

E-Commerce Applications Evolution Issues: the case of E-Banking

Nikolaï Partnov, Thibault Estier

University of Lausanne, Information Systems Institute, Internef, 1015 Lausanne, Switzerland,
{nikolai.parnov, thibault.estier}@unil.ch

Abstract. As a specific case of E-Commerce, E-Banking is a typical service combining a communication and a distribution channel. E-Banking applications have had a continuous evolution over the time, from their apparition in the context of innovation in the banking sector to the relative standardisation and convergence of current state. This paper reports the results of the field research aiming to identify the various issues related to the evolution of these applications. Several players of banking sector were studied. Core issues are identified and discussed. The research target is to extrapolate from E-Banking cases a framework to understand main business drivers over web-based applications evolution and change management.

Key words: Software Evolution, E-Commerce Applications Evolution, IT Alignment

1 Introduction

E-Banking developed and evolved rapidly during the last ten years. IT innovations like web-commerce and secure information exchanges have been a triggering factor for E-Banking appearance. These IT factors continue to bring pressure to e-banking development. E-Banking functionality is also evolving continuously driven by the necessity to cover new client's needs and to procure more integration between electronically available banking services. The evolution of demand in online services induces a continuous evolution of the underlying E-Banking applications. This evolution pressure raises a number of interesting questions to developers and maintainers, some of which can be easily extrapolated to other web-based e-commerce applications. This paper discusses the technical, organisational and methodological issues of E-Banking applications evolution. Several players of Swiss banking sectors were studied using interviews and a questionnaire. Then a first set of common issues was identified and examined.

This paper has the following structure. At the first we describe the context of our research: we give a definition of E-Banking and identify the close standing domains, we give the scope of our research, and discuss the used methodology. Next, we define E-Banking evolution, we treat the reasons that lead toward the evolution and we give an

example of it. Finally, the set of issues associated with E-Banking applications evolution is formulated and discussed.

1.1 E-Banking

E-Banking or Electronic Banking is an externalisation of front-office processes and bank services toward clients using information technologies. E-Banking is a virtual front office (counter) with no human actors on the Bank side participating in the interaction. Using standard web browser, client can be in contact with his bank from everywhere. This makes access to E-Banking channel, like any other E-Commerce, universal. E-banking in contrast to the traditional banking brings the service with a new quality and features. The banker is replaced by the piece of software. This way of interaction with clients is usually mixed with the traditional Banking using the physical counter (represents only one of the existing distribution channels for a bank). But there are also cases when the bank does not have any physical counter at all and only virtual ones. All customers' interactions are done through a website supported by a telephone hot line. This is the case of Swissquote - a Swiss purely electronic bank [12]. E-Banking depends completely on the IT solution. This dependence can be compared to the reliance of the traditional banking on the physical assets such as buildings. Traditional or "physical banking" highly depends as well on the business applications. However in the case of system blackout the later would be able to function for some short time, the e-banking activity would be stopped immediately. E-Banking applications are evolving continuously. That is why we believe that the ability of the bank to support the evolution of its E-Banking applications is one of its core capabilities. Regrettably this subject, as far as we know, isn't addressed by academic research. Complex and multi-dimensional character of the E-Banking applications evolution makes it complicated and expensive.

1.2 Related Work

The close standing domains of E-Banking applications evolution are: software evolution, web applications evolution, E-Banking. Here we mention some but not all of the existing publications covering these thematic. E-Banking applications evolution can be associated first of all with change management: IT service management discipline [23] or ITIL [24]. This fact underlines the interdisciplinary nature of the E-Banking applications evolution phenomena and the difficulty studying it from only one perspective, for instance, technical or organisational one. Lehman [7] proposes fifty rules for software evolution planning and management. This work complements the series of publications of the same author, published over a long period of time, covering the subject of rules, laws, models and taxonomies for software evolution. According to this author, the evolution can be seen as a complex feedback process. Cook [3], basing partially on the works of the previous author, proposes the approach for measuring the evolvability of software system at different levels of abstraction. The authors are trying to develop a tool for predicting and long term planning of the evolution. Ciraci [2] developed taxonomy of software evolution for identifying the contexts of the evolution that must help to evolve the system without breaking it down. Among some efforts to support the web applications evolution, we can mention the following publications: Giuseppe and al. [5] are trying to suggest an approach for supporting web application evolution by reverse engineering analyses of the existing

