their individual components. A motivation for this approach is not only given by the continuing discussion on the economic efficiency of mobile systems, but also by the fact that appropriate methodologies for comprehensive evaluation still do not exist. Starting point for a research agenda is the definition of the term mobile system, followed by the explanation of the single components and singularities of such systems. The findings of the present work motivate the development of a generic model for economic evaluation. By defining the research agenda we provide guidance for constructing such a model.

1 INTRODUCTION

For nearly three decades, the debate about the cost-effectiveness of information and communication systems (ICS) is consistently resurrected. In the late 80´s Solow stated, that the effects of computers can be seen everywhere – except in the productivity statistics (Solow, 1987). Also Loveman had no doubt that “IT capital had little, if any, marginal impact on output or labor productivity, whereas all the other inputs into production -including non-IT capital – had significant positive impact on out-put and labor productivity” (Loveman, 1994). The current state of scientific knowledge though presents opposite results: The productivity paradox does not exist in praxis – it is caused by the lack of appropriate methodologies for the economic analysis of ICS (see e.g. Brynjolfsson, Hitt and S. Yang, 2002).

Information and communication technologies (ICT) are often implemented in order to conduct businesses as efficient as possible; the quantitatively definable monetary effects are considered the most important objectives when implementing such a system. For the economic evaluation mostly methodologies are applied that focus exactly on these effects. This approach may easily fudge the results due to the fact that the full benefits of the technologies are insufficiently reflected – and thus leads to the assumption that a productivity paradox exists.

Literature study shows that there is still a lack of appropriate evaluation methodologies (see e.g. Högler, 2012; Ashurst, Doherty and Peppard 2008). Especially integrative and qualitative effects of the systems are mostly not considered in the calculation (Pietsch, 1999) – one of the main benefits of ICS. This is even more important for mobile systems that represent a special "mobile" form of ICS. It can be assumed that mobile systems face the same difficulties concerning the economic evaluation as stationary ICS. Additionally they are affected by challenges that result from the fact that mobile technologies are mostly used during “mobile actions” like travelling or walking. Literature on the effectiveness of mobile systems is scarce; therefore, in this position paper, we explore the domain of mobile systems from an evaluation angle.

The term “mobile system” is defined in section 2, and section 3 describes the single components of such systems. The unique singularities of mobile systems are elaborated in section 4. Section 5 will outline economic evaluation of mobile systems based on their singularities and main characteristics; for this we define a number of research questions. We finish our paper with conclusions.

2 HOW TO DEFINE MOBILE SYSTEMS

Although often used synonymously in the literature,

Högler T..
A Research Agenda for Mobile Systems Evaluation.
DOI: 10.5220/0004972504540459
In *Proceedings of the 16th International Conference on Enterprise Information Systems* (ICEIS-2014), pages 454-459
ISBN: 978-989-758-028-4

this work strictly distinguishes between ICT and ICS. Starting point for the elaboration of a definition is systems theory, an approach that focuses on entities and that postulates that the system itself comes into existence by the *relationships* among the system elements and the resulting interactions. This approach was chosen due to the fact that for an economical evaluation based on singularities of mobile systems the relationship of entities or components respectively is of key importance. The analysis of structures, reactions and functions of the entities allows certain predictions about the expected system behaviour, whereas it does not focus on a separate consideration of each element (see also Boulding, 1956 and Bertalanffy, 1976).

Having the above given considerations in mind, it becomes clear that in contrast to ICT, the term ICS has to include also system-elements of human nature (human beings) besides technologies that support information exchange and communication (so called "technical components") and thus take into account the relationships between the single components, properties as well as their behaviour (so called system parameters).

System parameters are variables, whose values characterize the behaviour of the system with a given structure (DIN, 1995). Since the behaviour of a system and therefore its cost-effectiveness are influenced by their interaction or controlling of system parameters, they play an important role for the evaluation of mobile systems. System parameters with the largest influence on a system are characterized in the present work as "success factors". The term success factor is used in the literature to characterize the cause of success. (Corsten, 2000) defines success factors as "[...] factors that have a significant impact on the potential success of a strategic business area. While on the one hand it is emphasized that the individual factors [....] depend on the industrial sector in which the company operates, on the other hand a hypothesis is supported that there are so-called basic factors [....], that matter for the success or failure over all industries, i.e. it is assumed that the structure of the factors´ system is relatively constant, while the weighting of the individual factors is subjected to frequent changes". In dependence on (Rockart, 1979) and relating mobile systems, the current work defines critical success factors as technical as well as human system parameters that have a significant impact on the economics of the mobile system.

