RFID-BASED MEDIA USAGE PANELS IN REAL-WORLD SETTINGS

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Abstract

Traditional paper-based longitudinal or cross section panel surveys, used for market research are time and cost consuming and can suffer from contaminating effects like social desirability bias or respondent conditioning. Electronic data capture methods can improve the time and cost efficiency of market research panels. Radio Frequency Identification (RFID) technology allows a seamless and non-intrusive integration of information systems into everyday life environments. This enables the automated electronic acquisition of media usage data, without direct interference with the media consumption and thus without the contaminating effects of traditional panel surveys. Consequently, we introduce an RFID-based prototype system called MUSE (Media Usage in Supportive Environments) that supports automatic measurements of print media usage in public environments. MUSE was tested in an initial field study over the course of six weeks in the waiting room of a German medical practice. The study showed that MUSE could monitor the usage of print media, laid out for waiting patients, autonomously and with minimal errors. Furthermore, the RFID technology was perceived as non-intrusive. This study is the first to show how RFID enhanced real world settings can be used for non-intrusive media usage analysis in real life. Based on the findings we derive recommendations for future research for RFID supported media usage analysis.

Keywords: Market research, electronic data capture, RFID, social desirability bias.

1 INTRODUCTION

Since the advancement of standardization in radio frequency identification (RFID), the interest in using the technology for the tracking and tracing of items and products in retail supply chains has risen in the past years. RFID technology features seamless and non-intrusive integration of novel applications and services into everyday life environments (Leimeister & Knebel & Krcmar 2007, Resatsch & Sandner & Leimeister & Krcmar 2008). This vision is referred to as ”Ubiquitous Computing“, in which computers as hardware artifacts dissolve and devolve into intelligent objects (Weiser 1991), also known as ”the internet of things” (Gershenfeld & Krikorian & Cohen 2004). The motivation for the underlying study is based on the mentioned non-intrusive integration of information system (IS) solutions into everyday life environments - enabled by RFID technology - for the purpose of real time and accurate data collection.

This motivation led to the initial idea of a prototype, which was planned to support people who buy magazines with additional benefits in the form of value-added services (VAS), and at the same time help publishers of print media with the generation of data on user behaviour in panels. Upon further elaborating on this initial idea, we realized that media panels can be highly cost intensive and do suffer panel effects, such as social desirability bias or respondent attrition and reactivity, stemming from repeated measurement (Duncan & Neil & Paul 2001, Singleton & Straits 2005). Consequently, we established a concept for an electronic data capture (EDC) prototype called MUSE (Media Usage in Supportive Environments)[1], supporting automatic measurements of print media usage, integrating RFID technology. Assuming that RFID tags will be an integral part of future print media, our aim is to evaluate and present a first approach on how studies on media consumption can be supported and realized by ubiquitous RFID technology concepts, in order to overcome panel bias effects, inaccuracies, troubles and cost in data collection processes. Accurately collected data on reading patterns and durations and interests of readers is critical to publishing houses in a fast moving and changing market environment.

In the subsequent chapters we will first give an overview of related research on RFID technology, EDC methods and panel effects. We then present the MUSE prototype, its application environment and its technical implementation. The performance of the MUSE prototype application was evaluated from a technological, user and company perspective in a six week field study[2]. The results of this evaluation are elaborated. We close with a discussion of the contributions from this research, its implications and the derived recommendations for future research on RFID supported media usage analysis.

2 RELATED WORK

A vast body of literature focuses on the application of RFID technology in retail business processes optimizing and solving complex logistics, tracking and tracing problems of objects within the supply chain (Fleisch & Thiesse 2007, Knebel & Leimeister & Krcmar 2007, Loebbecke & Palmer 2006, Murphy-Hoye & Lee & Rice 2005). More recent publications describe the application of RFID technology in retail marketing (Resatsch & Karpischek & Sandner & Hamacher 2007) and for general

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[1] The MUSE prototype was developed in the context of the research project Mobil50+ (Innovative NFC- und IT-basierte Dienstleistungen für mobiles Leben und Aktivität der Generation 50+). Mobil50+ is funded by the German Federal Ministry of Education and Research (BMBF - FKZ: 01FC08046). It is a joint project of the Technische Universität München and various partners. For further information, see www.projekt-mobil50.de.