web application with limited documentation. [4] use active rules for automatic evolution of adaptive web applications. Bebjak and al. [1] in order to reduce the costs and increase the speed, suggesting the approach for web applications evolution using aspect-oriented design patterns. Hong and al. [6] discusses in their publication the users feedback and requirements management system which must help to support the financial portal evolution. They agree with the fact of the importance and complexity of corporate financial portal evolution, and underline iterative, contentious character of the evolution. The key incentive of evolution for them is a feedback or change proposal coming from the end user. Wu and al. [14] talk about core capabilities necessary for E-Banking. While mentioning the “planning new IT infrastructure” and “delivering differentiated services” among eight core capabilities, they don’t distinguish clearly the capability to conduct easy applications evolution. Shah [9] investigates the factors that are critical for the success of E-Banking. Like the previous authors, while talking about "system integration" and "organisation flexibility", researchers don't focus on applications evolution. [22] describes the case of e-business model and e-business strategy for e-banking implemented by Citibank in the United Arab Emirates. Other authors work on evolution and versioning of databases [17] or ontologies [16]. While database evolution is also a very important research domain, we focus in this paper on the evolution of E-Banking applications as they are perceived by the users through the user interface and driven by the continuous change in offered services. In the next section, we describe more precisely the scope of this research.

1.3 Scope of research

The scope of our research is the evolution of E-Banking applications. From the most general point of view, it is included in the domain of software evolution. Next, between different types of applications existing today, we concentrate our research on web applications. Then we concentrate on E-Commerce applications. And finally, we focus on E-Banking applications. The total number of applications used in a bank can go up to several thousands. So we use two criteria to place the scope of our research within the common evolution of software: the type of application and its application domain. It is necessary to specify that E-Banking activity is sometimes supported by technologies that are not 100% Web technologies. The choice of E-Banking applications was influenced by the following reasons: web applications' evolution is not trivial and less studied, E-Banking applications are evolving continuously, the concentration of financial institutions in Switzerland and their highly important role in the national economy [15]. Banking and finance domain is an integral part of world economy. Banking can be seen as special case of commercial activity. But by contrast with such commercial activities as consumer goods retail selling, banking activity needs much more sophisticated tools and techniques. The activities of a retail store and of a bank have different degree of complexity. The variety of banking services offered generally requires E-Banking applications to be more powerful and complicated than common E-Commerce applications. For this reason the significance assigned to E-Banking activity supervision by international institutions such as Basel Committee is relatively very high [20]. The figure below represents clearly the positioning of the scope of our research compared to enclosing and closely related domains.

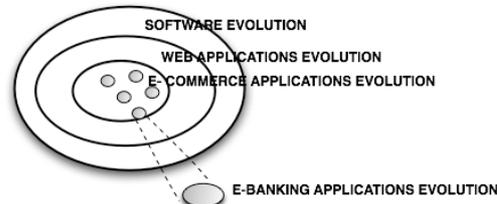


Fig. 1. Inclusion of evolution related domains

After defining the scope of the research, it is necessary to describe the methodology used for carrying out of the research.

1.5 Research Methodology

We used interviews of e-banking experts as a starting point for our research. The main data were collected through series of interviews with different actors coming from various financial institutions. The target group for our research included: traditional private bank, universal bank, insurance company, consulting company and software development company. The last two actors deal as external providers of IT services and products for financial institutions such as banks and investment funds. The specifics of the financial sector – highly reserved character of the IT security policy, due to confidentiality issues - make quantitative research almost impractical: e-banking applications managers consider this subject as too sensible strategically to accept answering general surveys. That is why a first round of interviewed actors was limited to the companies mentioned above. Then we applied content analyses to interviews results. The way the research was carried out can be depicted by the following figure:

