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User Acceptance of Multifunctional Smart Cards

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Abstract

The introduction of smart cards in the Austrian public sector has been discussed since the late 1980s. Public organisations including the national health insurance institute and the national citizen registration office are in the conceptual phase of the introduction.

One of the pilot projects was the roll-out of the multifunctional student ID card to the students of the Vienna University of Economics and Business Administration (WU Vienna) in autumn 2000.

To assess the pilot and to gain insight into further projects, it is necessary to investigate the students' point of view and their acceptance of the WU smart card. Furthermore it would be interesting to gain knowledge about the integration of further functionalities such as payment services or health insurance data.

In this paper, which is a co-operation of three departments at the WU Vienna, we want to give a report on the current status of the research project focused on investigating the issues affecting the introduction of new functionalities of the multifunctional student ID card at the WU Vienna. While the research reported here is still at an early stage of analysis, we have already gained significant findings on students' attitude towards usage of current as well as of potential extended functionalities of the student ID card. The main focus of our research is to gain knowledge about the general students' acceptance. The data collection was carried out through an online questionnaire and the data analysis was based on a sample of 417 students.

Evaluating the findings of the first phase of our research project, we have been able to draw implications for the next stage of our investigation.

Keywords: Smart Card, Digital Signature, User Acceptance, Technology Acceptance

1 INTRODUCTION

Smart cards are continuously introduced into different areas of life around the globe. Per definition 'smart card is a standard-sized plastic card that contains an integrated circuit or chip which gives the card the ability to store and/or process data' (Walters 1992). A smart card is characterised uniquely by its chip, with its ability to store much more data than is held on a magnetic stripe, all within an extremely secure environment, with the physical characteristics defined in the ISO norm 7810 (ISO/IEC, 1995) and the recording techniques in the ISO norm 7811 (ISO/IEC 2001; ISO/IEC 2002).

Smart cards can be used for a wide variety of general purposes, e.g. authentication, data storage and data processing. There are many specific applications of the generic functions within particular industry sectors such as financial services and health insurance.

The research project described in this paper focuses on investigating the issues relevant to the introduction of multi-purpose, multi-function smart cards at Austrian Universities. The major issues are the acceptance and satisfaction of smart card technology in education. It's not only the final acceptance and satisfaction with the service consumed through the application but also the users', in our case the University students', basic attitude towards smart cards and their awareness of possible advantages gained through its diverse applications. Our main concern is to deal with those issues in our research project investigating the situation at Austrian Universities. Hence, the addressed research questions in this study are: "Which factors influence the acceptance of multifunctional smart cards in the education sector in Austria and is Technology Acceptance Model (TAM) (Davis et al 1989) an applicable framework in this context?" In the following we want to give an overview of smart card applications in Austria with a special focus on University applications. Furthermore we outline our empirical investigation introducing the applied methodology and presenting our main results. The close-down is discussing the limitations to our present study and describing our planned further research.

1.1. Smart card applications in Austria

Smart cards are becoming an important part in the daily life in Austria. There are several smart card projects that have already been launched or are going to be launched in the near future.

The start of discussions on implementing identification cards can be found in the year 1987, when the former dean of WU Vienna proposed to introduce a chipcard. Back then the discussion stopped mainly because of massive protest of the local student union as they feared surveillance of the students' activities (ZID 1997). The project was stopped and reinstated in 1993 by the center of information systems of the same University that started with a pilot project called "power card". Following the positive experience stated in the final report (ZID 1997) the WU-IS2000 project was started to raise the efficiency of the Universities administration (B.I.T. 1999) and consists of back- and frontoffice software as well as smart cards for University personnel and students for identification purposes (Miksch 2002). So far more than 20.000 students of WU Vienna have been equipped with the student ID card since autumn 2000 (Obermayr 2001).