2 The authors would like to thank Prof. Dr. Dr. Thomas Schildhauer from the Institute of Electronic Business (IEB) and Dr. med. Sabine Schildhauer for their support in the project. Sabine allowed us to use her practice for the case study. The authors' gratitude also goes to Aico Osterkamp and Dr. Michael Hallemann for their support from a publisher point of view.

marketing purposes (Doyle 2004). According to Resatsch (2007), ubiquitous RFID infrastructures on item level could generate a better understanding of the technology and boost its perceived value. This trend can be seen in combination with results from literature that document and postulate changes and upheavals in the print media sector (Henning & Simon 2007), primarily caused by the introduction of novel media outlets. Based on these two trends, we generated our initial idea of a prototype which was planned to support people who buy magazines with additional benefits (e.g. VAS) using RFID technology and additionally help publishers of print media with the EDC of user behaviour observations.

There exists a comparatively large body of literature on the various occurrences of EDC for survey taking, ranging from comparisons of web and paper based surveys (Stanton 1998) to the usability of different computer assisted interviewing methods (Couper 2000). The main incentive for the use of EDC in surveys is the fact that the data is collected in digital form, ready for an instant data analysis, thus cutting costs on digitalization and improving data quality, as evidenced in various studies (El Emam & Jonker & Sampson & Krleza-Jerić & Neisa 2009, Hyde 1998). The most widespread application of EDC surveys seems to be in the field of clinical trial research. In that research field, there is a noticeable trend going from remote data entry by the patients or care personnel through a web based user interface to a direct capture of the data using barcode scanning, or most recently, RFID tags. This allows further improvement of generated data quality and enables cost reduction (Hyde 1998, Morak & Hayn & Kastner & Drobics & Schreier 2009, Smith & Offodile 2002).

Weber (2008) describes how the use of mobile devices for EDC in panel surveys can lead to cost and time reduction and improvements in recruiting methods. Concerning recruiting purposes, he mentions the application of RFID tags on real life objects to approach "particular target groups at specific locations", what he calls "location based recruiting".

Other EDC research approaches, especially in the domain of psychology, track the eye movement of individuals while looking at printed advertisement (Rayner & Rotello & Stewart & Keir & Duffy 2001) to understand user behaviour in print media consumption.

Considering the implications of the advantages of EDC, we found that traditional paper based media panels can also be highly cost intensive and additionally suffer panel effects, such as panel non-response and panel conditioning, reported by Duncan et al. (2001). Panel conditioning describes the phenomenon, where "responses in a given interviewing round may be conditioned by participation in prior rounds of interviews" (Duncan et al. 2001). One exemplary result of panel non-responses are missing data sets caused by individuals participating in panels who may refuse or reject respondents to interviewing questions. Literature discusses strategies to counteract this effect by applying different methods, e.g. estimators (Nijman & Verbeek 1992). A number of additional possible contaminating effects of panel surveys are documented by other scholars, such as the change of the respondents opinions and behaviours by the mere act of responding to panel survey (Morwitz 2005), respondent attrition and social desirability bias (King & Bruner 2000).

Social desirability bias is the falsifying "tendency on behalf of subjects to deny socially undesirable traits and to claim socially desirable ones" (Nederhof 1985), especially in front of an interviewer taking a panel survey. King et al. (2000) stress the importance of addressing social desirability bias especially in marketing research since the self reporting on potentially sensitive topics related to product attitudes and purchase behaviours is prone to be affected by the "socially acceptable response". While the research on social desirability bias proposes different ways to detect, measure and counteract this falsifying effect, such as behavioral covariate scales (King et al. 2000), forced choice items and the self administration of questionnaires (Nederhof 1985), the literature on the influence of EDC, direct data capture and even hidden data capture on social desirability bias is scarce.

Therefore this research paper presents the MUSE media tracking prototype application based on EDC via RFID technology. The MUSE prototype is designed for the logging of patients' print media consumption in a general practice anteroom in Germany, with the goal of delivering cost effective and bias free insights on user acceptance and consumption data to publishers in order to optimize print media consumption among readers and increase value of advertisement space based on reader data.