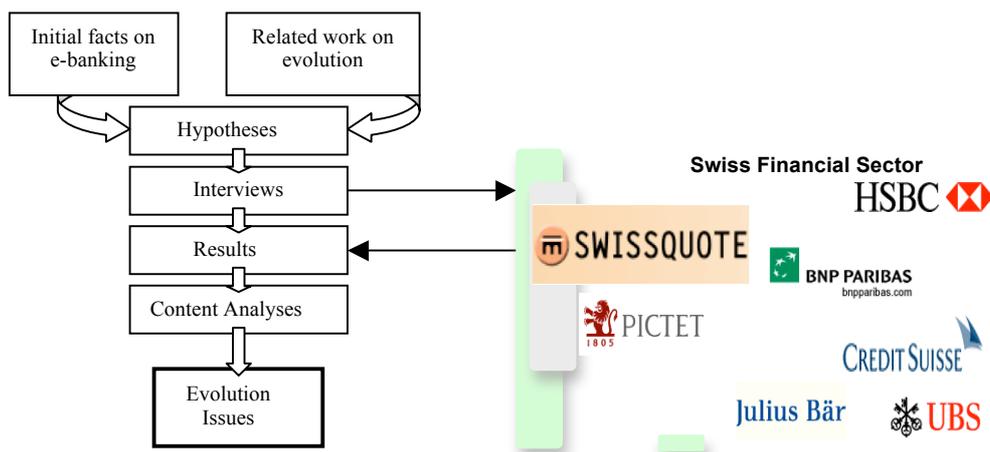


Fig. 2. Overall methodology

A number of hypotheses coming from the study of the related work, the knowledge of the E-Banking applications lifecycle and our intuition were formulated:

- H1: E-Banking applications evolve continuously rather than by very different versions,
- H2: this evolution is complex and has a multi-dimensional character,
- H3: applications evolution is directly driven by business evolution.

In order to test these hypotheses a questionnaire was created. It contained about forty questions concerning different evolution issues. Next, this questionnaire was used as a guideline for conducting the interviews with the number of financial sectors' actors. The results of the interviews were systematized and then analysed according to content analyses methodology [8]. We can classify our research methodology as being mostly "interpretation-centric". Various data was gathered including facts, negotiated meanings by subjects/researchers and subjective understanding [10]. The answers to closed questions received during each interview confirmed the existence and importance of an issue. Then, we drew more detailed conclusions from the answers of the opened questions. In order to retrieve and group the issues, we considered the significance and the concerns interviewees given to each of them. Finally, we draw a set of major issues associated with evolution of E-Banking applications from this analysis. In fact, the results of interviews confirm the hypotheses formulated at the beginning. As we mentioned above, we based partially our hypotheses on the results of the related works, but neither of them talks about phenomenon of E-Banking applications evolution. For this reason, we start next paragraph by giving some definition of our conception of E-Banking applications evolution.

2 E-Banking Evolution

We consider E-Banking applications' evolution as a process of progressive changing of the functionality of the underlying applications through the time. Evolution has a continuous character. In contrast to the versioning, an evolving application passes smoothly from one state to another. At each new state, application offers some new functionality. New functionality is added to the existing part of application. There is no such situation when one version of the entire application is replaced by another. The complex character of the E-Banking applications' architecture, organisational structure and technical infrastructure makes E-Banking evolution highly complicated. Evolution of the functionality reflects on all the above-mentioned dimensions of the E-Banking. Evolution of the functionality implies not only the direct modification of the underlying applications, but reflects on all other connected dimensions, components and architecture. That is why multiple issues can be associated with this phenomenon. The fact of the existence of E-Banking applications evolution is confirmed by all interviewed persons during our research. Various actors have slightly different perception of this phenomenon and not necessarily use the term "evolution" talking about it. Anyway, the activity of conducting bank information system evolution is well known for bank IT practitioners.

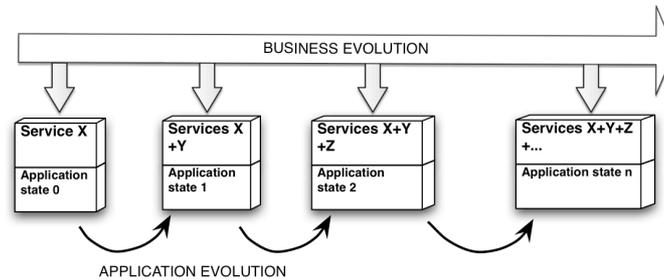


Fig. 3. Alignment between business evolution and application evolution

The figure number 3 serves to clarify the distinction we made between evolution or development of E-Banking business services and evolution of E-Banking applications. In fact, the “historical” evolution of electronic banking like [21], the services that was offered and still being offered, is not the main intend of this paper. Our research is focused on the evolution of underlying applications and of their functionality. This evolution is completely driven by evolution of business needs. However being closely connected, these two “dimensions” must be distinguished. Some common phases of E-Banking evolution can be identified (see section 2.4).