Relationships between the single components are represented by the processes that take place between them whereas the structure and organization of the ICS symbolize the characteristics of the elements. When reflecting on the given definition of the term ICS it becomes clear, that the human component is of key importance when discussing the profitability of ICS. Users are involved in all processes, they are using the technical components and determine the success factors for the (economic) efficiency of the whole system.

Within this research work, mobile systems are chosen as subject of investigation. Mobile systems can be regarded as ICS that are extended by mobile aspects. They exist in different forms and have a multiplicity of characteristics, aiming at integrating people, mobile processes and workstations into internal, mostly stationary corporate and enterprise-wide process chains and thus to overcome their spatial separation and accompanying information losses.

Basing on the general systems theory and following the above given socio-technical definition of the term ICS, the present work defines a mobile system *as a set of mobile technology and human (system) elements, which are inherently related* (see also the discussion of (Goos and Zimmermann, 2005) concerning the term system). They form an entity due to their interactions that is task-related and that executes corresponding business processes. Mobile systems, as a unit, distinguish themselves in this respect from the surrounding environment by the relations between their components and the effects that take place between the single components. In the following sections the components as well as the singularities of a mobile system are discussed.

3 COMPONENTS OF MOBILE SYSTEMS

A mobile system consists of two types of components: Technical and non-technical components. The distinction of the components is important because the economy of mobile business processes is not only affected by technical, but particularly by the human system components (users).

Technical components comprise mobile hardware (e.g. Smartphones and Tablets), appropriate applications as well as mobile operating systems and middleware (if necessary). They include also wireless communication technologies like LTE, UMTS and WLAN (see figure 1). The particular potential of mobile technologies lies primarily in the possibility of reorganizing processes and thus in the exhaustion of the value added that is facilitated by mobile technologies. Especially mobile ICT contributes to the efficient support of processes by bridging spatial and temporal distances (Schiller, 2000). Figure 1 shows technical as well as non-technical components of mobile systems. Security issues play an important role for mobile processes and thus can influence significantly the economic efficiency of such systems. The importance of security in the field of wireless and Internet-based systems is a key research topic of the project Be Wiser – Building Enterprises: Wireless and Internet Security in European Regions, funded by the European Commission under the 7th Framework Programme (project reference FP7-REGIONS-2012-2013-1). It is expected that main findings of this project will be included in the authors further research.

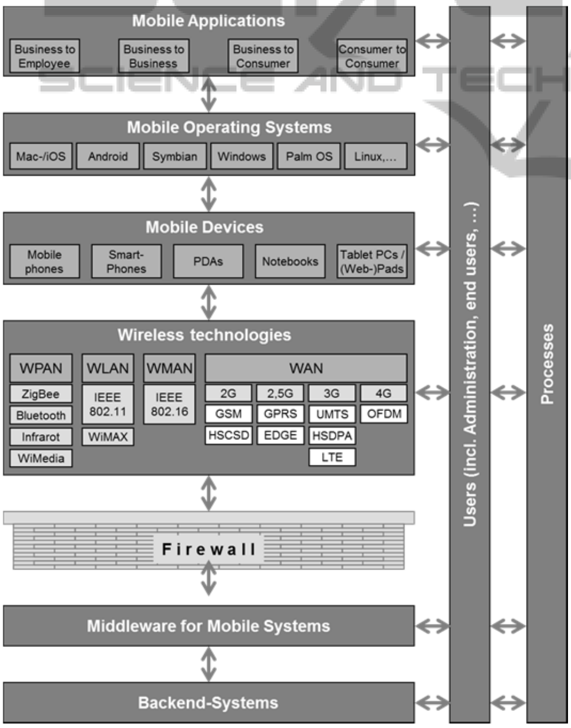

Figure 1: Components of a mobile system.

Non-technical 'components' are users who use the technical components in order to perform their tasks. These can be for example employees who accomplish their jobs in a mobile way (means: not at a stationary workplace) either within or outside the enterprise (e.g. sales people, customer service and maintenance engineers). Human-Computer-Interactions (HCI) is a well investigated research field, thus this work refers to books and proceedings like "Human-Computer Interaction – INTERACT" (Gross et al. 2009), "Digital Technology Research" (Price et al., 2013) and articles within the IEEE-journal "Pervasive Computing". They explain the human-computer-interactions in detail. The effects of HCI on economic efficiency is still an open research topic and will be elaborated by the author to a later point.