3 APPLICATION ENVIRONMENT

For the specific use case we chose a Germany based mid-sized medical practice anteroom as a typical environment for print media consumption. We wanted an application environment in which readers have the choice of a variety of journals and which is frequented by a certain amount of different persons. Displaying print media (e.g. diverse types of magazines) in waiting rooms in German medical practices is a common method to ease the waiting time and pre-treatment period for the patients. Other possible application environments would include hair dressers' or an attorney's waiting rooms. As the medical practice offers a closed environment and usually bears a frequently changing, demographically diverse reader group, it was our desired study environment. The chosen prototype test environment additionally suits our motivation for the underlying study which is the evaluation and introduction of an approach on how studies on media consumption in the public space can be supported and realized by ubiquitous RFID technology concepts to overcome panel effects, inaccuracies and troubles in data collection processes.

Therefore magazines were equipped with RFID tags and exhibited to individuals waiting for their treatment on a table that was equipped with an RFID transponder reading device. The device was attached under the table board, so that the table did not differentiate in its physical characteristics (e.g. height, width and length measurements) from its unaltered form. Data on the magazines name and edition, as well as the location in which the print media was displayed to potential readers was saved on RFID tags, attached to the magazines, in order to facilitate a statistical analysis on media consumption, including name, type, reading time and space. A sequential description of the MUSE prototype functionality can be seen in Figure 1. The setup was designed to guarantee non-intrusive integration into the physical environment of public spaces (i.e. doctor's practice waiting room) to decrease alterations in media consumption. Nevertheless, due to ethical considerations, the patients were informed by multiple posters displayed throughout the medical facility that a prototype study on print media consumption was being conducted. This poster information included a short description on the utilized technology and chosen study environment and additionally carried information on participating institutes involved in the study with respective contact details. No attempt to identify the patients or gather any personal data of the patients apart from the anonymous print media usage was included in our first field study.

Figure 1. Sequence of the MUSE prototype functionality (own illustration)

The MUSE prototype system detects when a potential reader takes a magazine from the table and accordingly also captures when the reader terminates the reading process by putting the chosen magazine back onto the table surface. Additionally, the prototype affords the fully automated logging of detailed reading duration data which can be transformed to table styled and graphical outputs (e.g. pie and bar chart diagrams) through an integrated statistical component.

4 TECHNICAL PROTOTYPE DESCRIPTION

Regarding the hardware, the MUSE prototype system uses an RFID antenna to facilitate the detection of the RFID tags. This antenna functions in combination with an RFID reader that possesses a mid-ranged WLAN module (wireless local area network). The MUSE software itself runs on a separate server with WLAN and internet access.

As shown in Figure 2, the RFID reader/antenna unit is controlled by a two-part software system that constitutes the MUSE prototype:

- *ReaderAp*: a standalone Java-application that realizes the data-retrieval from the RFID reader.
- *WebAp*: an application framework that is implemented as a JBoss Application Server with EJB3, including GUI elements based on HTML/Ajax and an integrated MySQL-database. It tracks and maps all the relevant RFID tag movements and allows the user to filter, aggregate and analyze that data on the fly.