2.1 E-Banking Evolution and "Change the Bank" activity

The evolution of the bank applications can be divided into two distinct activities known by the professionals as "Run the Bank" and "Change the Bank". The first one is mostly connected to technological issues as upgrading, patches etc., it is corrective or adaptability maintenance. The second is about adding a new functionality or changing the existing one. This activity can be also seen as evolving maintenance, which adds some functionality or functionality value. Sometimes it's difficult to make a clear distinction between two activities. We associate the term evolution with the "Change the Bank" activity. Of course, one activity depends closely on another. By giving later some examples we will make this distinction quite apparent. Below we discuss the most important reasons that make the process of evolution almost constant.

2.2 Reasons of E-Banking Evolution

Speaking in the most general way, the cause of E-Banking applications evolution changes application domain or context. Being more precise we must mention the evolution of clients' needs. It's the most evident, important and common reason that leads the banks to the evolution of E-Banking. Banks are facing the constant evolution of the clients needs. They need to follow this evolution in order to achieve clients' satisfaction and to preserve bank's competitive advantage. E-Banking solution must cover the clients' needs, otherwise bank risks to lose its clients. Below we give an example of such an evolution. The Evolution of the business model can be as well an incentive to E-Banking Evolution. An excellent example of such an evolution is how the Swissquote bank evolved first from online financial information provider to online brokerage firm and then became a full electronic bank. Entrance to the new market or in the national law can be another source of

changes. Differences in rules and national authorities requirements can result in specific procedures or different security level. In the same manner an evolution can appear, when existing laws basis are changing. We believe for instance, that current financial crisis will bring some deep changes to law regulations and as a result on E-Banking applications. In conclusion of this section we need to underline the following statement: No matter which exactly of the abovementioned reasons or set of them leads to evolution, but what is the most important is that the initiator of this incentive is always a business side. The needs of business are transformed into business requirements. Business representatives which use the IT solution, must always approve specified business requirements. The evolution of the E-Banking applications caused by the evolution of the clients needs is the most perceptible for the external study. E-Banking applications were exposed to such an evolution especially during the last ten years.

2.3 Real Life Example of E-Banking Evolution

As an example, we present here a sequence of the E-Banking solution evolution for private clients of a Geneva private bank for the period of 1999 - 2007 [11]. This E-Banking application solution is available to the clients by using a simple browser (only web-based access).

State 0. (1999-2000) Features: Login Logout, Financial Info, Valuation online (read only).

State 1. (2001) Login Logout, Financial Info, Valuation online, Documents online, Secure messaging, Financial research. So about 2000-2001 this Geneva private bank arrived towards operational E-Banking channel.

In the same time period the number of relatively young clients in the HNWI and UHNWI categories (High Net Worth and Ultra High Net Worth individuals) raised considerably.

State 2. (2003) Login Logout, Financial Info, Valuation online, Documents online, Secure messaging, Financial research, Transaction Orders (write), Payments, Transfers from account to another, Deposit Trust. These features were planed to develop, but are still in implementation phase nowadays, slowed down by technical infrastructure issues.

State N. (the future) Art-Banking, E-Reporting, Corporate Actions, and Proxy Voting.

The mentioned functionality had been evolving continuously in order to support the core banking activities. Other "less banking" features, such as "My home Page", "My preferences", "Language", "Date" etc., were developed in the same time. At the end of this section, we would like to mention that one web page provided for the bank client is composed by the flows coming from about eight different applications. This example shows not only the need of evolution during the last ten years, but what is also highly important, the need of application evolution for the nearest future.

