# Assessment and practicability testing of the low level data copy system Radiology Information System Nodepad (RISPad) in radiological routine workflow

Master Thesis

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by
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# Declaration

I declare that I have developed and written the enclosed Master Thesis completely by myself, and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. This work was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

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# Abstract

The RISPad-application is able to document high resolution captures from relevant clinical and medico-legal data obtained during a radiological examination and stores them together with the corresponding examination record in the Picture Archive and Communication System (PACS). The aim of this thesis was to assess the usability and acceptance of this software in daily routine work at a radiological department based on the descriptors of the technology acceptance model (TAM) proposed by Davis F. [1]. Therefore, a structured assessment process was designed that consisted of (1) a self-assessment form asking for the personal computer skills and technology affinity, (2) a tutor controlled evaluation of successful documentation of a clinical document using the RISPad-software and (3) a feedback questionnaire enabling the test persons to state their feedback regarding their perceived ease to use the RISPad-application.

The self-assessment of the technology affinity of the test persons suggested categorization of test persons as: beginners, advanced users and experts. However, the personal self-judgment of computer skills etc. did not significantly influence the confidence a test person felt when working with RISPad. Only age showed some impact on a test person's attitude toward using RISPad. All over the acceptance and perceived usefulness was high throughout the whole tested sample of prospective users. The learning success tested in a tutor guided setting with two rounds was near 100% already after the first instruction round, where all test persons were able to successfully document and store an informed consent sheet together with the correlated examination in the PACS. Only a reduced readability of the documented sheet due to unfocused captures was encountered in few test persons. Thus the all over perceived ease to use RISPad was also high. After each round of the learning success assessment the test persons were asked for their feedback. Comparison of first and second feedback revealed a slightly negative trend in their attitude to use RISPad, when the test persons had work alone, which did not prove significant.

As all TAM derived descriptors scored high in the assessment, it is concluded that RISPad can potentially also reach an intensive actual system use. At least among the test persons a high grade of practicability and acceptance of the RISPad-application could be shown.

# Kurzfassung

Die RISPad-Anwendung ist in der Lage, relevante klinische und medizinisch-rechtliche Daten, welche während einer radiologischen Untersuchung dokumentiert werden, mit hoher Auflösung zu erfassen und zusammen mit der entsprechenden Untersuchung im PACS zu speichern. Das Ziel dieser Arbeit, war die Bewertung der RISPad-Software bezüglich der Usability und Akzeptanz in der täglichen Routine einer radiologischen Abteilung, anhand der von Davis F. beschriebenen Deskriptoren des Technologie-Akzeptanz-Modells (TAM) [1]. Daher wurde ein strukturierter Assessment-Prozess entwickelt, welcher (1) ein Self-Assessment-Formular für die Erfragung der persönlichen Computer-Kenntnisse und der Technologieaffinität enthält und (2) eine, vom Tutor kontrolliert Bewertung der Dokumentation eines klinischen Dokuments mit der RISPad-Software. Weiters wurde (3) ein Feedback Fragebogen erstellt, um den Testpersonen die Möglichkeit eines Feedbacks, bezüglich der wahrgenommenen Benutzerfreundlichkeit der RISPad-Anwendung zu geben.

Die Testpersonen, wurden durch ihre Selbsteinschätzung der Technologieaffinität in Anfänger, fortgeschrittene Anwender und Experten unterteilt. Jedoch hatten die persönliche Selbsteinschätzung der Computer-Kenntnisse etc. keinen signifikanten Einfluss auf das Selbstvertrauen, welches die Testperson bei der Arbeit mit RISPad bekam. Nur das Alter zeigte bei den Testpersonen eine Auswirkung auf die Einstellung zur Nutzung der RISPad-Anwendung. Insgesamt, waren die Akzeptanz und die wahrgenommene Nützlichkeit während der gesamten Bewertung durchwegs hoch. Der, vom Tutor, in zwei Runden geführte Lernerfolg, ergab bereits nach der ersten Runde beinahe 100%, bei dem alle Testpersonen in der Lage waren, eine Einwilligungserklärung erfolgreich zu dokumentieren und zusammen mit der entsprechenden Untersuchung im PACS zu speichern. Nur eine reduzierte Lesbarkeit, aufgrund der unscharfen Aufnahme des Dokumentes, wurde bei einigen Testpersonen gefunden. Somit, war die wahrgenommene Benutzerfreundlichkeit von RISPad insgesamt hoch. Nach jeder Bewertungsrunde des Lernerfolges, wurden die Testpersonen um ihr Feedback gebeten. Im Vergleich des ersten zum zweiten Feedback, ergab sich ein leicht negativer, nicht signifikanter, Trend in der Einstellung zu Nutzung von RISPad, wenn die Testpersonen allein arbeiten mussten.

Dadurch, dass alle abgeleiteten TAM Deskriptoren eine hohe Bewertung erhielten, wird der Schluss gezogen, dass RISPad möglicherweise ein intensiv genutztes System werden kann. Zumindest konnte unter den Testpersonen ein hohes Maß an Praktikabilität und Akzeptanz der RISPad-Anwendung gezeigt werden.

# Table of Content

# 1 Introduction

Digital media became an essential part of our daily way of living, which equally concerns professional and private activities. Especially, life at work is embedded into multiple computerized processes necessary for management and administration of the given respective work-load. This circumstance is also true for medicine and, in particular, for radiology. Since the late 1990ies a continuous digitalization of radiological image data took place that also required the progressive use of computer aided systems to store the produced images and, with an increasing number of examinations, to manage the acquisition of those. For this purpose several components administrating radiological data were introduced into the radiological work-flow with the Radiology Information System (RIS) and the Picture Archive and Communication System (PACS) being the most important ones [2].

RIS basically manages the patient master data, schedule planning of radiological examinations and documentation of services relevant for billing. Furthermore an interface to imaging modalities (for example: magnetic resonance imaging scanner) is supplied, which is used to transfer the identifying patient data [2]. Via this patient data, the designated examination can be carried out. Prior to the clinical investigation, the patient must be allocated electronically, by the doctors of the inpatient our outpatient department. This particular allocation is done via Hospital Information System (HIS), which regulates acquisition, editing and transmission of clinical and administrative data [3]. In the case of a radiological allocation the following data is provided via HIS, for instance: patient data, examination modalities, examination area, medical history, suspected diagnosis, preferred date, urgency, etc. After examination, the created image data is transferred to the PACS. In the medicine sector, PACS is used to store image data of all radiological modalities [4]. This image data can be fetched, for miscellaneous tasks, by the corresponding viewing and post-processing devices, as well as it can be retrieved by connected imaging modalities. Management of image display request, for medical investigation is done by selecting the desired examination in RIS, which loads the image data via interface in parallel from PACS. The radiological findings can be created and stored in RIS afterwards, which sends the information to the HIS, where it accessible for the assigning doctor.

In the radiological workflow also additional, often manually filled data, like informed consent documents and patient education sheets is generated, and often relevant for later examination. Currently available HIS-RIS-PACS structure doesn’t support storage of these handwritten documents together with the corresponding image data. Storage of these documents is carried out in HIS, while radiological image data is stored in PACS. During the generation of the radiological findings, additional document data has to be searched manually from HIS, because the two systems (HIS and PACS) are not interconnected. From a RIS and PACS point of view, there is no possibility to access the HIS data directly. As a result, there is a high potential to loose relevant data, which leads to an inconsistent documentation. Therefore it would be useful, to store the relevant documentation straightforward with the radiological image data.

Together, with my project partner Nasel C., our main target, during the master's degree study, was to find a solution, to store relevant clinical and medico-legal data, acquired during radiological routine work together with the corresponding examination and therefore to the radiological image data. In the course of the master's degree study project ‘RISPad’ (Radiology Information Storage Notepad), a Graphic User Interface (GUI) was programmed for a document camera, to acquire relevant documents such as an informed consent sheet, and to store the data, together with the assigned radiological image data. To enable a wide field of application a simple, effective and well accepted design was essential.

Therefore the thematic area of my master thesis is the assessment of field data, concerning usability and acceptance of the RISPad-application. The corresponding field data was acquired in the University Hospital Tulln – Department of Radiology under real-life conditions.

The aim of this document is to answer the following research questions:

- How high is the practical usage value of the application ‘RISPad’ in the radiological routine workflow?
- How well accepted is the ’RISPad’ application by employees belonging to the Department of Radiology?

For the assessment of the RISPad-application, an assessment process, a self-assessment of computer experience and technology affinity, a learning success sheet and a feedback sheet where developed and used. Additionally the chance was given to address possible problems.

The achieved data has been analyzed via the programming language ‘R’, especially designed for statistical and graphical evaluation. For evaluation purposes, the Technology Acceptance Model (TAM), described by Davis F., was chosen.

The subsequent chapter explains the theoretical background, followed by the chapter methodology, which concentrates on the execution of the developed assessment and describes the used statistical tests. Hereinafter the results will be shown in detail, followed by the discussion and conclusion.

# 2 Theoretical Background

This chapter focusses on the description of the HIS/RIS/PACS environment, as well as the radiology workflow. Furthermore the realization of the master thesis project ‘RISPad’ is covered and the resulting usage of the technology acceptance model.

## 2.1 HIS/RIS/PACS Environment

Common data storage of these two data sets is a challenge, due to the existing software structure. Generally the radiological examination is performed, in collaboration with RIS and PACS. Both components do not support storage of documents together with radiological image data [5, 6]. Storage of relevant documents is carried out with HIS, which doesn’t allow a direct query of documents together with radiological image data.