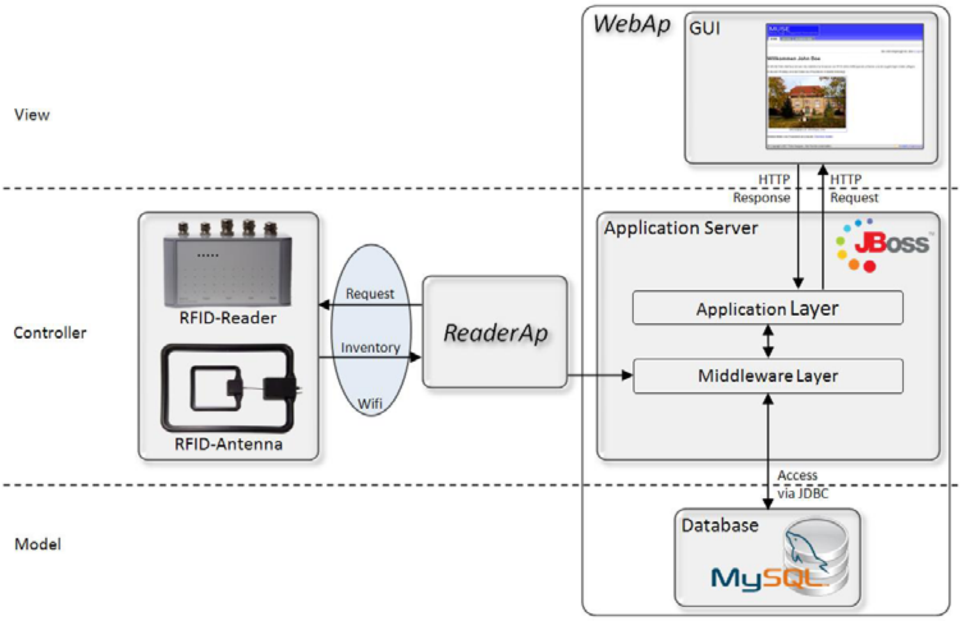

Figure 2. System architecture of the MUSE prototype (own illustration)

4.1 ReaderAp

The *ReaderAp* facilitates basic communication between the software system and the RFID reader, using Java libraries provided by the RFID reader manufacturer. It periodically requests an inventory from the RFID reader, containing all RFID tags within range. Whenever a change in the inventory occurs, the *ReaderAp* updates the database of the application server and triggers functions within the application framework if necessary. The physical communication between the RFID reader and the hardware that runs the *ReaderAp* is realized via a WLAN connection.

4.2 WebAp

The *WebAp* contains a middleware layer that allows cleansing the raw RFID tag events, reported by the *ReaderAp* and storing the data in an SQL database, as well as an application layer that provides business logic and functions to map the hardware domain (tags with unique ID numbers) to the application domain (magazine names). The *WebAp* also comprises a graphical user interface that allows easy administration and usage of the system as well as filtering, aggregation and analysis of the collected data. For the purposes of data analysis, the GUI of the *WebAp* offers different, freely configurable diagram types that can be generated dynamically from the collected usage data. There are three different types of statistics that MUSE can compile: a) Summary, b) Trend analysis, c) Average.

The variables for the ‘summary’ diagram are the reading time or number of readers per magazine. The diagrams ‘trend analysis’ and ‘average’ require the user to define time segments (i.e. day, week, month, etc.) as an additional parameter. The diagrams can be viewed as either bar or pie charts in addition to the raw table format.

5 FIELD STUDY EVALUATION

As previously noted, an initial field study was conducted with the MUSE prototype in a medical practice in a rural area near Berlin, Germany over the course of six weeks. During that time, approximately 1200 patients visited the medical practice and spent some time, typically reading magazines in the waiting room.

5.1 Execution

Thirteen different magazines were tagged with RFID tags and put on a central table in the anteroom of the medical practice to be read by the patients. The central table was the only tray surface in the room, to avoid patients placing the magazines in a spot, where they would not be detected by the RFID reader, while not reading them. The magazines were swapped bi-weekly for a total of three times over the course of the field study, with their most recent edition.

Since RFID tags cancel each other out when they overlap even marginally, the tendency of patients to neatly stack the magazines when putting them back onto the table needed to be addressed. By applying two RFID tags to each magazine and arranging them in a specific iterating placing scheme, the chance was minimized, that both tags of a specific magazine would overlap with other tags, thus making the magazine undetectable. It was the desired goal of the field study to run the MUSE prototype system autonomously over the course of six weeks without direct maintenance, apart from swapping the RFID tags to the newer editions of magazines. This was possible, apart from a necessary reattachment of the RFID antenna after two days. However, the MUSE software needed to be updated and restarted remotely several times during the six weeks of the test run.

5.2 Objectives

The objectives of this field study were (1) a test of the technical feasibility, (2) an evaluation of the practicability, and (3) an assessment of the potential for future usage in panels:

1. Test of the technical feasibility of the RFID tag measurement. The relevant issue in this case was if the RFID reader/antenna unit was able to detect the 26 RFID tags on the magazines through the table with an acceptable error rate.
2. Evaluation of the practicability of the entire MUSE prototype system. In order for the proposed system to be beneficial in measuring print media consumption, both in the financial aspect and the avoidance of panel bias effects, the MUSE prototype system would have to be able to run stable and mostly autonomous in a well defined environment without attendance, aside from assembly, disassembly and remote data access. Furthermore, it needed to be assessed whether the MUSE prototype application concept was capable of gathering paper media usage data in the described setting. Additionally, we wanted to evaluate whether the provided data analysis tools in the *WebAp*-GUI were sufficient and suitable for panel-research.
3. Assessment of the potential of the MUSE prototype system to conduct panels on print media consumption without distortion from panel-effects. Since this first study was not set up as a

comparative field study, we only estimated on this issue, based on the user acceptance of the MUSE prototype system.