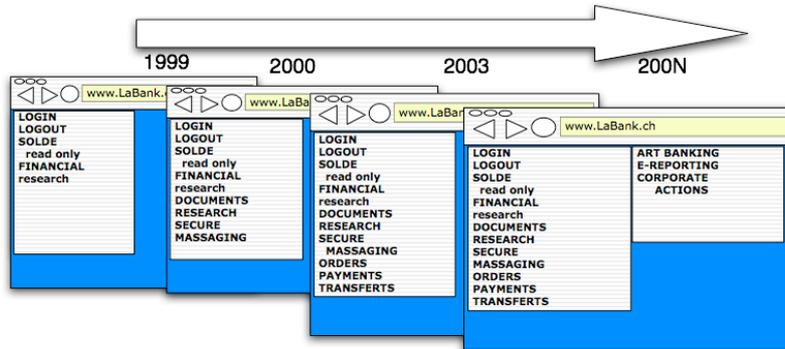


Fig. 4. Geneva private bank functionality evolution

According to the interviewed professionals, there are phases which are more or less common to other banks E-Banking applications. So, we grouped the functionality to three main groups, which are: functionality or services allowing the retrieving of the current market and account information, functionality allowing manipulation of the personal assets and finally trading. On one hand, one of the common trends of E-Banking evolution in private banks is the integration between these three groups. On another hand, the services of the last groups imply much more widely integrated with the external entities than just assets management. This integration is not trivial, normally 5 to 7 different applications are requested in order to produce one screen (one web page) for assets management. The E-Banking applications of some banks are currently at the state 2 or are passing to next state, but there are a lot of others banks whose applications are at the state 0 (see Fig. 5).

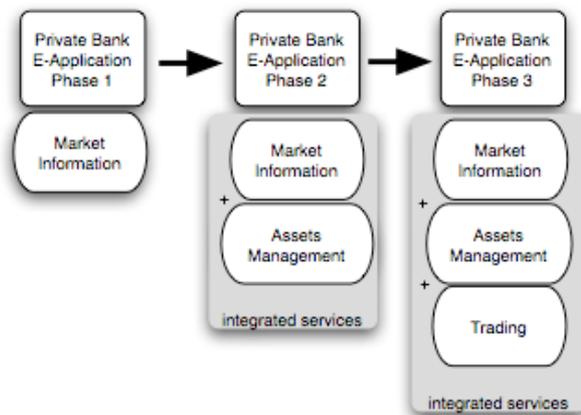


Fig. 5. Three common phases of private banks applications evolution.

This fact proofs one more time that, E-Banking applications are still evolving and some of them have to evolve a lot, in order to offer a competitive service. The evolution of the traditional private bank e-applications follows different scenario, than completely electronic players. This can be explained by the fact that traditional private banks offer first of all the most ordinary for them services.

2.4 Business Model evolution as a driver of E-Banking applications evolution

We have already mentioned that, the Evolution of the business model is a driver for E-Banking Evolution. This thesis is the most viable for purely electronic (or virtual) players, online Forex traders or market information providers, such as ACM (Advanced Currency Markets) or Reuters. We mentioned as well the example of SwissQuote that evolved from an information provider to the bank. As we can see at the fig. 6 below each different business model is associated with some services to provide. Being purely electronic, the player can provide a specific service only by evolving his applications. At today financial markets, there are also online traders that were created directly, without passing by the stage of information provider. Here, we mention Reuters and Bloomberg only as an example of financial information provider. It is certainly difficult to predict the evolution of their business models. Nevertheless, what we can predict is that during this year all the Swiss based online traders must become banks. This transformation was required by the Swiss regulation. So they will need to adapt their e-applications to a new business model. This is a very interesting case when the change in the local regulations leads towards the evolution of the business model and finally to the evolution of the underlying applications.