In the field of the public administration the Austrian Chief Information Office that is installed in National Chancellery to coordinate the Austrian IT efforts, is in charge of coordinating the smart card projects. They developed a concept of a National ID card, what they call "Bürgerkarte" (Posch et al. 2002). It combines the certificate of a citizen's digital signature RSA key pair and the unique number of the citizen assigned by the national citizen register, the "ZMR" (Kessler 2002). The first implementation of this concept is the membership card of the Austria Computer Society (Österreichische Computer Gesellschaft, OCG), that was issued to the Austrian Computer pioneer Prof. Heinz Zemanek on 24th of February 2003. This card was issued in cooperation with A-Trust, the only accredited and certified trust center according to the Austrian signature law 1999 and the

European Electronic Signature Directive 1999/93/EG (EU 1999). Another smart card project is the highly discussed health insurance card in Austria. Here the public discussion concentrates on copying the successful German example of introducing a health insurance card to the members of the AOK health insurance (BMGS 2003). The Austrian card should not only include a digital signature but also so called first-aid-information (Hauptverband der Sozialversicherungsträger 2003).

Multifunctional Student ID cards have already been introduced at two State Universities in Austria and other educational institutions are in the planning phase of introduction. The University sector is one domain which has been active in pursuing multifunctional cards because of the number of functions involved in managing student life such as photocopying, gaining access to security doors, using the card as photo ID etc. Combining these functions in one single multifunctional student ID card provides an enormous easement in handling effort instead of holding separate cards for each function. These facts indicate that smart cards are gaining importance in Austrian students' daily life. The recent development provides the necessity not only to analyse the introduction and availability of the new technology but also the user acceptance and related influencing factors. As educational bodies of University we see the emerging need to do and plan more research activities for student ID card applications. In this regard, we attempt to gain an understanding of the influencing factors on usage and acceptance of multifunctional cards at Austrian Universities, which are planned to be all-in-one cards that would function e.g. as ID card, bank card and access card. The current and potential extended functions of the multifunctional student ID card, that were first issued by WU Vienna in 2000, are shown in Figure 1 and 2.

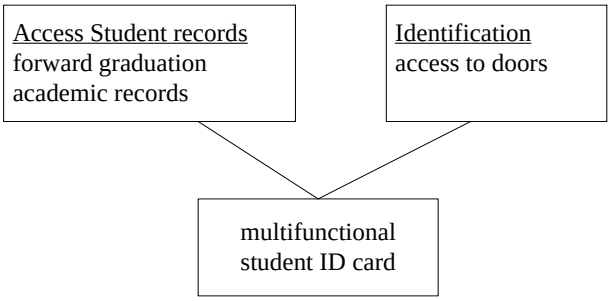

Figure 1. *Current functions of mutifunctional student ID cards at Vienna University of Economics and Business Administration*

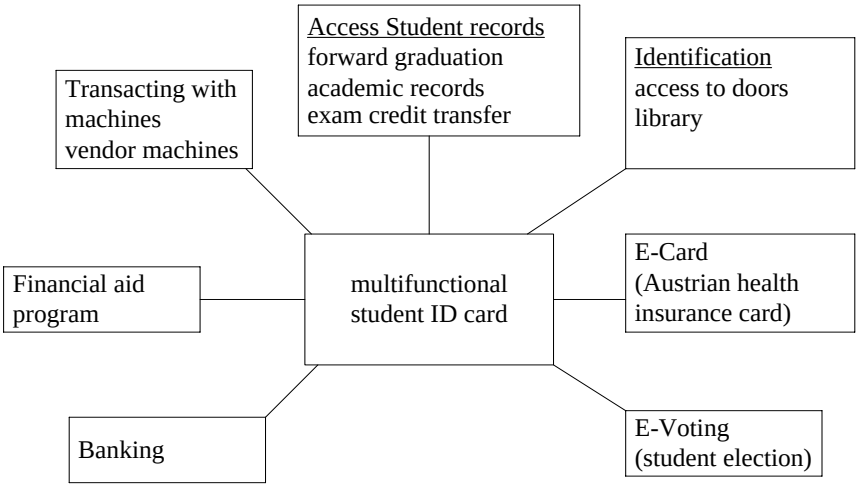

Figure 2. Potential extended functions of mutifunctional student ID cards at Vienna University of Economics and Business Administration

The current and potential applications of the student ID card at WU Vienna are the focused functionalities of our empirical investigation. In the following we outline our study design and main results.