6 PRACTICAL RESULTS AND LIMITATIONS

We conducted several evaluations on a technological (technical feasibility), user (practicability) and company (panel) basis.

6.1 Technical feasibility

As a test of the technical feasibility of the proposed MUSE system, the mentioned field study was a great success. As previously noted, the MUSE prototype system was able to run almost autonomously over the course of six weeks without direct attendance. However, the RFID antenna needed to be reattached to the central table after two days of the test run, because the used adhesive tape turned out to be inadequate. The chosen RFID hardware proved to be a bit unstable and was prone to lose the WLAN-connection to the *ReaderAp* as well as to crash on occasion. This meant that the *ReaderAp* had to be manually restarted via remote access a few times during the field study, until it was updated with an auto-reconnect-feature.

As previously noted, the two RFID tags per magazine were attached in a specific placing scheme. This was done in order to minimize the chance of both tags of one magazine overlapping with the tags of other magazines, thus making them undetectable. At the first swap of the magazines with their most recent editions, the pre-fixed iterating placing scheme was changed to a randomized attachment of the RFID tags. This resulted in a drastic drop in the rate of detection by the RFID hardware. Some magazines seemed to be fairly undetectable with the randomized tag placement. This shows that a strategic placement of the RFID tags on each magazine is necessary to enable an acceptable rate of detection by the used RFID hardware.

The field study showed that the used RFID hardware in combination with the *ReaderAp* was able to detect the 26 RFID tags (if applied strategically) with a high accuracy and very low error rate. This estimation was deduced from the fact that a) almost no magazine was absent from the RFID-equipped table during the night time or weekends and b) almost no magazine was read an excessively long time (more than 120 minutes) during practice hours. This absence of erroneous media usage data implies a very high accuracy of RFID detection in a field setting, especially when contrasted to the trial run with the random RFID tag placement. A very high scanning frequency turned out to be beneficial in respect of RFID tag detection. The best outcome was achieved by scanning every 10 milliseconds and combining the corresponding results to a single readout per minute.

In a later iteration of the MUSE prototype application, the parameters maxReadTime, minReadTime, minHour and maxHour were integrated into the *ReaderAp* to automatically disregard falsifying, implausible media usage detections. A minimal reading time of one minute was determined to disregard the removal and immediate replacing of a magazine onto the table. The other parameters were integrated to automatically disregard excessively long magazine reading times or reading times during off-hours. While these false readings predominantly occurred during the trial run with the randomized RFID tag placement, they can still occur with the strategic placing scheme, e.g. when a magazine is put right on the edge of the table and therefore should be actively disregarded by the MUSE prototype system. It should also be noted, that we did not achieve complete automation of the entire data capture process, since new magazines still needed to be equipped with RFID tags manually and the MUSE system needed occasional software (remote) and hardware maintenance. However, prototypes show that it is possible to automatically integrate RFID tags in a magazine production process with inlays.

6.2 Evaluation of the practicability

The field study took place in a rural area in Northern Germany. The practicability relates to (1) the practicability to apply the setup in the medical practice, (2) the user acceptance, and (3) the feedback of the staff:

1. Medical practice feedback: It takes approximately half a day to equip a medical practice with everything needed to conduct the field study. As previously mentioned, there must be a process in which an assistant must make an effort to bring out and tag new magazines from time to time. In our setting, there was no support with cameras or spectators who could have spotted distorting effects, such as magazines that were not placed back on the table. Such a setup would reduce practicability in a medical practice, but presents a possibility to verify the MUSE prototype application. If this approach is taken to validate the MUSE application data, obviously all patients need to be informed of the fact that their movements are recorded and be given the choice to reject. The constant video surveillance might have an effect on the actual media usage of the patients, but that effect would be irrelevant for the mere validity testing of the MUSE prototype. For other locations, such as a participant home, the whole MUSE setup would not be practical – mainly due to the change in reading processes: a user needs to put the magazine back to a certain location – that might or might not disturb actual reading behaviour. A future solution should bear that in mind and pursue a near body reading mechanism (e.g. in a watch).
2. User acceptance: As already noted, during the field study, we attached posters to the wall that explained the study setup and what the RFID tags are used for. There have been few questions and no complaints throughout the whole study duration concerning the RFID tags. Therefore, we assume that the visitors in the medical practice were not aware of the technology. In an urban setting, such as a big city practice, there might have been more conscious and skeptical patients who would have asked about the setup.
3. Staff feedback: According to statements of the medical practice's employees, the feedback of the few patients that asked about the MUSE field study was positive and there were no complaints about it. The medical practice's supervisor also stated that the RFID-tagged print media offering was received continuously well by the patients throughout the field study. These combined observations imply a high acceptance of the MUSE prototype technology by the patients and therefore allow a positive assessment about the potential of the MUSE system to avoid distorting panel effects.