Mobile processes differs from stationary processes primarily by its spatial distribution and the mobility of the persons who are involved in the process. Mobile processes can be characterized as follows: At their beginning it is often not exactly known where and when they will take place – many uncertainties can influence these processes and thus make them at least partly unpredictable. Example: Even if a sales man has an appointment with a customer at a defined location and at a defined time, there is still an uncertainty that he will not be able to attend this meeting: A strike, storm, breakdown or even an accident can foil his plans. Thus, following these explanations, distributed processes with a determined distribution structure are not mobile processes (Köhler and Gruhn, 2004).

The evaluation of a mobile system has to take into account all interdependencies between the single components. In order to do so, e.g. following questions have to be answered: "How do technical components like mobile devices, applications and data transfer affect each other? And how can the most important component of the mobile system – the human being – be affected by the technical components or by the surroundings when proceeding tasks? How can the singularities of different working profiles (e.g. maintenance engineer, businessman) and their experience with mobile technologies be considered within the holistic profitability analysis?" In order to be able to answer these questions, it is necessary to understand the singularities of mobile systems that will be discussed in the following section.

4 SINGULARITIES OF MOBILE SYSTEMS

In an investigation we identified the following singularities, which are supported by argumentation as we present them. Note that not only literature study but also practical experience and observation have contributed to the identification of the singularities.

Mobile systems have many different forms and a multiplicity of characteristics and singularities in comparison with stationary ICS. These findings motivate the development of a profitability analysis that takes into account the singularities of mobile systems and that takes the human component as central hub and pivotal point when evaluating such a system.

The aim of mobile systems is to integrate mobile processes and workstations with internal, mostly stationary corporate and enterprise-wide process chains and thus to overcome their spatial separation and accompanying information losses. By the ubiquitous access to relevant information, mobile technologies promise an increased efficiency of business processes and enable new ways of working.

At the same time, mobile systems face many challenges and hurdles stationary ICS are not confronted with, like security issues or the absence of data networks. The following paragraphs will enlighten the most apparent singularities of mobile systems.

Mobile systems can be easily distinguished by stationary ICS due to their singularities. Starting with the technical components of a mobile system, it becomes clear that in contrast to desktop computers mobile devices are continuously transported. This in turn requires a minimum weight and a small size of the devices with maximum robustness.

According to (Schach et al., 2007, Lonthoff and Ortner, 2007; Högler, 2014) mobile devices face many restrictions despite intensive research and technological progress of the past years. In contrast to ICT, mobile devices have – due to the low battery capacity – only a limited power supply and are seldom plugged in local area networks. This fact requires increased energy efficiency of mobile devices and corresponding applications and stable wireless Internet connection. With decreasing size of the devices, also the computing capacity becomes lower. In conjunction with inefficient main storage mobile devices have lower information processing capacities compared to the capacities of stationary ICT. This fact must be taken into account when developing mobile applications, which have to cope with the mentioned restrictions of mobile devices (see also Kornmeier, 2009). Also the input options of mobile devices offer only restricted possibilities: Most keyboards are missing or incomplete and in many cases unhandy, virtual keyboards still do not offer the same usability as standard ones. Additionally, in many cases the worker has not both hands free, which imposes additional usability requirements on the keyboards and the input methods respectively. Especially as regards to the writing speed, this kind of keyboards will not achieve the comfort and usability of traditional ones.

The output options hinder the usage of mobile devices due to the relatively small displays, which have limited facilities for the presentation of contents. Thus, special applications which take into account peculiarities of mobile devices are specifically designed and developed.

The distraction caused by the surroundings depicts also a singularity of mobile systems. In contrast to stationary working places, a mobile worker is distracted by his surroundings, e.g. by noise, incidents and weather. For example, mobile devices are hardly usable in rain or dusty areas, also ambient light is a real challenge: Images and texts are less visible than in closed rooms and thus exhaust the eyes of the users, although automatic recognition of ambient light and adjustment of the backlight is available for most devices.

Reliable data transmission is an unsolved field, too. Transmission problems can be caused by fluctuating bandwidth or insufficient network coverage and thus can hinder continuous work with mobile devices (Gerpott and Kornmeier, 2004; Princen and Schreurs, 2010). Slow or interrupted connections represent disruptive factors and may not only reduce the quality of service, but also affect the efficiency of work: The accessibility of required data everywhere and anytime is of key importance in order to reach the maximum possible efficiency of mobile systems (Högler, 2014).