In detail, when a patient indicates, prior to the actual magnetic resonance imaging examination, that he has a contrast agent allergy, the responsible radiology technologist (RT) takes a handwritten note on the informed consent document. This kind of information is essential for the examiner, because in this case, an examination with contrast agents is contraindicated. Unfortunately it is hardly possible to store this information together with the image data in RIS/PACS. The storage in HIS is even problematic, because it is only possible in a later stage of the examination workflow. Furthermore HIS doesn’t enable a direct access from relevant documents to the designated image data. For radiological examination, this information must be requested manually from HIS respectively has to been asked for by the RT. Therefore there is a high risk, that essential information is lost, or that the traceability and reasonability of decisions is not ensured, and can be problematic during subsequent inspection.

The reason for this shortcoming is due to the communication structure from RIS/PACS to HIS. Most of the RIS’s where designed to receive an examination inquiry from HIS, whereby the central task was to link designated patient data, with the correct examination. Usually after the examination, a report is sent back to the HIS. Both components don’t inherit a communication structure, which enables a two way communication, and information exchange, between HIS and RIS, because the initial idea was a simple transfer of examination results from

RIS to HIS. The requirement of multidirectional communication of HIS-RIS-PACS is implemented for the implementation of additional system architecture, like the patient centered electronic health record system: 'Elektronische Gesundheitsakte' (ELGA) [7-9].

From the user’s point of view, disadvantages in the radiological information management become clearly visible, as important information should be saved together or within the examination, which is the foundation of the subsequent examination report. Most of the RIS/PACS workstations do not provide integrated HIS functionality. Therefore the examiner has no access to critical information [10]. This circumstance is often solved, by implementing of a second workstation in the radiological working environment. This rather impractical workaround interferes with the need for an efficient workflow, but is still state of the art in medical routine business.

The more or less rigorous, functional restriction, of relevant patient data access, limit the diagnostic abilities and addresses the restrained communication between HIS and RIS/PACS as a problem of ‘E-health’ or particular, as a problem of ‘Electronic Health Records’ (EHR) [10]. The EHR is a subfield of E-health, where the connection between HIS and RIS/PACS is a key issue in the area of Digital Health care [11]. Although the latest development in EHR tries to implement all kind of information into an comprehensive system (for example Austria’s e-Health project ‘ELGA’), these concepts still rely on a bottom-up concept, which is in use for the last 40years, in most of the EHR applications. Systems with Bottom-up design do not primary emphasis on day-to-day usage requirements of the medicine workflow, as they are tools for public healthcare management and economics [12]. The concept of these EHR systems originates in an era, where usage of computers was not common in data processing and storage.

## 2.2 Radiology Workflow

The radiological workflow is based on the interaction between HIS, which sends an allocation to the RIS/PACS structure and while RIS sends a report to the HIS environment (**Figure 1**). An information retrieval from RIS to HIS, which is accessible in the subsequently used PACS, is not implemented. It is a matter of fact that radiologists have to rely on availability of HIS access in almost every case, where additional clinical data for medical report generation is necessary. Electronic medical record are almost completely maintained in HIS, most hospitals even use electronic documentation devices, but the functionality of the interface between HIS and RIS/PACS, regarding clinical data, is rather modest. This is the reason, why future utilization of RIS was questioned [2]. The historical background for this structure can be seen in the mindset, that only the allocation of the radiological examination has importance for radiologists. This is in complete accordance with the communication between HIS and RIS, although it is highly complex in detail [11, 13-15].

The main work area for the radiologist is PACS, while RIS is required to create the medical report. The most important data in radiology is image data, and the radiologist examines the images directly in PACS-viewer, whereas only a relative small amount of information is needed from the RIS. In this combination, the HIS is only a parallel structure, which isn’t integrated into the radiological workstation, as shown in **Figure 1**. However it has been proven, that the radiologist needs access to clinical data, which has an impact on the interpretation of the radiological image data [10].

In this system architecture there is no possibility to grant access to clinical data, respectively image data, on PACS or RIS. For instance, the radiologist has no possibility to document an informed consent discussion. This is still done by a handwritten paper and the ‘promise’, that the informed consent document will be transferred into HIS. On the other hand, it is not possible to collect and administrate all the clinical data together with the image data in PACS. The first scenario even implicates the risk that the informed consent document gets lost on its way to the HIS. Therefore there is a potential risk for the patient, that fundamental information, like a pregnancy, possible incompatible implants or undesired pharmaceutical side effects is lost. The second scenario could undermine the documentation rules of the Good Clinical Practice (GCP), as the clinical data cannot be stored together with the image data [16]. These rules imply that an instant storage of relevant clinical data together with radiological image data on PACS-level and a direct access to this data by the radiologist should be utilized. In this context, it has been shown, that an automatic and immediate acquisition of relevant clinical date leads to significantly reduced amount of documentation errors compared to a delayed and manual data insertion [17].

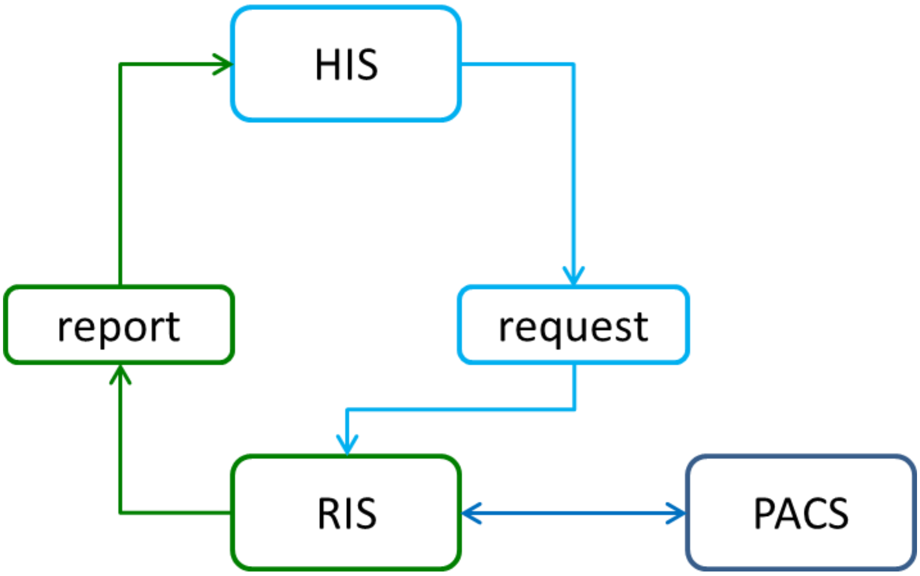



***Figure 1:*** *Bottom up structure from HIS to RIS/PACS*

The negotiation between HIS, RIS and PACS is hampered by the rudimental configuration of the interface between the various components.

Considering the published evidence for integrating clinical, scientific and medico-legal data at the acquisition time into the radiological image data and the given technical possibilities and storage standards currently available, efforts are justified to realize the Master project 'RISPad'. In the wide field of digital health care to, the presented project aims to realize a practical tool that enables incorporation of correlated clinical data directly into radiological examinations, thereby generating valuable data.

The developed tool is conceptualised as a Java language-based application that should work in conjunction with any associated radiological modality. On the one hand, the tool has to work independent from the modality, on the other hand, is has to assure, that the scanned documents are linked to the corresponding image data. As a consequence, this tool incorporates an interface, which ensures, that valuable information, generated throughout an examination is linked and stored in a correct way with the corresponding image data in PACS. The intended interface should open a possibility to document simple written clinical records as second screen captures according to international standards for Digital Imaging and Communications in Medicine (DICOM). The interface, therefore, offers functionality comparable to a notepad, where relevant non-image data records collected during an examination can be directly accessed in the PACS. Simply scanned written data or photographical documentations could be stored together with the radiological image data.

This straight forward concept fits the bottom-up structure of the given EHR-environment and consistently puts the data where they are needed for further evaluation.

## 2.3 Master project 'RISPad'

The RISPad project offers an opportunity to expand data management and handling in the existing bottom-up structure and to store valuable extra information together with radiological image data in PACS. RISPad utilizes a browser based application and a high resolution document camera. The open architecture design of RISPad enables connection of multiple clients within the whole department of radiology, whereby only basic Personal Computer (PC) hardware requirements have to be maintained (for instance Intel i5 standard). As the client is executable in a modern standard browser (FireFox) and the chosen camera supports USB Video Class (UVC)-standard no additional software installation is required. Only on the server PC, the software, together with integrated application package has to be installed. This system architecture enables a maximum flexibility during selection of client workstations in proximity to the radiological modality and is minimum maintenance effort for the server (**Figure 2**).