Aside of these practicability issues, there were several challenges figured out in the study when it comes to user behaviour:

- The MUSE prototype in its current state can only detect the presence or absence of certain magazines from the tray surface equipped with an RFID reader. It is assumed, that these absences correlate with the time that a magazine is read. There are however certain situations, where this is not the case: multiple magazines are taken by a patient at once, the magazines are not put back onto the proposed tray area after reading, but for example onto another chair or magazines are stolen from the collection.
- Interpreting these situations as reading time of a magazine would significantly falsify the result of the automated panel.
- The MUSE prototype system is by design unable to map the identity of a reader to a reading process, and thereby unable to enrich the panel results with demographic data.

The issue of magazines not being put back onto the RFID reader equipped table might be circumvented by, for example, putting RFID readers underneath the seats and all other remaining tray surfaces in the waiting room as well, assuming that a magazine is not read while lying on a tray surface. The issue of magazines not actually being read when taken from the RFID reader equipped table however is inherent in the design of our automated panel system. Resolving this issue would require the active participation of the reader, thus potentially negating one main advantage of the

MUSE system – the avoidance of contaminating bias effects. The profiling of the readers (i.e. the collection of demographic data and mapping between a reader's identity and a reading process) in the context of our prototype system would also only be possible through the intentional, active reporting by the reader. From a technical perspective, a reporting could be integrated into the MUSE prototype system through the use of Near Field Communication-enabled mobile telephones. NFC is a short ranged wireless communication standard that enables mobile devices, e.g. cell phones, to read RFID tags. Demographic data could be collected through traditional questionnaires. We speculate that a necessary participation of the reader could be motivated in this case through the offering of VAS, as it was devised in our initial idea of the MUSE prototype application. While the profiling of readers would certainly be beneficial to researchers and publishers, the mere reading data itself, collected by the MUSE prototype is easier to obtain, unaltered by panel effects and still quite useful. Additionally, it should be evaluated, whether a conscious self reporting by the reader on his print media consumption through the scanning of the attached RFID tags with an NFC enabled mobile telephone would have a direct, altering influence on it.

6.3 Company (panel) evaluation

Besides evaluating the MUSE prototype application from a users' perspective in a real life situation, we also addressed the benefits of the generated data for publishers or advertisers. Therefore we analysed the raw data, generated by the *ReaderAp* of the MUSE prototype application in respect of panel usage possibilities. The *WebAp* of the MUSE prototype application was able to extract numerous data sets regarding the usage of the thirteen available magazines in the medical practice during the course of the six week field study. An excerpt of this data can be seen in Table 1.

	Total amount of readers	Total reading time in min.	Average reading time per reader in min.
MAG 1	144	2201	15'17"
MAG 2	120	1722	14'21"
MAG 3	91	1297	14'15"
MAG 4	110	1478	13'26"
MAG 5	144	1999	13'53"
MAG 6	127	1739	13'41"
MAG 7	36	504	14'00"
MAG 8	96	912	09'30"
MAG 9	86	1313	15'16"
MAG 10	86	1384	16'05"
MAG 11	69	764	11'04"
MAG 12	3	15	05'00"
MAG 13	127	1706	13'26"

Table 1. Key figures, gathered by the MUSE prototype during the field study (own table)

As previously noted, the *WebAp* of the MUSE prototype application was able to dynamically compile various types of statistics from these data sets and display them as diagrams through the GUI, including trend analyses (as seen in Figure 3) and averages (as seen in Figure 4). Table 1 shows that there are significant differences in the number of readers (see highlighted table cells). MAG 1 to 3 are well known "brands" in the German magazine sector whereas the least wanted magazine (MAG 12) was a free, medicine sector-specific magazine. One interesting outcome is that the data does not indicate a relation between duration of reading time and the number of readers. The average reading times were very similar for the different magazines (12 min 89 sec average). This indicates that once a magazine is in the reader's hands including the time spent reading it is rather identical, assuming the waiting time of the patient is sufficient. From an evaluation perspective, it was possible to compile and visualize summaries, trends and also averages of media usage. Additionally, the collected data allows for a more in-depth analysis (readers/day, specific reading times, best magazine, etc.) and thus provides important insight for publishers and their advertising customers.