The relatively broad variety and fast enhancements of operating systems are still regarded as a challenge for the employment of mobile devices. Many mobile applications run only under one operating system and thus can cause synchronization problems. Additionally, the integration of applications into existing systems and their interoperability is not resolved satisfactorily in many cases. With the widespread adoption of cloud-based solutions these problems should become less important within the next few years.

Compared to stationary computers, data security in mobile applications and devices is low – although a broad variety of security mechanisms already exists. The main reason for this security problem is not technology, but the user of mobile devices who bypass security mechanisms for convenience or ignorance. As mobile devices are lost or stolen much more frequently than their stationary counterparts (Frolick and Chen, 2004; Gluschke, 2001; Day et al. 2000) and as many users log into unsecure wireless networks without taking into account all the risks they are facing, the security issue is not yet solved in the area of mobile technologies satisfactorily.

The last paragraphs have shown the most evident singularities of mobile systems. When evaluating such a system, it is necessary to take into account all these restrictions and particularities – they may not only affect the work but also the economic efficiency of mobile systems. For example, major security problems can decrease the monetarily quantifiable advantages of mobile systems. In order to benefit from the full potentials mobile systems bear, it is important to take into account not only the depicted singularities, but also to approve the human component as the most influencing (success) factor on the economic efficiency. This finding motivates the development of a research agenda that covers evaluation of mobile systems and that is based on the singularities of mobile systems.

5 A RESEARCH AGENDA FOR ECONOMIC EVALUATION OF MOBILE SYSTEMS

In order to plan research steps for mobile systems evaluation, based on the above considerations, we are now able to identify a number of research paths. We believe that once answers to related research questions are provided mobile systems productivity can be monitored and improved. Results pave a path in 1) creating more insight into the productivity of mobile ICT, 2) identifying possible areas of improvement for existing mobile systems, 3) managing running mobile system implementation projects, and 4) evaluating mobile system implementations. We identify the following research areas:

- Generic identification and further validation of components of mobile systems and their relations as suggested in our figure 1;
- Further confirmation, detailing and identification of singularities as touched upon in our section 3;
- Determination of success factors from singularities, system components behaviour and interdependencies between components;
- Construction of a model or models for mobile systems evaluation taking into account success factors, components and interdependencies of components, leveraging system theory;
- Validation, case studies and more related to constructed mobile systems evaluation models.

These areas can be stepwisely addressed in further maturing the knowledge base of research on mobile system evaluation.

6 SUMMARY AND RECOMMENDATIONS

The present work has shown the motivation for and necessity of economic evaluation models that address singularities of mobile systems. The current state of scientific knowledge has shown that the productivity paradox does not really exist in praxis. In fact, it is caused by the lack of appropriate methodologies for the economic analysis of ICS. Appropriate evaluation methodologies for ICS are still missing. None of existing methodologies takes into account all components, their interdependencies and singularities of these kinds of systems (section 1). This is even more important for mobile systems that represent a special "mobile" form of ICS.

The present work takes the systems theory as starting point for the development of a definition for mobile systems (section 2). The reason for this approach lies in the fact, that systems theory focuses on entities and that postulates that the system itself comes into existence by the relationships among the system elements and the resulting interactions – the basis for the development of an economic evaluation model that is based on singularities of mobile systems. Section 3 has presented the single components of a mobile system and thus rounded off section 2.

Mobile systems, as seen in section 4, are affected by challenges stationary systems do not face. Their singularities result from the fact that mobile technologies are mostly used when the employee is working apart from a stationary workplace. It is these singularities that – in addition to the human component of a mobile system – decide about the success and thus about the economic efficiency of a mobile system. When evaluating such a system, it is of key importance to take into account all singularities and to analyse the interdependencies of the single system components; our section 5 provides a stepwise research agenda for this.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Prof. Dr. Johan Versendaal as my supervisor for his most support and sharing his knowledge. He kindly read my paper and offered detailed valuable comments and advices on the topics addressed. Second, I would like to thank Gunther Schäfer – without his support and patience this work would not have been possible.

REFERENCES

Ashurst, C. A.; Doherty, N. F.; Peppard, J. P. (2008): Improving the Impact of IT Development Projects: The Benefits Realization Capability Model. In: European Journal of Information Systems 17 (2008) 4, p. 352-370.

Bertalanffy, L. v. (1976): General System Theory. George Braziller Inc., New York.

Boulding, K. (1956): General Systems Theory – The Skeleton of Science. In: Management Science 2: 197-208.

Brynjolfsson, E.; Hitt, L.; and S. Yang (2002): Intangible Assets: How the Interaction of Computers and Organizational Structure affects Stock Market Valuations. In: Brookings Papers on Economic Activity: Macroeconomics (1), p. 137-199.