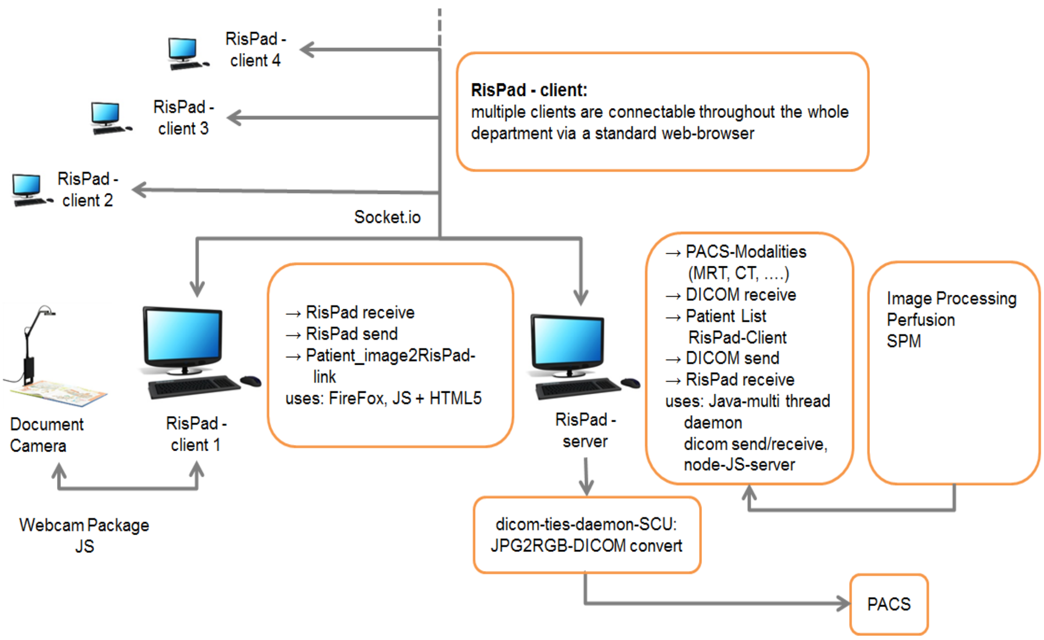



***Figure 2:*** *RISPad Environment*

The RISPad-environment in its simplest form can be installed on any number of PCs. Since the client architecture is web-browser based with a UVC-standard device communication to the Universal Serial Bus (USB)-document scanner camera there is no software installation at the client side necessary.

For better applicability of RISPad a GUI has been developed, which can be displayed in the web-browser (**Figure 3**). The document camera can be connected via USB-terminal to any client workstation within the department, which has access to the server PC. The GUI shows the live image of the document camera (1) on the right side. By simply clicking on the live image, a screenshot with medium resolution is generated in the control screen (2), to judge the image sharpness. After the user approval, the relating screenshot gets stored and a small image thumbnail is shown on the screenshot bar (3). The lower part of the GUI contains information about available patients and the correlating examinations, which can be connected with the screenshots. The quantity of screenshots was limited to a maximum requirement of radiology to reduce potential risk of documentation and operating errors. Before linking patient data with screenshots, the patient data overview (4) enables a validity check. After clicking the 'link to dicom'-button, the patient data gets irreversible connected and interlinked with the screenshots, and the data set as whole is transmitted to the PACS via the server PC.

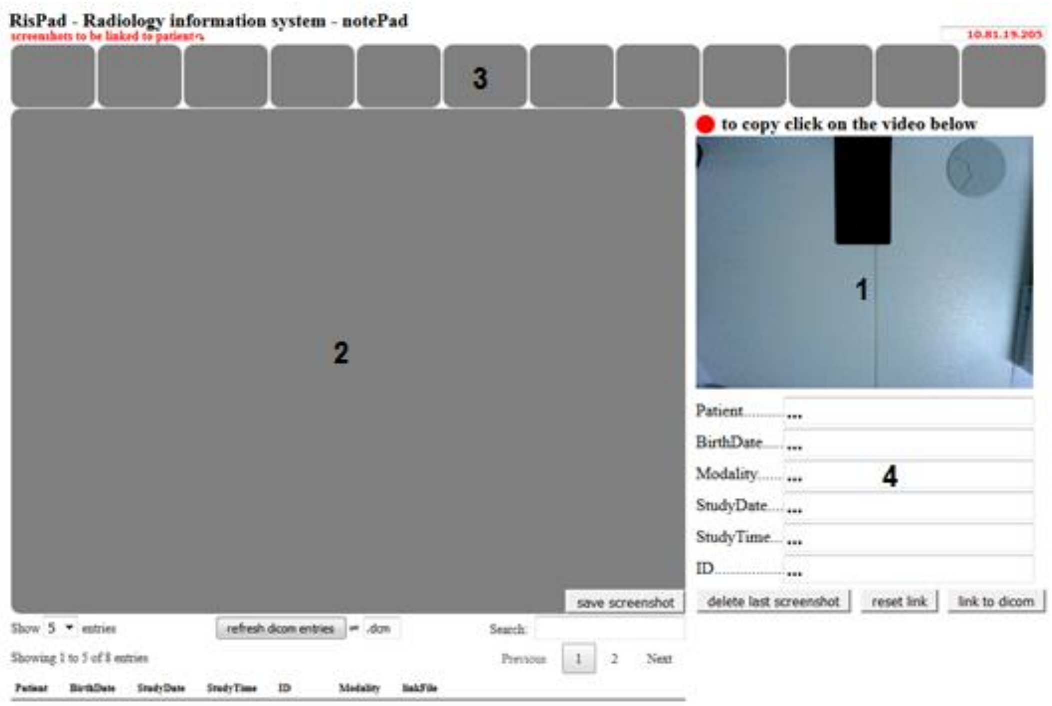
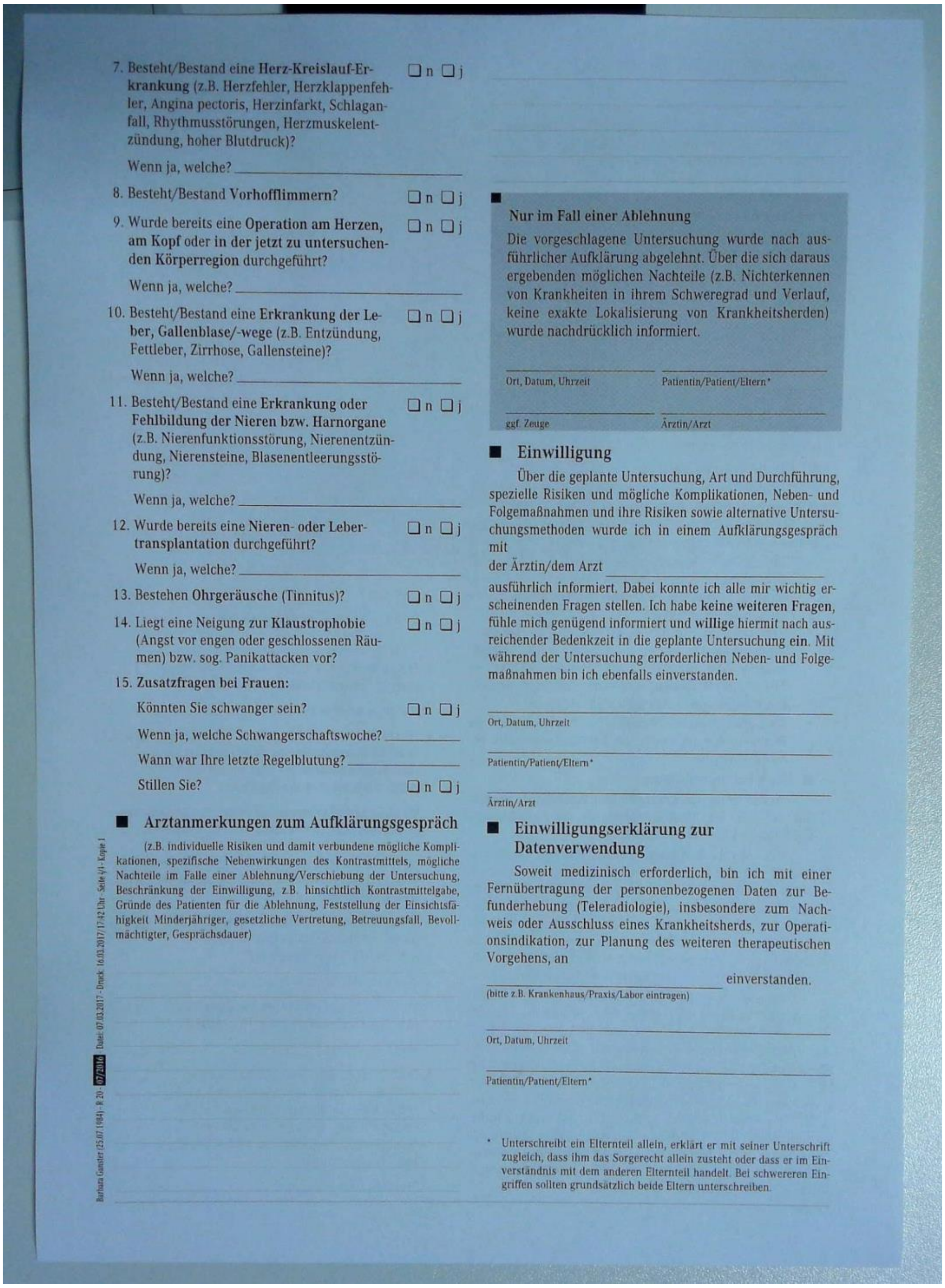



***Figure 3:*** *Graphic User Interface of the RISPad-Application*

(1) live image, (2) control screen, (3) screenshot bar, (4) patient data overview

To ensure a good readability, RISPad generates and saves high resolution images due to the circumstance that generated data often is a copy of text and/or handwritten documents (for instance, an informed consent document). **Figure 4** shows the check of the first available example for readability with a satisfying result.