It became clear for example, that some magazines are read more frequently during specific time periods throughout the day. This knowledge would help advertisers to use the data to specifically add their advertisements based on a more thorough evaluation of reader behaviour. For example: a coffee manufacturer could place his advertisement in those magazines that are read in the morning. Therefore it becomes more likely that a user perceives his advertisement and converts his actual behaviour accordingly. Fogg (2003) for example stresses in his research on persuasive technology the importance of choosing the right time to make suggestions on behaviour change in order to achieve a maximal effect - a technique he calls the “kairos effect”.

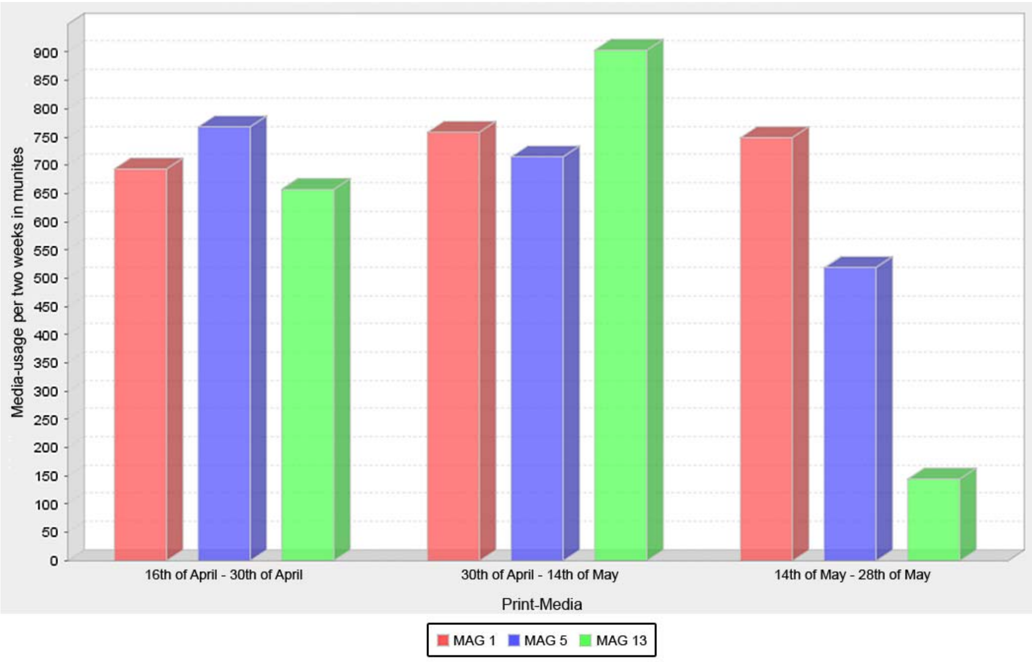

Figure 3. *Exemplary trend analysis of total reading time in two-week sections (own illustration)*