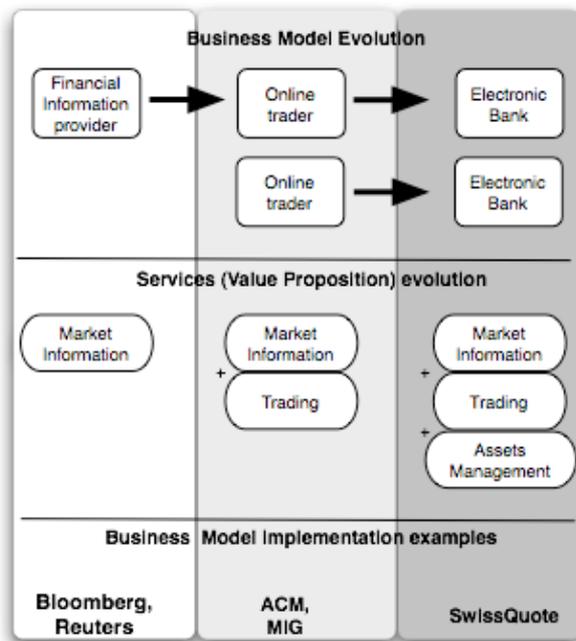


Fig. 6. Business models evolution cases.

3 E-Banking Evolution Issues: a first set

The main purpose of our research was to find the most common issues associated with E-Banking applications evolution. Some of the issues are common to E-Commerce

applications evolution or speaking even more generally to software evolution. Others are more specific to E-Banking applications. Anyway, the E-Business context and the reliance on the web-based solutions rise the significance and implications of all issues. In figure 5, we present the issues grouped by our three research hypotheses (see parag. 1.5). This grouping may be seen as a first step towards a fully detailed model of the E-Commerce applications evolution issues. The following list of issues may not include all the existing ones but those that were identified during our research, we keep here only the issues confirmed by all interviewees.

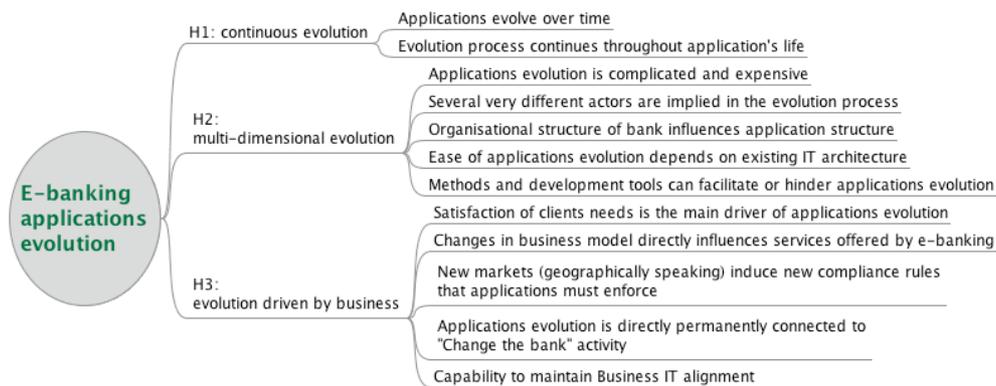


Fig. 5. Issues confirmed by all interviews grouped by hypotheses

Next we procure some explanations and details for each of the issues.

H. 1.

E.I. 1. E-Banking applications are exposed to evolution. We need to underline that we distinguish clearly between evolution and versioning of the applications. Quite apparent for practitioners acting in the domain of E-Banking, the problem of the E-Banking applications evolution, as far as we know, isn't addressed by academic research. Our research obtained numerous evidences that confirm the fact that E-Banking applications evolve over the time. The observation of this fact is important because it makes obvious the need to find some response to the existing hindrance.

E.I. 2. E-Banking Applications Evolution has a continuous character. We mentioned that E-Banking applications are aligned with the bank business strategy. Bank business strategy needs to be updated and corrected in order to respond to a constantly changing business environment. The changing business environment makes the E-Banking application evolution almost never-ending.

H.2.

E.I. 3. E-Banking Applications Evolution is complicated and expensive. The projects related to evolution of E-Banking applications take usually more time and cost more than expected during their planning. Quite often only a small part of the existing code is reused. Integration with existing legacy systems is not trivial and sometime impossible.

E.I. 4. E-Banking Applications Evolution is conducted by different actors. Various dimensions and levels of a bank IT imply different evolution issues and different perception of these issues by different actors. These actors are playing different roles in the evolution process and inside the organisation. Developers, project managers, IT architects,

product managers and units responsible who participate in evolution process. Being in charge for different tasks, these actors have different perception and understanding of the evolution. The considering of this issue is important for academic research as well as for conducting the evolution process.