7. Besteht/Bestand eine **Herz-Kreislauf-Erkrankung** (z.B. Herzfehler, Herzklappenfehler, Angina pectoris, Herzinfarkt, Schlaganfall, Rhythmusstörungen, Herzmuskelentzündung, hoher Blutdruck)? ❑ n ❑ j

Wenn ja, welche? ______

8. Besteht/Bestand **Vorhofflimmern**? ❑ n ❑ j

9. Wurde bereits eine **Operation am Herzen, am Kopf oder in der jetzt zu untersuchenden Körperregion** durchgeführt? ❑ n ❑ j

Wenn ja, welche? ______

10. Besteht/Bestand eine **Erkrankung der Leber, Gallenblase/-wege** (z.B. Entzündung, Fettleber, Zirrhose, Gallensteine)? ❑ n ❑ j

Wenn ja, welche? ______

11. Besteht/Bestand eine **Erkrankung oder Fehlbildung der Nieren bzw. Harnorgane** (z.B. Nierenfunktionsstörung, Nierenentzündung, Nierensteine, Blasenentleerungsstörung)? ❑ n ❑ j

Wenn ja, welche? ______

12. Wurde bereits eine **Nieren- oder Lebertransplantation** durchgeführt? ❑ n ❑ j

Wenn ja, welche? ______

13. Bestehen **Ohrgeräusche** (Tinnitus)? ❑ n ❑ j

14. Liegt eine Neigung zur **Klaustrophobie** (Angst vor engen oder geschlossenen Räumen) bzw. sog. Panikattacken vor? ❑ n ❑ j

15. **Zusatzfragen bei Frauen:**

Könnten Sie schwanger sein? ❑ n ❑ j

Wenn ja, welche Schwangerschaftswoche? ______

Wann war Ihre letzte Regelblutung? ______

Stillen Sie? ❑ n ❑ j

■ **Arztanmerkungen zum Aufklärungsgespräch**

(z.B. individuelle Risiken und damit verbundene mögliche Komplikationen, spezifische Nebenwirkungen des Kontrastmittels, mögliche Nachteile im Falle einer Ablehnung/Verschiebung der Untersuchung, Beschränkung der Einwilligung, z.B. hinsichtlich Kontrastmittelgabe, Gründe des Patienten für die Ablehnung, Feststellung der Einsichtsfähigkeit Minderjähriger, gesetzliche Vertretung, Betreuungsfall, Bevollmächtigter, Gesprächsdauer)

■ **Nur im Fall einer Ablehnung**

Die vorgeschlagene Untersuchung wurde nach ausführlicher Aufklärung abgelehnt. Über die sich daraus ergebenden möglichen Nachteile (z.B. Nichterkennen von Krankheiten in ihrem Schweregrad und Verlauf, keine exakte Lokalisierung von Krankheitsherden) wurde nachdrücklich informiert.

Ort, Datum, Uhrzeit ______ Patientin/Patient/Eltern* ______

ggf. Zeuge ______ Ärztin/Arzt ______

■ **Einwilligung**

Über die geplante Untersuchung, Art und Durchführung, spezielle Risiken und mögliche Komplikationen, Neben- und Folgemaßnahmen und ihre Risiken sowie alternative Untersuchungsmethoden wurde ich in einem Aufklärungsgespräch mit

der Ärztin/dem Arzt ______

ausführlich informiert. Dabei konnte ich alle mir wichtig erscheinenden Fragen stellen. Ich habe **keine weiteren Fragen**, fühle mich genügend informiert und **willige** hiermit nach ausreichender Bedenkzeit in die geplante Untersuchung **ein**. Mit während der Untersuchung erforderlichen Neben- und Folgemaßnahmen bin ich ebenfalls einverstanden.

Ort, Datum, Uhrzeit ______

Patientin/Patient/Eltern* ______

Ärztin/Arzt ______

■ **Einwilligungserklärung zur Datenverwendung**

Soweit medizinisch erforderlich, bin ich mit einer Fernübertragung der personenbezogenen Daten zur Befunderhebung (Teleradiologie), insbesondere zum Nachweis oder Ausschluss eines Krankheitsherds, zur Operationsindikation, zur Planung des weiteren therapeutischen Vorgehens, an

______ einverstanden.

(bitte z.B. Krankenhaus/Praxis/Labor eintragen)

Ort, Datum, Uhrzeit ______

Patientin/Patient/Eltern* ______

* Unterschreibt ein Elternteil allein, erklärt er mit seiner Unterschrift zugleich, dass ihm das Sorgerecht allein zusteht oder dass er im Einverständnis mit dem anderen Elternteil handelt. Bei schwereren Eingriffen sollten grundsätzlich beide Eltern unterschreiben.

***Figure 4:*** *Example of the readability*

All RISPad-Images are stored at a resolution of 3264 x 2448 pixels, which warrants readability of the copied forms and notes.

As an additional tool in the field of digital components (like HIS, RIS, PACS) and digital modalities, RISPad had to be easy to implement and the design had to be user friendly. To test the acceptance and user-friendliness of the recently integrated tool, RISPad was implemented in the University Hospital Tulln – Department of Radiology and an assessment was generated. The assessment was carried out based on the TAM, developed and published by Davis [1].

## 2.4 Technology Acceptance Model

The TAM tries to predict acceptance of newly introduced technologies and to evaluate why persons use or don't use a certain technology. In business informatics, the TAM is one of the most prominent and examined models, with the target to predict the intention of utilization of a computer technology and it is the cornerstone of the technology acceptance models depending on it, in the field of information system research. It builds upon the recommendations in previous studies, which refer to the socio-psychological model 'Theory of Reasoned Action' (TRA), developed by Ajzen und Fishbein in 1980. The TAM indicates that the attitude towards system usage depends on two factors: 'perceived usefulness' and the 'perceived ease of use'. The 'perceived usefulness' is the subjective perception of a person, if the utilization of a technology improves work performance or not. The 'perceived ease of use' is a measure for the perception the person has of how much effort it is to learn the application of the new technology (**Figure 5**) [1].

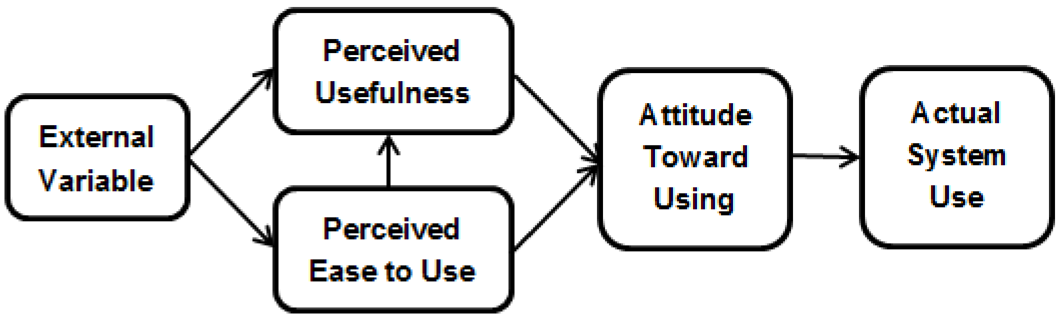



***Figure 5:*** *Technology Acceptance Model (according Davis F. et al. 1989)*

In the year 2000, the TAM was extended by some input variables under the designation TAM2 by Venkatesh und Davis. These variables where structured in two groups: 'social influence' and 'cognitive instrumental processes'. The variables 'subjective norm', 'image' and 'voluntariness' belong to the group 'social influence'. 'Subjective norm' is defined as the human perception, which behavior of a person is expected by the social environment of that person. 'Voluntariness' is defined as a scale for how mandatory a given usage task is perceived by the person. Furthermore the variable 'experience' was defined, which has an influence on ‘subjective norm’. ‘Experience’ causes that ‘subjective norm’ has a positive effect on the ‘intention to use’, if usage of new technology is mandatory. In addition ‘subjective norm’ has a positive influence on ‘image’, which is defined as level of influence on the social status of a person by utilization of a new technology. In TAM2 a positive effect by ‘subjective norm’ onto ‘image’ and a positive influence from ‘image’ to ‘perceived usefulness’ is described. A higher ‘experience’ reduces the impact of the direct effect from ‘subjective norm’ to ‘intention to use’ when usage is mandatory and even reduces the impact of the positive effect from ‘subjective norm’ to ‘perceived usefulness’ [18].

The second group ‘cognitive instrumental processes’ consists of the variables ‘job relevance’, ‘output quality’ and ‘result demonstrability’. ‘Job relevance’ is defined as the perception of a person regarding suitability of utilization of a new technology for his working activities. This means, if the system functions are useful for completing his tasks. ‘Job relevance’ is a rather quantitative measure for the degree of how much technology improves efficiency. ‘Output quality’, in exchange, is a qualitative measure for effectiveness. ‘Result demonstrability’ finally defines the degree of how good positive effects can be allocated directly to the new technology. If a system increases working performance in a not so perceptual way, the user realizes the benefits in a lesser extent. As a result all three variables have a positive impact onto ‘perceived usefulness’ (**Figure 6**) [18].