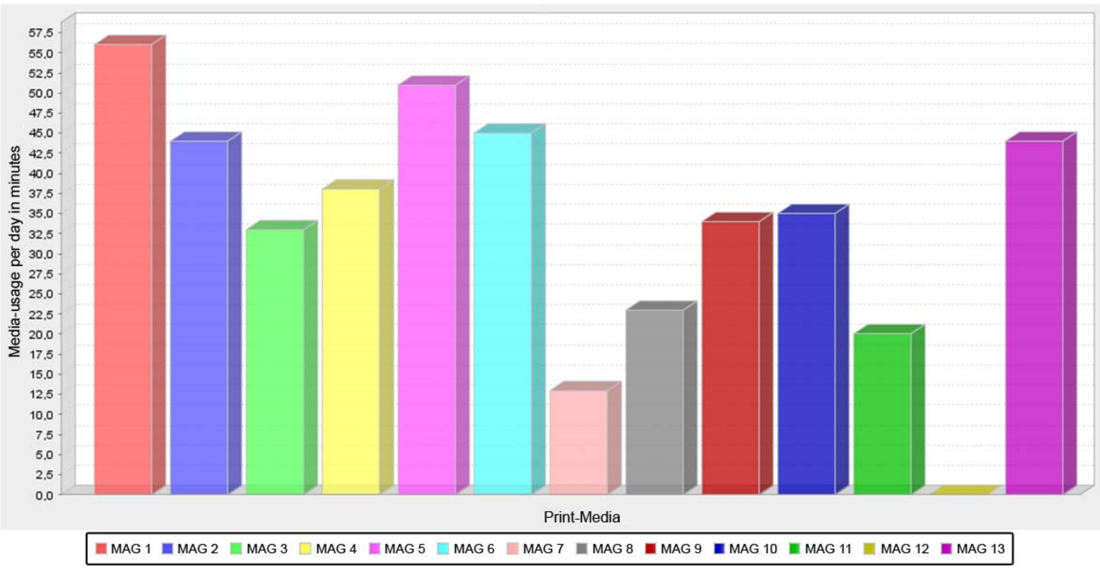

Figure 4. *Average reading time per day of all thirteen magazines (own illustration)*

To gain further valuable insight on media usage, a panel conducted with the MUSE prototype application could also be correlated with the actual locations of the prototype setup (medical practice, hair dresser, etc.) – with this data, publishers and advertisers can make more informed decisions on advertisement placing.

7 CONCLUSION AND FUTURE WORK

This research paper describes development, implementation and evaluation of an application prototype that allows the automated electronic capture of media consumption data in supportive environments using RFID technology. The field test allows assessing the technical feasibility, practicability and panel usage possibilities of the proposed concept and the MUSE system. The field study shows that the RFID technology holds a great potential for partially automated media usage panels from a technical perspective. In the well defined environment of a medical practice waiting room, the MUSE system was able to run mostly autonomous and therefore cost efficient over the course of six weeks, while detecting the usage of a limited amount of print media items with more than adequate accuracy.

The evaluation of the practicability of the MUSE prototype application shows that the concept of equipping tray surfaces with RFID readers and print media with RFID tags allows detailed estimations on print media consumption. However, whether a print media item is actually read while it is held by an individual cannot be discerned. A subsequent study could identify if there is a significant difference in accuracy between the estimation of print media consumption with the MUSE prototype and the real print media consumption, surveyed by traditional panel methods. Additionally, the integration of small, NFC-enabled mobile devices into the prototype system could increase the data quality in that respect and allow the aggregation of demographic data, provided that the user can be motivated to actively participate. This motivation could be achieved by offering VASs to the users. The initial observations on the acceptance of the MUSE prototype by the participating patients suggest that the RFID technology is perceived as highly non-intrusive. This suggests that the deployment of the MUSE prototype has a minimal, if any influence on the print media consumption of the monitored patients and accordingly, could enable the aggregation of consumption data without the possible contaminating effects of panel surveys, like social desirability bias. The patients might have been aware of the prototype system during the field study, but their intended real life purpose while consuming the print media was passing the waiting time during a visit to the doctor, not the media consumption itself, as it would have been in a laboratory setting. Future research needs to be conducted on how the detection accuracy scales with a significantly increased number of (print) media items. Scaling the RFID hardware accordingly, either by increasing the number of RFID tags per magazine or by employing more RFID readers per monitored tray surface area, might be necessary to compensate in that respect.

From a market research perspective, the MUSE concept shows significant potential for the electronic capture of media consumption data. The field study of the MUSE prototype illustrates that it is possible to capture true, unaltered consumer behaviour, e.g. the actual number of readers per print media item with RFID technology in a real world setting.

These initial observations and implications need to be verified with a comparative study, exploring the difference between data, collected with the MUSE prototype and with traditional panel-methods, such as multi-scale surveys. A longitudinal comparative multi-setting study could help in extending the capacity of the findings. Furthermore, we aim to assess the portability of the MUSE concept to different application environments, like e.g., newsstands as the point-of-sale of print media or libraries. This will then bring our research back to the initial idea of allowing VASs for the (print) media consumers.

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