2 STUDY

2.1 Methodology

In selecting an appropriate approach to investigate the acceptance of multifunctional student ID cards, we were influenced by the lack of documented research on multifunctional student ID cards. After analysing the relevant literature, we found, that there is an emerging demand for further research on established models or theories on which to build or test. That was the reason why we planned a two phase research project. In the first stage we wanted to gain some basic knowledge concerning multifunctional ID cards in education followed by evaluating appropriate research models planned to use in the second stage. We studied the existing literature specially Technology Acceptance Model (TAM) (Davis et al.1989). In the first stage, we selected some items for an explorative study analysing the correlation between them. The gained knowledge will support us to build the conceptual framework for adapting TAM external variables and analysing them, concerning acceptance of smart cards in education, which is planned in the second stage.

The survey instrument of the present first stage was an online questionnaire consisting of 28 items. The data was collected at the so called e-Learning platform of WU Vienna, which was launched 2001. All University students have access to the e-Learning platform. The questionnaire was implemented with OpenACS survey module, which is the implementation environment of the e-Learning project.

2.2 Results

The subjects participated in our study included a total of 417 students; females and males compromise 41.5 and 58.5 % of the respondents. The WU Vienna offers degree programs leading to the Magister (roughly equivalent to a master's degree) in the disciplines of Business Administration, Business and Economics, International Business Administration, Economics, Business Education and Information Systems. 43.4 % of the students were enrolled in Business Administration.

Most of the respondents were in the 20-22 year old group, 32.9 % of the respondents have 4-6 years of internet experience. In the questionnaire, respondents were asked to complete and submit the electronic survey to the authors. The students were asked about how their multifunctional student ID card might benefit from further improvements and about their overall satisfaction with the usefulness of their multifunctional student ID cards. The first 7 items of the survey instrument assessed demographic characteristics such as age, gender, field of study and internet experience. Table 1 summarises the demographic profile and descriptive statistic of the respondents.

In the second part of the survey instrument we focused on investigating the issues relevant to acceptance and usage of the current applications of the student ID card and introduction of new functionalities. The data was collected to determine levels of satisfaction with a five-point Likert scale, 12 items with 1 representing totally agree and 5 totally disagree and 10 items with 1 representing extremely likely and 5 extremely unlikely.

We highlight some important results considering the current functions of the Student ID card presented in Figure 1: 87.1% of the students totally agree that using the ID card helps them to do

administration jobs faster, 66.0% use the ID card for room access regularly and 68.1% use the student ID card to access to student records. These results give strong advice that the current functions to ease the fulfillment of administrating jobs are well accepted and valued by the students.

We had three items on usage of the student ID card concerning the added values gained through the current administrative functionalities. The added values we analysed were: helping them to do administrative jobs faster and use the time spent at the University efficiently. The general opinion was that the multifunctional student ID card makes student life easier manageable.

These results lead us to the assumption that a major importance of the student ID card is time efficiency of fulfilling administrative task at the University. An additional issue which we addressed was the ease of use which we assumed to have an important influence on the acceptance of the student ID card. Regarding to our results, 86.1% found it easy to learn the functionalities of the card and 94.0% of the students found that it was easy to handle the functionalities of the student ID card. 88.9% responded that all functionalities worked out well and were overall satisfied with the multifunctional student ID card. The limitations of this study include that the students were self-selected by which it means we probably only got students that are satisfied with the card as not satisfied students don't use the computer facilities.