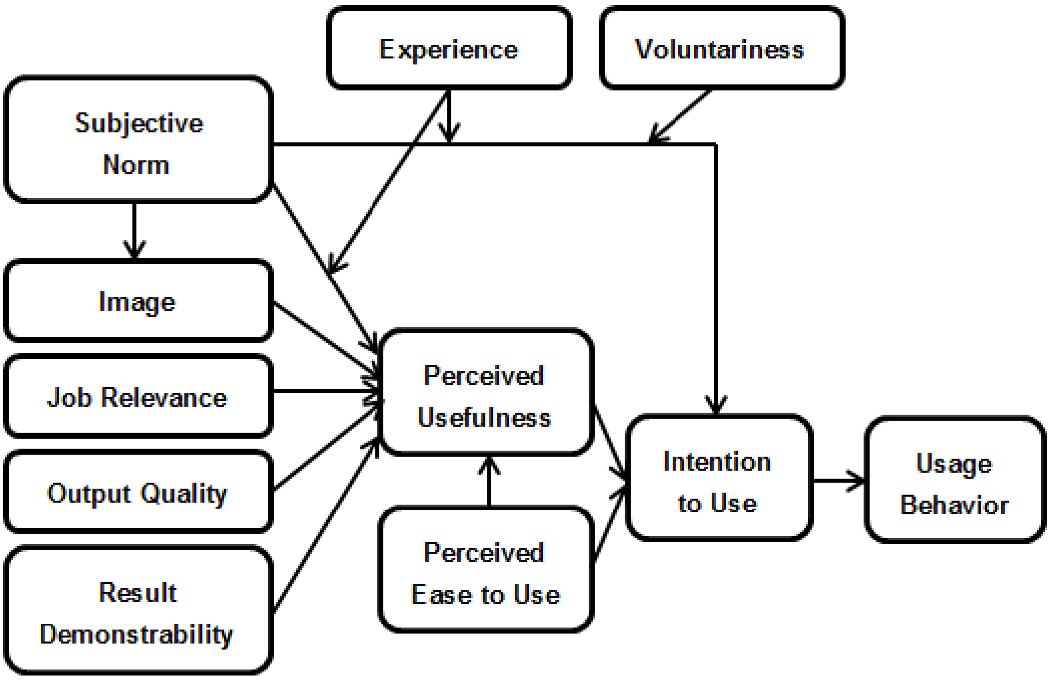



***Figure 6:*** *Technology Acceptance Model 2 (according Venkatesh V. et al. 2000)*

# 3 Methodology

To determine acceptance and practicability of RISPad TAM, described by Davis F., was chosen. In detail extended TAM, published in the year 2000 and designated as TAM2 was used to meet the requirements of RISPad. An extensive technical description of the RISPad-application is provided by Nasel C., co-author of the RISPad-project, who will report all technical and implementation aspects in a related thesis.

## 3.1 Self-judgment of Computer Experience and Technology Affinity

The impact of the variable ‘experience’ was essential, in particular, for RISPad software, because it had not been possible to evaluate RISPad, in the field of radiology technology and computer sciences without it. TAM2 postulates a direct impact of ‘experience’ on ‘subjective norm’ and ‘Intention to use’ and an indirect impact on ‘perceived usefulness’ as a result. Therefore, persons with higher levels of computer experience were expected to obtain better results than users with less experience, which could potentially influence the usage and integration of the software in daily routine work. Testing this social variable was consecutively defined as the first part of the assessment prior to any evaluation of cognitive variables.

To evaluate ‘experience’, a questionnaire about technology-affinity has been designed. Additionally the demographic data, age divided in groups, gender and profession, divided in categories medical-technological assistants (MTA), RT or medical doctor (radiologist) where gathered in the questionnaire. The topic technology-affinity was covered initially by a self-assessment of the test person regarding computer skills divided in the categories beginner, advanced user and expert. In the next step the test persons had to answer four questions, focusing on how much and willingly they work with computers, the amount of private computer usage and the integration of computers in their private life (mobile-apps, etc.). The correlation of the computer skills self-assessment and the answers about usage behavior are supposed to give an insight on personal sympathy before first contact with a new application, like RISPad. To answer the questions, a numeric rating-scale was chosen, rating from 1 ‘not correct’ to 10 ‘fully correct’. The aim of this analysis was to find out the user utilization value of RISPad in daily routine work.

## 3.2 Assessment of Learning Success

The cognitive variables ‘output quality’ and ‘result demonstrability’, which have an impact onto ‘perceived usefulness’ where examined in correlation with the usage success evaluation. To enhance understanding of these variables, the documentation process had been divided into single sections, each one containing a step of the result generation process. All items of the assessment, except the item ‘SCREEN SHOT READABLE’ were categorized as ‘SOFTWARE SKILLS’. ’SCREEN SHOT READABLE’ had its own category (‘ATTENTION-RELATED’), because it is an item which only measures the attention during documentation and therefore isn’t strictly necessary for a successful documentation process. All other items corresponded to a step of documentation of the informed consent sheet, which was necessary for successfully accomplishing the documentation. The test person received a point for each completed step. The total amount of achieved points was a measure for describing the output quality. A correct documentation result could only be obtained if at least the majority of the single steps were completed successfully. As a result, the ease of operation was a key element of GUI-Design in RISPad, because a complicated GUI was expected to increase the failure rate compared to a rather simple GUI. The single steps of documentation have been described in a manual (appendix A), which was accessible during test phase. An additional goal of this analysis was to detect possible weaknesses of the documentation process.

## 3.3 Assessment of Feedback

In order to get a measure of the ‘Perceived Ease of Use’ a feedback questionnaire was constructed (appendix E; **Figure 7**). In correlation with the assessment of ‘learning-success’, the documentation of the informed consent document via RISPad was organized in major subtopics, to achieve the objectives. A ten point scale, ranging from 1 ‘not correct’, to 10 ‘fully correct’ was used by the test users to state their personal perception on how easy it was to execute the single documentation aspects and procedures.

Following questions where treated:

| **Question** | **Items** |
|---|---|
| Is it easy to start the program? | ‘ACCESS’ |
| Is the graphical user interface easy to understand? | ‘GUI’ |
| Is it easy to generate a screenshot? | ‘IMAGE’ |
| Is it easy to operate the patient list? | ‘LIST’ |
| Is the patient selection designed clearly? | ‘DISPLAY’ |
| Is the transfer to PACS safe to operate / fault proof? | ‘TRANSMIT’ |
| Is the manual easy to understand? | ‘MANUAL_EASY’ |
| Was the manual necessary to operate RISPad? To possible answering options ‘yes’ or ‘no’ where given.<br>→ if answer=yes, then additional question: Was the manual useful during documentation process? | ‘MANUAL_NEEDED’<br><br><br>‘MANUAL_HELPFUL’ |

***Figure 7:*** *Questions and the associated items of the categories ‘APPLICATION and ‘MANUAL’*

This additional question and the question, ‘Should the transfer to perfusion II happen automatically?’ and ‘Was the demonstration lesson sufficient?’ can be addressed directly to ‘perceived usefulness’ according to the TAM. Furthermore the question concerning the demonstration lesson is able to display the teaching skills of the tutor. In the questionnaire, the personal perception of the test person was also recorded, if a stand-alone documentation via RISPad can be carried out at a later point in time (item: ‘SELF_CONFIDENCE’). This question was addressed to the variable ‘experience’ and has direct impact onto the ‘perceived usefulness’. The latter questions where dealt with the same 1 ‘not correct’ to 10 ‘correct’ numeric rating-scale as the questions before. To make the point of view of the test person more transparent (item: ‘ALL-OVER’), in terms of general impression, an evaluation, ranging from 1 ‘application is not good’ to 10 ‘application is very good’, was implemented. This question is a scale for the variable ‘job relevance’, which has a direct impact on ‘perceived usefulness’. The aim of the feedback sheet was basically the evaluation of the ‘perceived ease of use’, although additional questions grant a statement on ‘perceived usefulness’.

## 3.4 Assessment Process

The assessment was carried out after implementing RISPad in University Hospital Tulln at the Department of Radiology. In total 5 radiologists, 5 MTA and 15 RTs were included in the assessment. Persons, which took a major part in RISPad development, as well as persons, not operating the MRI where excluded. The assessment plan was structured into several parts. As a first step, the project goals of the master thesis project ‘RISPad’, basic requirements for data acquisition and a schedule for evaluation where determined (appendix B). Afterwards, the test persons were asked to carry out the questionnaire for technology affinity (appendix C). In this form, they were asked to assess their computer skills and the degree of computer technology integration into their day-to-day life. Then the manual (appendix A) and a two-sided informed consent document of a MRI examination for application of RISPad documentation were handed out. During the first time utilization of RISPad by the test person, the procedure was shown by the tutor under usage of the manual and arising question where clarified. The second try, to carry out a RISPad documentation of an informed consent document, was conducted by the test persons without the aid of the tutor, with the risk of complete fail of documentation process. The manual was accessible during the second try. Occurring problems could be noted on an error report sheet by the test persons (appendix D ‘Problemerfassung’). The correct execution of documentation process was assessed with a rated scoring system by the tutor in parallel and noted in the corresponding table (appendix D ‘Lernerfolg’) to calculate an overall score. After the completion of the documentation, the test persons were asked to fill out the feedback report (appendix E), to record their perception of the ease of use. The feedback report also offered a space for remarks at the end of the document, were the test person could write down their additional thoughts or further explanations. The documentation was repeated seven days afterwards in average. Again, the test persons had to carry out the documentation of a four-sided informed consent document via RISPad without the aid of the tutor, but could use the manual if ambiguities occurred. As in the previous executions, the steps were assessed with a scoring system with subsequent summation of the partial results. This time, the feedback report was carried out, to determine differences in perception, regarding user-friendliness, after a specific period.

## 3.5 Statistical Analysis

Data quality of the assessment sheets: ‘Technology Affinity’ and ‘Learning Success’ was judged as rank scaled, since both sheets were used to derive a sum-score from all positively mastered tasks. Since the assessment sheet: ‘Feedback’ contained several questions, where the answer itself was derived from a given scale, also, the data quality of these answers was interpreted as rank scaled for the further statistical evaluation. If not denoted otherwise, all demographic data are displayed as median and median absolute deviation (MAD) or, simply, the 1st and the 3rd quartiles are given.

In the statistical analysis of the 'Technology Affinity' – sheet the evaluation was based on three groups: beginners, advanced users and experts, where the grouping resulted from a self-estimation of personal information technology (IT)-skills. Due to rather small group sizes and the given data quality Kruskal-Wallis tests for detection of differences of self-estimated personal IT-skills were used, even more, since no normal distribution of data was assumed. In the post hoc analysis differences between groups were tested using the Dunnett-Tukey-Kramer (DTK) method with correction for multiple comparisons according to Bonferroni. The DTK-analysis especially takes a small sample size in the groups and the heteroscedasticity between the groups into account.