Corsten, H. (2000): Lexikon der Betriebswirtschaftslehre. 4th Edition. Oldenbourg. Munich.

Day, R., Daly, J., Sheedy, T. and Christiansen, C. (2000): Widening Your Secure eBusiness to Wireless. Framingham: IDC. http://www.bandwidthco.com /whitepapers/wirelessforensics/security/Widening%20 Your%20Secure%20ebusiness%20to%20Wireless.pdf

DIN 1995: OENORM DIN 19226-1:1995-07-01: Leittechnik – Regelungstechnik und Steuerungstechnik – Allgemeine Grundbegriffe. Beuth, Berlin.

Frolick, M. N. and Chen, L.-D. (2004): Assessing m-Commerce Opportunities. Information Systems Management, 21 (2), 53-61.

Gerpott, T.J. and Kornmeier, K. (2004): Electronic Security (E-Security). In: Sjurts, I. (Ed.): Gabler Lexikon Medienwirtschaft. Gabler. Wiesbaden.

Goos, G. and Zimmermann, W. (2005): Vorlesungen über Informatik, Band 1: Grundlagen und funktionales Programmieren. 4th Edition, Springer, Berlin.

Gluschke, G. (2001): Sicherheit in mobilen Systemen. In: Rossbach, G. (Ed.).: Mobile Internet. dpunkt. Heidelberg.

Gross, T., Gulliksen, J., Kotzé, P., Oestreicher, L., Palanque, P., Prates, R.O., Winckler, M. (Eds.) (2009): Human-Computer Interaction - INTERACT 2009. Proceedings of the 12th IFIP TC 13 International Conference, Uppsala, Sweden.

Högler, T. (2012): Framework for a Holistic Evaluation of ICT. In: Proceedings of the 25th Bled eConference Graduate Student Consortium. http://bledconference .org/public/conferences/1/Bled2012GSC-Proceedings.pdf

Högler, T. (2014): Success Factors and the Holistic Approach for Profitability Analysis of Mobile Systems. Submitted for conference publication at the Twenty Second European Conference on Information Systems, Tel Aviv.

Köhler, A. and Gruhn, V. (2004): Mobile Process Landscaping am Beispiel von Vertriebsprozessen in der Assekuranz. In: Pousttchi, K.; Turowski, K. (ed.): Mobile Economy: Transaktionen, Prozesse, Anwendungen und Dienste. *Proceedings of the 4. Workshop Mobile Commerce*. Köllen, Bonn.

Kornmeier, K. (2009): Determinanten der Endkundenakzeptanz mobilkommunikationsbasierter Zahlungssysteme: Eine theoretische und empirische Analyse. PhD thesis, published at: http:// duepublico.uni-duisburg-essen.de/servlets/Derivate Servlet/Derivate-21559/Dissertation_Kornmeier.pdf.

Lonthoff, J. and Ortner, E. (2007): Klassifikations- und Lösungsansätze für Web Services im mobilen Umfeld. In: König-Ries, B., Lehner, F., Malaka, R. and Türker, C. (Ed.): Proceedings of the MMS 2007 – Mobilität und Mobile Informationssysteme, p 73-84. Lecture Notes in Informatics. Aachen.

Loveman, G. (1994): An Assessment of Productivity Impact of Information Technologies. In: Allen, T. and M. Scott Morton: Information Technology and the Corporation of the1990's. Oxford. New York.

Pietsch, T. (1999): Bewertung von Informations- und Kommunikationssystemen – Ein Vergleich betriebswirtschaftlicher Verfahren. Erich Schmidt, Berlin.

Price, S.; Jewitt, C.; Brown, B. (2013): Digital Technology Research. London. Sage Publications.

Princen, T.; Schreurs, J. (2010): Secured Blackberry Used in E-Learning. In: Auer, M.; Schreurs, J. (Ed.) Academic and corporate e-learning in a global context. International Association of Online Engineering. Hasselt.

Rockart, J.F. (1979): Chief Executives Define Their Own Data Needs. In: Harvard Business Review 57 (1979) 2, p. 81-93.

Solow, R. (1987): We'd Better Watch Out. In: New York Times Book Review, July 12.

Schach, R., Scherer, R., Menzel, K. et al. (2007): Mobile Computing im Bauwesen: Konzepte, Anwendungen, *Potenziale. Expert Verlag. Renningen.*

Schiller, J. (2000): Mobilkommunikation. Techniken für das allgegenwärtige Internet. *Addison-Wesley, Munic.*