E.I. 5. E-Banking Applications Evolution depends on the bank organisational structure. The evolution of E-Banking application of an universal bank and some small or middle size private bank don't have the same degree of complexity. Decomposition of the application according to banks divisions or products, impacts significantly its capability to evolve.

E.I. 7. The ease of E-Banking Applications Evolution depends heavily on the banks IT architecture. Different IT architectures and technological solutions may make the evolution process much easier or almost impossible. The number of parallel ongoing projects in large banks can reach several hundreds. Decomposition of the IT architecture according to: geographical approach; different layers such as "Urbanisation", "Architecture", "Application" and "Technology"; or different architectural assignments - "Business Architecture", "Application Architecture", "Technical Architecture" can highly facilitate or hinder the applications evolution.

E.I. 8. Better organisational, methodological approaches and technical tools can facilitate considerably the evolution. All the interviewed persons admitted the existence of a gap in current organisational, methodological approaches and technical solutions. There are ameliorations to be done in order to facilitate the evolution process.

H.3.

E.I. 9. The satisfaction of the clients needs is one of the most important incentives of E-Banking Applications Evolution. Today the value proposition offered to the client and clients satisfaction are the key issues of banks business strategy. Banks are looking for new services and products in order to be competitive and to improve their positioning. The struggle for the client is reflected in the evolution of the E-Banking applications.

E.I. 10. The evolution of the bank business model leads to its continuous alignment with applications. Different business models require different functionality of the underlying applications. The set of applications needed to support the online information provider is not the same then the one indispensable for online brokerage firm. As far as a business model is aligned with the existing IT solution, the changing of the business model reflects on the underlying applications.

E.I. 11. The entrance of a bank to the new market or changing in local regulations may lead to E-Banking Applications Evolution. The application disposed to client must respect the local regulations. In the same manner as different overseas bank departments are working with some differences in order to satisfy national regulations, E-Banking application must "distinguish" customers coming from different countries. For instance, the procedure for account opening is not the same for US and for Swiss citizens. If some existing regulation changes, this will reflect on the application.

E.I. 12. We associated E-Banking applications evolution with the "Change the bank" activity. E-Banking applications are the part of the entire bank information system, composed of numerous applications. Two activities, well known by the professionals, are conducted in order to maintain the bank information system. They are: "Change the bank" and "Run the bank". By its essence the evolution process, touching E-Banking applications as well as some other bank applications, corresponds mostly to the first one.

E.I. 13. The ability of the bank to support the evolution of its E-Banking applications is one of its core capabilities. E-Banking applications must be completely

aligned with the bank business strategy. The core element of E-Banking is its IT solution(s). Each business decision changing the way the current activity is conducted, new services, products or changing in the processes, must be supported by the E-Banking applications evolution.

Each of the listed above issues can be and we hope will be studied much more profoundly.

4 Conclusion and Future Work

The results of the research confirm the existence of the phenomenon of software evolution in such specific domain as E-Banking. Next we identify issues associated with E-Banking applications evolution. E-Banking is a kind of expansion of the traditional banking which is trying to offer to its clients at least the same services and products. Nowadays, very often E-Banking is able to offer the services with new, unprecedented characteristics. From the point of view of the functionality offered to client, most of the e-banking applications pass through three common phases. E-Banking can be seen as an advanced E-Commerce activity. Some of the identified issues are valid for other close standing domains, some of them are specific for E-Banking applications evolution. There are some common scenarios for business model evolution in finance and banking domain. Awareness of the existence of the issues is extremely useful for practitioners and academic researchers. For the first ones, these issues may serve some guideline through the evolution process, for second ones the identified issues represent the field for the wide research. In fact, we identified the existing gap in scientific knowledge that must be completed. We believe that each of the identified issues deserves to be studied deeply. E-Banking applications, as a part of a bank information system, have complex composition and different dimensions: business, technological, and organisational. We plan to consolidate issues in a much more detailed manner and derive from it a model for understanding E-Commerce applications evolution. We plan as well to focus some efforts of our future research on the evolution of the E-Banking applications related to the evolution of clients needs.

Acknowledgements

We would like to thank Gabor Maksay, Daniel Stieger, Ivan Torreblanca and Stefano Mastrogiacomo for their help in conducting of our research.