From the 'Learning Success'-sheets a sum-score of all mastered tasks was calculated. Due to the fact that the number of sheets asked to be copied during the instructed and individual working tests was different, the item: 'SCREEN SHOT READABLE' was not included into the sum-score assessment (**Figure 8**). This item was considered to represent actually more of a test person's level of attention than her or his skills to work with the assessed software. Thus, this item was placed in a category for attention-related items. All other items were interpreted to indicate primarily the skills a test person had to fulfill the given task. These items were, therefore, classified as skill-related and collected in a separate category. Since descriptive statistics concerning the learning success already showed small differences between the groups only and given the quite small sample size, just the odds to get a failure in one of the tasks were calculated and compared using the (log) odds ratio – test.

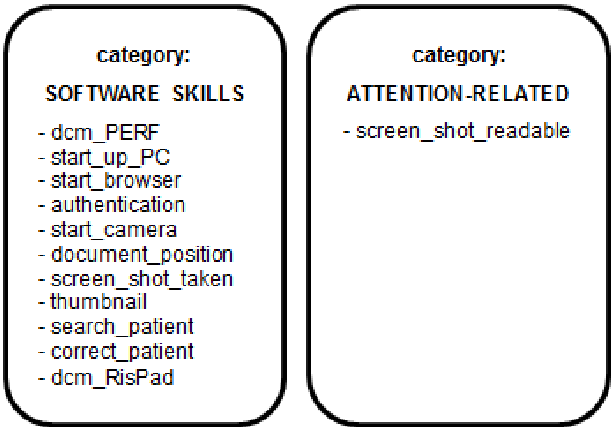



***Figure 8:*** *Categories and Items of the Assessment Sheet: learning success*

In the assessment sheet: ‘Feedback’ generally the practicability of the RISPad-application as perceived by the test persons was evaluated. Initially, the test persons scored their perception of the usefulness of the RISPad-application, which could also include the personal judgment of the job-relevance. Thus the item: ‘ALL_OVER’ was placed in the category: ‘RELEVANCE’. The items: ’ACCESS’, ’GUI’, ’IMAGE’, ’LIST’, ’DISPLAY’, ‘TRANSMIT’ were placed together in the category: ‘APPLICATION’. Also, the usefulness of the provided manual was asked for. The three items (‘MANUAL_EASY’, ‘MANUAL_NEEDED’ and ‘MANUAL_HELPFUL’) were assessed separately from all other items (category: ‘MANUAL’), since not all of the test persons really used the manual. Additionally, the grade of self-confidence concerning the personal skill to fulfill the respective tasks was asked (item: ‘SELF_CONFIDENCE’) and placed in another separate category: ‘CONFIDENCE’. All items were tested in the assessment under two different conditions, namely, instructed and individual working. This was interpreted as testing the same rank-scaled, not necessarily normally distributed items in the same person under two different conditions, which was considered to apply best to the Wilcoxon Test for two dependent samples (**Figure 9**).

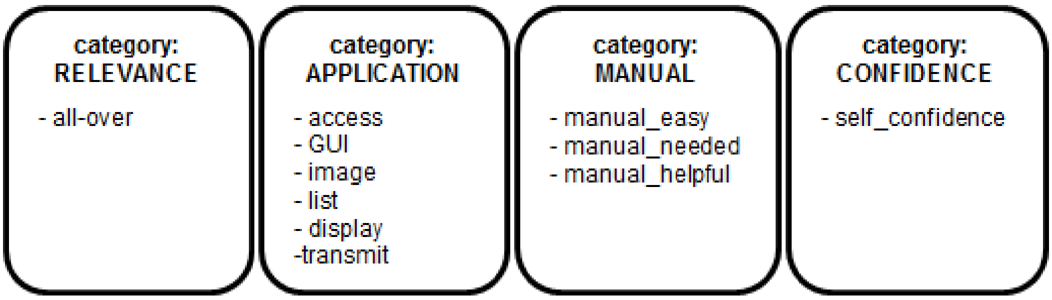



***Figure 9:** Categories and Items of the Assessment Sheet: Feedback*

Furthermore, interactions between CONFIDENCE vs TECHNOLOGY AFFINITY AND AGE, as well as AGE vs TECHNOLOGY AFFINITY were tested using Spearman rank correlations.

A probability level of $p<0.05$ was defined to represent a result significantly different from the tested $H_0$. All statistical analyses were performed using the freely available software package R (v 3.0.1), with installed packages: ‘vcd’, ‘pspearman’, ‘robustbase’ and ‘DTK’ [19-23].

# 4 Evaluation Results

All test persons were able to complete the tasks in the various test situations. The examined sample suffered an inclusion bias, since more female colleagues were working in the department where RISPad was assessed. Also, more RT and MTA were tested, since the number of employees in this field was higher, than the number of Radiologists working in the department.

The age in the beginners group was slightly higher (median: category 50-59 years) than in the advanced users group (median: category 40-49 years). The only expert was male and applied to the age-category: 30-39 years. For more details see **Table 1**.

## 4.1 Self-Assessment of Computer Experience and Technology Affinity

Self-assessment of computer experience allowed the differentiation of three groups. Totally nine test persons estimated themselves as beginners assigning themselves a technology affinity score of 14 ± 8 points, fifteen test persons judged themselves as advanced user with a technology affinity score of 27 ± 5 points and another one test person judged himself as an expert with a technology affinity score of 40 ± 0 points. Descriptive statistics and demographic data are given in **Table 1**.

***Table 1:*** *Assessment Sheet: Technology Affinity*

| | **Age** | **N** | **Profession** | | | **Technology Affinity** | |
|---|---|---|---|---|---|---|---|
| | | | **MTA** | **RT** | **Radiologists** | **median** | **MAD** |
| **Beginners** | 50-59 years | 9 | 4 | 4 | 1 | 14 | 7,78 |
| **Advanced User** | 40-49 years | 15 | 1 | 11 | 3 | 27 | 5,33 |
| **Expert** | 30-39 years | 1 | 0 | 0 | 1 | 40 | 0 |

Testing for differences between the groups (beginners, advanced users, expert) showed a significant difference concerning their TECHNOLOGY AFFINITY (KW-test, n=25 with 3 groups, p= 0.0066 sig.). The post hoc analysis revealed that only beginners and advanced users were significantly different (post hoc: Dunnett-Tukey-Kramer, adjustment: Bonferroni, n= 9 vs. 15 vs. 1, adj. p (beginenrs vs. advanced users) = 0.0187 sig.). More test persons in the beginners-group assigned themselves a lower technology affinity score than did test persons in the advanced and in the expert user-group. Although, the MAD found in both groups were comparable, scores in the beginners-group ranged from 5 to 38 points, while in the advanced user group a range from 19 to 40 points was found. The only expert assigned himself a score of 40 points (**Figure 10**).

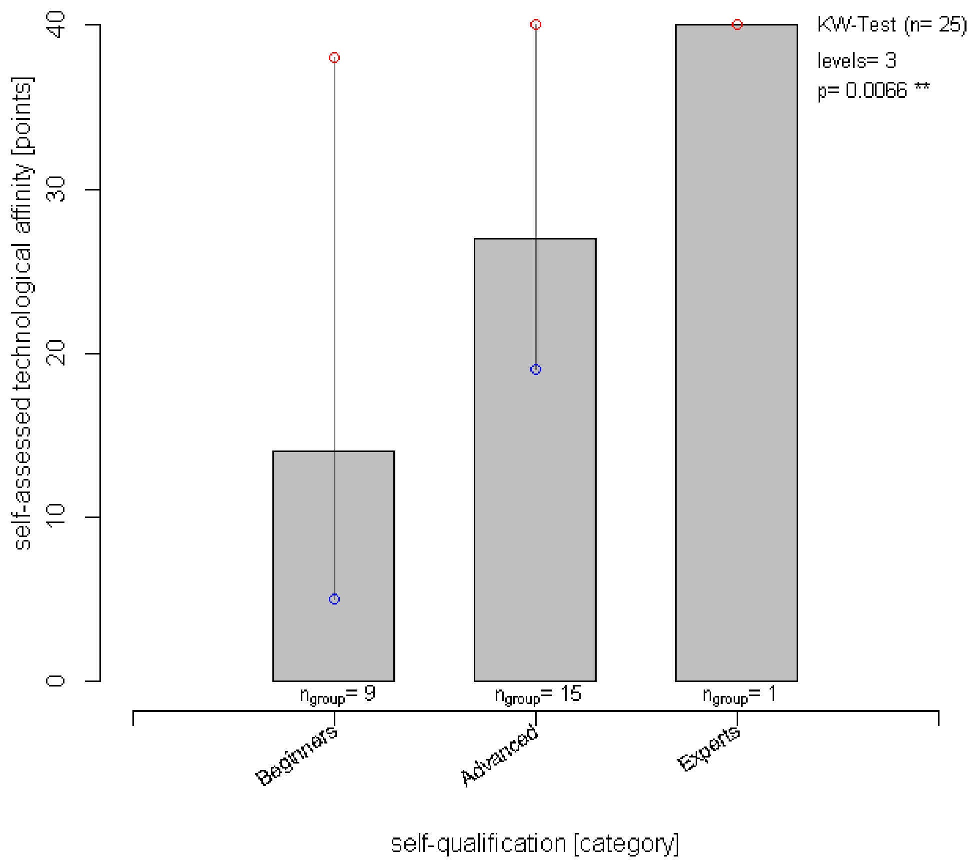



***Figure 10:*** *RISPad-Self-Assessment of Technological Affinity*

## 4.2 Learning Success

In the category: 'SOFTWARE SKILLS' all test persons of all three groups successfully completed all tasks in the instructed, as well as, in the individual round. Therefore, no further testing for differences was performed.