Item	**Frequency**	**Percent**
Gender		
Female	173	41.5
Male	244	58.5
Age		
17-19	32	7.6
20-22	212	50.8
23-25	102	24.4
>26	71	17.1
Years at University		
1-3	206	16.5
4-6	76	6.0
7-9	63	5.0
10-12	41	3.3
>12	31	7.4
Field of study		
Business Administration	181	43.4
Business and Economics	43	10.3
International Business Administration	119	28.5
Economics	10	2.4
Business Education	18	4.3
Information Systems	36	8.6
Phd	10	2.4
Years of experience with internet		
1-3 years	36	8.7
4-6 years	137	32.9
7-9 years	114	27.4
10-12 years	120	28.8
> 12 years	9	2.2

Working hours		
0 hours per week	155	37.2
10 hours per week	118	28.3
20 hours per week	79	18.9
More than 20 hours per week	65	15.6

Table 1. Descriptive statistics and demographic profile of the respondents

In the next part we examined and discussed the results concerning potential planned functionalities as shown in Figure 2. 73.5% would use the multifunctional student ID card for online exam credit transfer, 66.4% would use the student ID card for e-voting, 75.0% are likely to use the card for transacting with vendor machines and 67.1% would use PKI (Private Key Infrastructure). Answering the question about the willingness to pay for the extended functionalities, 63.0% answered that they were willing to pay for the new functionalities; the majority would pay a maximum of ten Euros per year. The overall acceptance and attitude towards the planned functionalities is positive. This point is a very important finding for our further research activities. The next issue we addressed is the usage of current functionalities of the student ID card and how this incidence is correlated with the ease of use.

Our next findings concern the integration of student ID card with other current and planned smart card applications in Austria e.g. e-card, banking cards and Citizen card. The findings are that 40.0% would use banking functionalities integrated with the student ID card, 45.1% SIM-card and 37.7% would use the integration with e-card. Although it is not the absolute majority are likely to use the integrated functionalities, the general attitude toward the integration of applications and the intention to use it, is positive. These are again valuable findings regarding the second stage of our research project.

In the following we want to mention some additional interesting results concerning the correlation analysis, which are relevant for our further research. Usage and experience with internet is highly and significantly correlated with usefulness of the student ID card for student life management. That leads us to the assumption that technical affinity is a relevant factor influencing technology acceptance. Another important finding is that time saving impacts the perceived usefulness of student ID card application and that students' intention to use smart cards is positively related to perceived usefulness.

3 CONCLUSION – FURTHER RESEARCH

The first research stage confirmed most of our initial assumptions about the attitude towards usage and acceptance of multifunctional student ID cards in the Austrian educational sector. Further research is needed to address e.g. how additional variables such as price, personality characteristics etc. relate to usefulness and ease of use of multifunctional student ID cards. In our present study we have found a strong positive correlation of items concerning current usage of the student ID card and ease of use. In the relevant literature we have found different approaches to analyse the acceptance of new technologies. A recurrent theme in information systems research involves predicting the adoption and future usage of newly-introduced IT (Hubona et al. 2003). A number of theoretical approaches have been investigated, incl. Diffusion of Innovations (Rogers 1962), the Theory of Reasoned Action (Fishbein et al. 1975) and its extension the Theory of Planned Behavior (Ajzen 1991).

Generally, acceptance is defined as an antagonism to the term refusal and means the positive decision to use an innovation (Simon 2001). Several researches developed theories and models to describe and analyse user acceptance and each of these models determines different factors to explain user acceptance. The Technology Task Fit Model (TTFM) by Goodhue explains acceptance with three factors: task, technology and individual. TTFM considers three variables: task characteristics, system configuration and user characteristics (Goodhue 1995). Kollman categorised acceptance in three phases: attitude, action and utilisation (Kollmann 1998). Herrmann distinguishes acceptance factors from general conditions (Hermann 1999). The acceptance model of Degenhardt focuses on the acceptance analysis of videotext applications (Degenhardt 1986). Its structure is similar to the TTFM

as it also considers three variables: task characteristics, system configuration and user characteristics. So far, these models are understood as a methodology for quality assurance.