References

1. Bebjak, M., Vrani, V., Dolog, P.: Evolution of Web Applications with Aspect-Oriented Design Patterns, Proceedings of the 2nd International Workshop on Adaptation and Evolution in Web Systems Engineering, AEWSE'07, Como, Italy, July 19, 2007
2. Ciraci, S., Broek, P.v.d., Aksit, M.: A Taxonomy for a Constructive Approach to Software Evolution, JOURNAL OF SOFTWARE, VOL. 2, NO. 2, AUGUST 2007
3. Cook, S., Ji, H., Harrison, R.: Software Evolution and Software Evolvability, Working paper, University of Reading, UK, 2000.

4. Daniel, F., Matera, M., Pozzi, G.: Combining conceptual modeling and active rules for the design of adaptive web applications. In Workshop Proc. of 6th Int. Conf. on Web Engineering (ICWE 2006), New York, NY, USA, 2006. ACM Press.
5. Giuseppe, A.D.L., Massimiliano, D. P., Fasolino, A. R., Tramontana, P.: Supporting Web Application Evolution by Dynamic Analysis Proceedings of the 2005 Eighth International Workshop on Principles of Software Evolution (IWSE'05)
6. Hong T.K.V., Elsner, H.: Management of Portal Evolution Introducing Evolution Management for the Corporate Financial Portal, in eOrganisation: Service-, Prozess-, Market-Engineering, Vol. 2, p.337-352, Wirtschaftsinformatik-Tagung 2007, (2007)
7. Lehman M.M., "Rules and tools for software evolution planning and management" in FEAST 2000 workshop: feedback and evolution in software and business processes, J.F. Ramil, Ed. London: Imperial College of Science, Technology and Medicine, 2000, pp. 53-68.
8. Oppenheim, A.N.: Questionnaire Design, Interviewing and Attitude measurement, Publié par Continuum International Publishing Group, 2001, ISBN 0826451764, 9780826451767, 303 pages
9. Shah, H., M., Branganza, A., Khan, S., Xu, M.: A Survey of Critical Success Factors in e-Banking, in the proceedings of EMCIS 2005, 2005
10. Suprateek Sarker: Qualitative Research Genres in the IS Literature: Emerging Issues and Potential Implications, Proceedings of the 40th Hawaii International Conference on System Sciences, 2007
11. Torreblanca I., Arvetica, <http://www.arvetica.com/en/about-us/>
12. Swissquote, http://www.swissquote.ch/index/index_group_f.html
13. UBS, <http://www.ubs.com/1/e/ebanking.html>
14. Wu, J.-H., Hsia, T.-L., Heng, M.: Core capabilities for exploiting electronic banking, Journal of Electronic Commerce Research, VOL 7, NO.2, 2006
15. Swiss Banking Association, <http://www.swissbanking.ch/en/home.htm>
16. Haase P., Sure Y., D3.1.1.b State-of-the-Art on Ontology Evolution, SEKT Deliverable, 2004
17. Hick J.-M., Evolution d'application de bases de données relationnelles méthodes et outils, Thèse, FUNDP 2001
18. The Rational Edge, What Is the Rational Unified Process, Jan 2001, <http://www.ibm.com/developerworks/rational/library/content/RationalEdge>
19. PMI, PMBOK A Guide to the Project Management Body of Knowledge, 2000, ISBN 978-1-880410-23-3
20. Basel Committee for Banking Supervision, Basel Electronic Banking Group Initiatives and White Papers, October 2000
21. Hannan A., Mohammad M., Rahman A., Uddin M., E-Banking: Evolution, Status and Prospects, The Cost and Management, Vol. 35 No. 1, January-February, 2007 pp. 36-48

14 **Nikolai Partnov, Thibault Estier**

22. Al-Mudimigh, A., S., E-Business Strategy in an Online Banking Services: A Case Study, Journal of Internet Banking and Commerce, April 2007, vol. 12, no.1

23. Schiesser, R., 2002. *IT Systems Management*. New Jersey, Prentice Hall. ISBN 0-13-087678-X

24. APMG, "ITIL® Service Management Practices: V3 Qualifications Scheme", <http://www.itil-officialsite.com/nmsruntime/saveasdialog.asp?IID=572&SID=86>, 2008