Concerning the SCREEN SHOT READABLE – item categorized as ATTENTION-RELATED differences between the various groups were found. Only one test person in the beginners group documented an unfocused screenshot during round 1 (instructed working). During round 2 (individual working) two test persons in the beginners group and three in the advanced users group produced and falsely documented an unfocused screenshots.

Statistically, despite the different number of unfocused captured screenshots the chance to finish the documentation using the RISPad software completely successfully was not significantly different between the three groups, neither in round 1 (odds ratio test, item: SCREEN SHOT READABLE - instructed working, n= 9 vs. 15, $OR_{log}$= -1.7 [-5.01,1.61], p=0.314 n.s.) nor in round 2 (odds ratio test, item: SCREEN SHOT READABLE - individual working, n= 9 vs. 15, $OR_{log}$= -0.13 [-2.15,1.88], p=0.8968 n.s.). Since no failure was registered for the only expert in the assessment, only beginners versus advanced users were statistically analyzed concerning their error-rate in the ATTENTION RELATED-category (**Figure 11**).

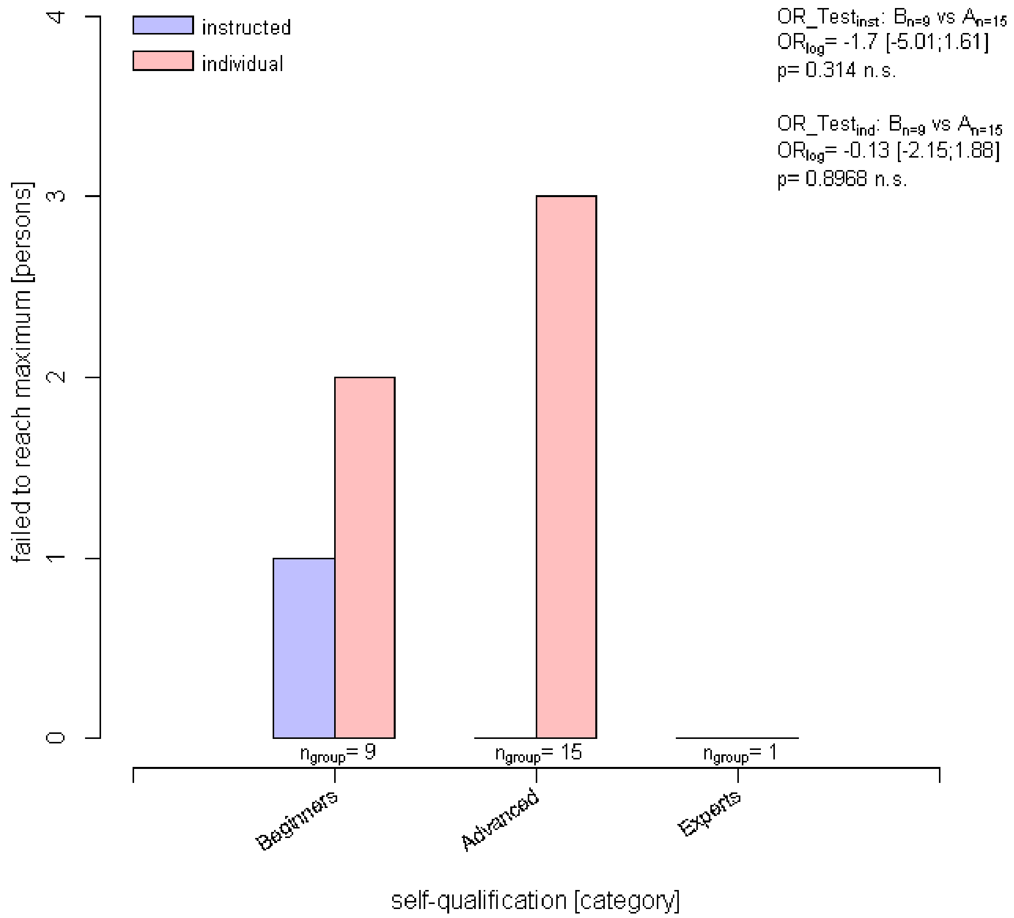



***Figure 11:*** *RISPad-Assessment Instructed vs Individual Working*

## 4.3 Feedback

In the categories 'RELEVANCE', 'APPLICATION' and 'CONFIDENCE' no significant differences between instructed (round 1) and individual working was encountered (Wilcoxon-tests, paired values, n.s.) (**Table 2, Table 3, Table 4**). In the category 'RELEVANCE' nearly all the test persons awarded at least 80% of the achievable maximum points in both rounds to the software's performance and GUI. Only one test person (TP) #4 in the beginner-group committed 5 points out of 10 only in the second, individual working, round, though, 10 points were given when working with the instructor (**Figure 12**). The same test person, also in the second round, gave only 43 points out of 60 for the performance and the GUI of the application, which was the worst result in the category 'APPLICATION' in all groups. All other test persons awarded at least 46 points of the maximum points achievable in the category: 'APPLICATION' (**Figure 13**). Concerning the category 'CONFIDENCE' a general increase of the self-confidence to manage all requested tasks occurred from round 1 to 2 in the beginners-group. Only two test persons (TP 4 and TP 9) in this group worsened for 3 and 4 points, respectively, from round 1 to 2 (**Figure 14**). Despite this, the median increased from round 1 to 2 in the beginners-group. In the advanced user group and the expert group no change of the median was observed.

In the item 'MANUAL_EASY' the agreement with the manual as a comprehensive tool was totally high reaching at least 7 points by all test persons (Table 5: 1st round vs. 2nd round of the item 'MANUAL_EASY'), accept for test person #4, who awarded 4 points only (**Figure 15**). All test persons, who really used the manual, gave at least 7 points out of 10 for the 'MANUAL_HELPFUL' of the manual (Table 6: 1st round vs. 2nd round of the item 'MANUAL_HELPFUL'). Again, test person #4 who used the manual in the second round only awarded only 5 points concerning this item. Generally, the manual was used infrequently ('MANUAL_NEEDED'), but a positive trend to use the manual in the second round, when the test persons had to work on their own with the RISPad-software was observed in the beginners- and the advanced user- group. In both groups a nearly 50% increase of manual-usage was noticed. The only expert never used the manual.

Concerning the interactions of the various categories linear regression analysis was performed, where a significant influence from technology-friendliness on the category: 'CONFIDENCE' was found in the 1$^{st}$ round (linear regression, $p= 0.0088$). However, the correlation between CONFIDENCE and TECHNOLOGY-FRIENDLINESS was weak, but proved significant (Spearman $\rho= 0.4313$; $p= 0.0314$), while this could not be shown relevant for the 2$^{nd}$ round (Spearman $\rho= 0.3181$; $p>0.05$ n.s.). As in total TECHNOLOGY-FRIENDLINESS did not explain more than 15% of the variance, the influence of AGE on CONFIDENCE was investigated. Age significantly influenced CONFIDENCE in the 1$^{st}$ round as well as in the 2$^{nd}$ round (linear regression, $p= 0.0002$ [1$^{st}$ round] and $p= 0.0261$ [2$^{nd}$ round]). Accordingly, AGE correlated negatively with CONFIDENCE, where a totally moderate correlation was found in both rounds (Spearman $\rho_{round\ 1}= -0.5268$, $p_{round\ 1}= 0.0068$; $\rho_{round\ 2}= -0.6108$, $p_{round\ 2}= 0.0012$).

***Table 2:** 1$^{st}$ round vs. 2$^{nd}$ round of the category 'RELEVANCE'*

| | | **RELEVANCE (maximum points reachable: 10)** | | |
|---|---|---|---|---|
| | | **1.quartile** | **median** | **3.quartile** |
| **beginners** | **round 1** | 10 | 10 | 10 |
| | **round 2** | 9 | 10 | 10 |
| **advanced user** | **round 1** | 9 | 10 | 10 |
| | **round 2** | 9 | 10 | 10 |
| **expert** | **round 1** | 10 | 10 | 10 |
| | **round 2** | 10 | 10 | 10 |

***Table 3:*** *1st round vs. 2nd round of the category 'APPLICATION'*

| | | APPLICATION (maximum points reachable: 60) | | |
|---|---|---|---|---|
| | | **1.quartile** | **median** | **3.quartile** |
| **beginners** | **round 1** | 56 | 58 | 59 |
| | **round 2** | 54 | 58 | 60 |
| **advanced user** | **round 1** | 57 | 59 | 60 |
| | **round 2** | 56 | 59 | 60 |
| **expert** | **round 1** | 60 | 60 | 60 |
| | **round 2** | 60 | 60 | 60 |

***Table 4:*** *1st round vs. 2nd round of the category 'CONFIDENCE'*

| | | CONFIDENCE (maximum points reachable: 10) | | |
|---|---|---|---|---|
| | | **1.quartile** | **median** | **3.quartile** |
| **beginners** | **round 1** | 8 | 9 | 10 |
| | **round 2** | 8 | 10 | 10 |
| **advanced user** | **round 1** | 9 | 10 | 10 |
| | **round 2** | 9 | 10 | 10 |
| **expert** | **round 1** | 10 | 10 | 10 |
| | **round 2** | 10 | 10 | 10 |