The Technology Acceptance Model (TAM) by Davis is one of the most common models. It evaluates user acceptance by two factors: perceived usefulness and perceived ease of use (Davis 1986). Moreover, it emphasises the importance of evaluating the considered system in respect of the tasks which should be accomplished.

Model	**Set of Construct**	**Summary**
Technology Acceptance Model (TAM), **Davis**, 1989	Perceived Usefulness, Perceived Ease of Use	Disjunction between benefit and effort as criteria for acceptance decision.
Technology Task Fit Model (TTFM), **Goodhue**, 1995	Individual, technology, task	Task oriented approach addressing employee's acceptance of IT solutions.
Degenhardt, 1986	User characteristics, tasks, system	Addressing the acceptance of communication services at the example videotext (BTX).
Kollmann, 1998	Acceptance of Behaviour, of Use, and of Attitude	Regards introduction of telecommunication and multimedia systems.
Herrmann, 1998	Widespread catalogue of criteria	Addressing acceptance of media services toward user competence

Table 2. Summary of selected Acceptance Models

Theoretical foundations of TAM are found in Self-Efficacy Theory (Bandura 1982), Cognitive Dissonance Theory (Festinger 1957) and mainly in Fishbein&Ajzen's Theory of Reasoned Action (TRA) (Fishbein et al. 1975). A review of scholarly research in IS acceptance and usage suggests that TAM has emerged as one of the most influential models in this stream of research. TAM represents an important theoretical contribution toward understanding IS usage and IS acceptance behaviour (Malhorta et al. 1999).

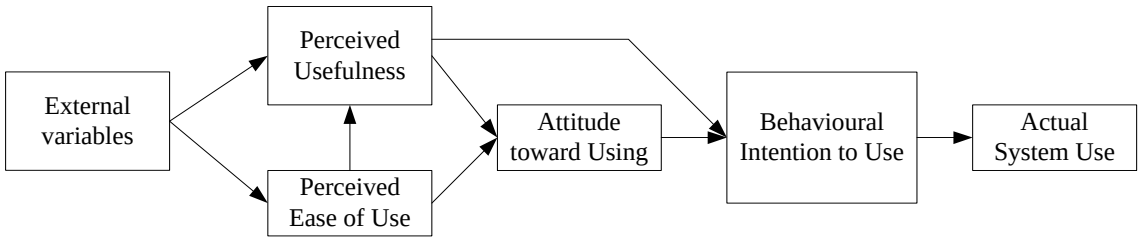

Figure 3. Technology Acceptance Model (TAM) (Davis et al. 1989)

Based on TRA, TAM provides a theoretical nexus for measuring beliefs and attitudes to predict future behaviour. Two particular constructs, perceived usefulness (PU) and perceived ease of use (PEOU) are centrally important in TAM for predicting information technology users' acceptance behaviour (Hubona et al. 2003). Following detailed literature review concerning the adoption and acceptance of new techological product innovations by consumers TAM seems to be an appropriate tool for our second stage of research investigating students' acceptance of multifunctional student ID cards. As the various functionalities of multifunctional smart cards are still more or less perceived as new and mostly unknown technological innovations by the users, further investigations of user acceptance and adoption behaviour seem to be inevitable.

To emphasise the variable of perceived risk in the human decision making process and according to findings about perceived risk in online-shopping (Bauer et al. 2003), the decision about multifunctional smart card usage provides high potential to arouse a high magnitude of perceived risk.

Furthermore the psychological construct of ‘perceived risk’ and other constructs related to the decision making process like ‘cognitive dissonance’ (Festinger 1957) or ‘satisfaction/dissatisfaction’ (Oliver 1997) seem to be crucial determinants when talking about new technology usage. As TAM is theoretically based on several of those great theories of social science, its explanatory power shall be used for our further investigation on acceptance and adoption behaviour of multifunctional student ID cards in Austria as well as for investigating the acceptance and adoption behaviour of other potential applications of multifunctional smart card technology in general.

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