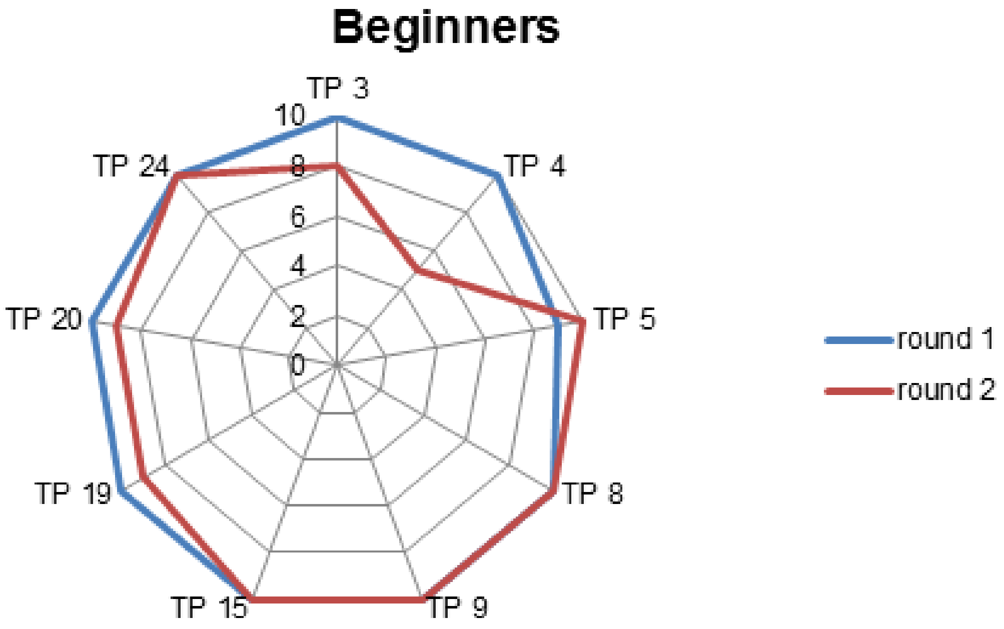
***Table 5:*** *1st round vs. 2nd round of the item 'MANUAL_EASY'*

| | | MANUAL_EASY (maximum points reachable: 10) | | |
|---|---|---|---|---|
| | | **1.quartile** | **median** | **3.quartile** |
| **beginners** | **round 1** | 7 | 10 | 10 |
| | **round 2** | 9 | 10 | 10 |
| **advanced user** | **round 1** | 9 | 10 | 10 |
| | **round 2** | 9,5 | 10 | 10 |
| **expert** | **round 1** | 10 | 10 | 10 |
| | **round 2** | 10 | 10 | 10 |

***Table 6:*** *1st round vs. 2nd round of the item 'MANUAL_HELPFUL'*

| | | MANUAL_HELPFUL (maximum points reachable: 10) | | |
|---|---|---|---|---|
| | | **1.quartile** | **median** | **3.quartile** |
| **beginners** | **round 1** | 9,25 | 9,5 | 9,75 |
| | **round 2** | 7,25 | 9 | 10 |
| **advanced user** | **round 1** | 9 | 10 | 10 |
| | **round 2** | 7 | 8 | 10 |
| **expert** | **round 1** | 10 | 10 | 10 |
| | **round 2** | 10 | 10 | 10 |

Category: ‘RELEVANCE’



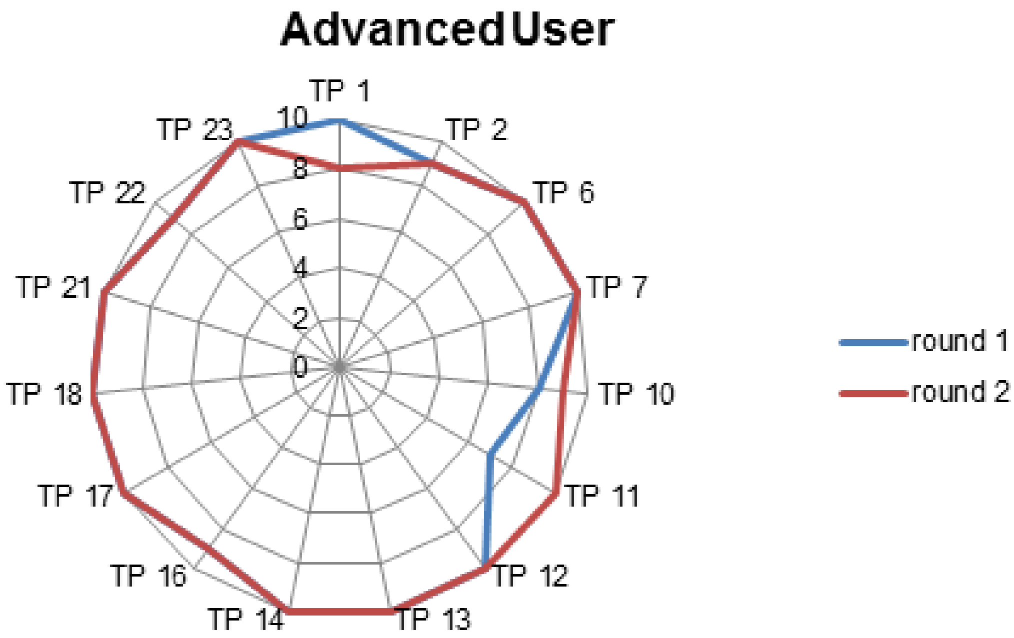




***Figure 12:*** *Star Plot of the category ‘RELEVANCE’ in the Beginners and Advanced User-group*

Category: 'APPLICATION'

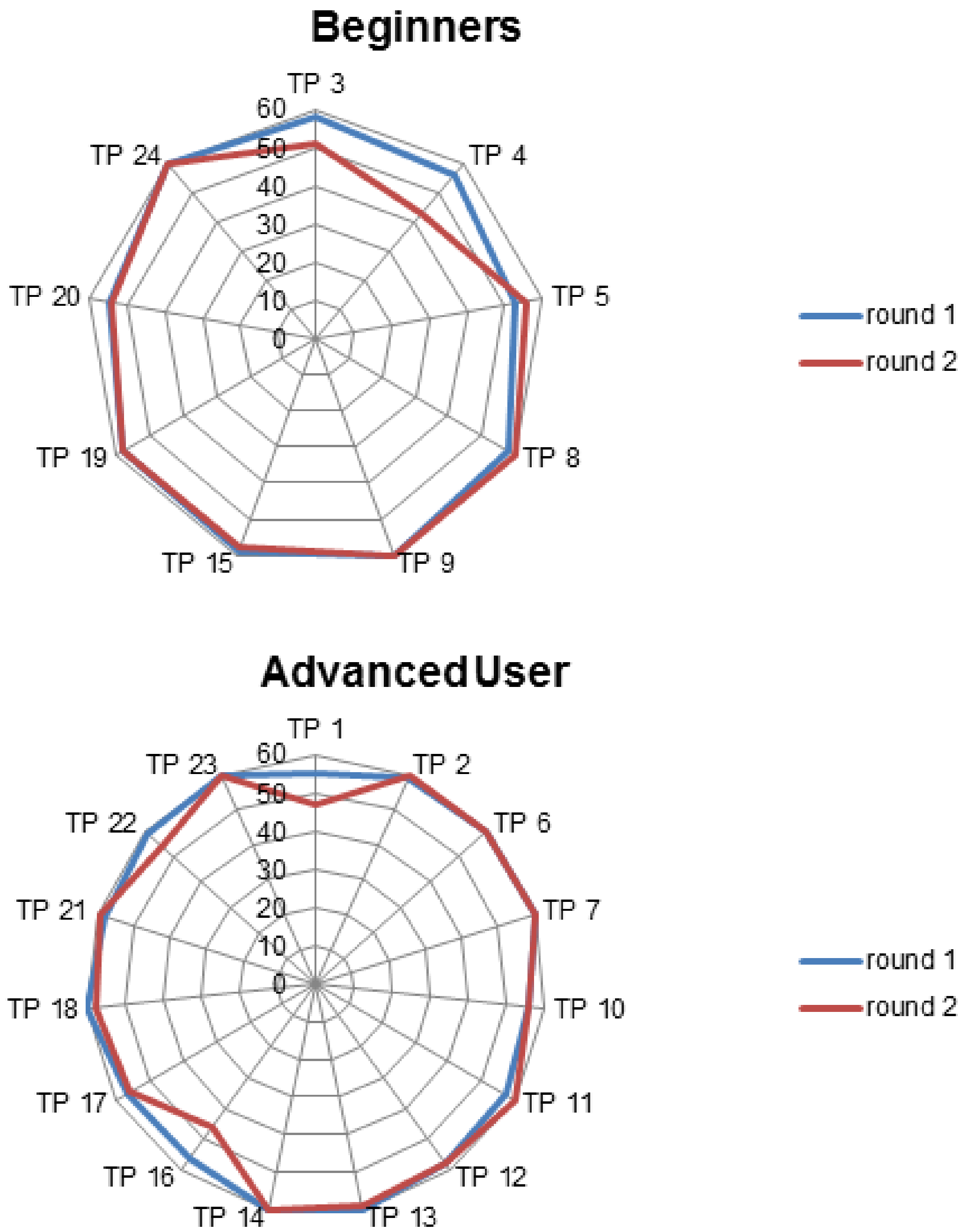



***Figure 13:*** *Star Plot of the category 'APPLICATION' in the Beginners and Advanced User-group*

Category: ‘SELF_CONFIDENCE’

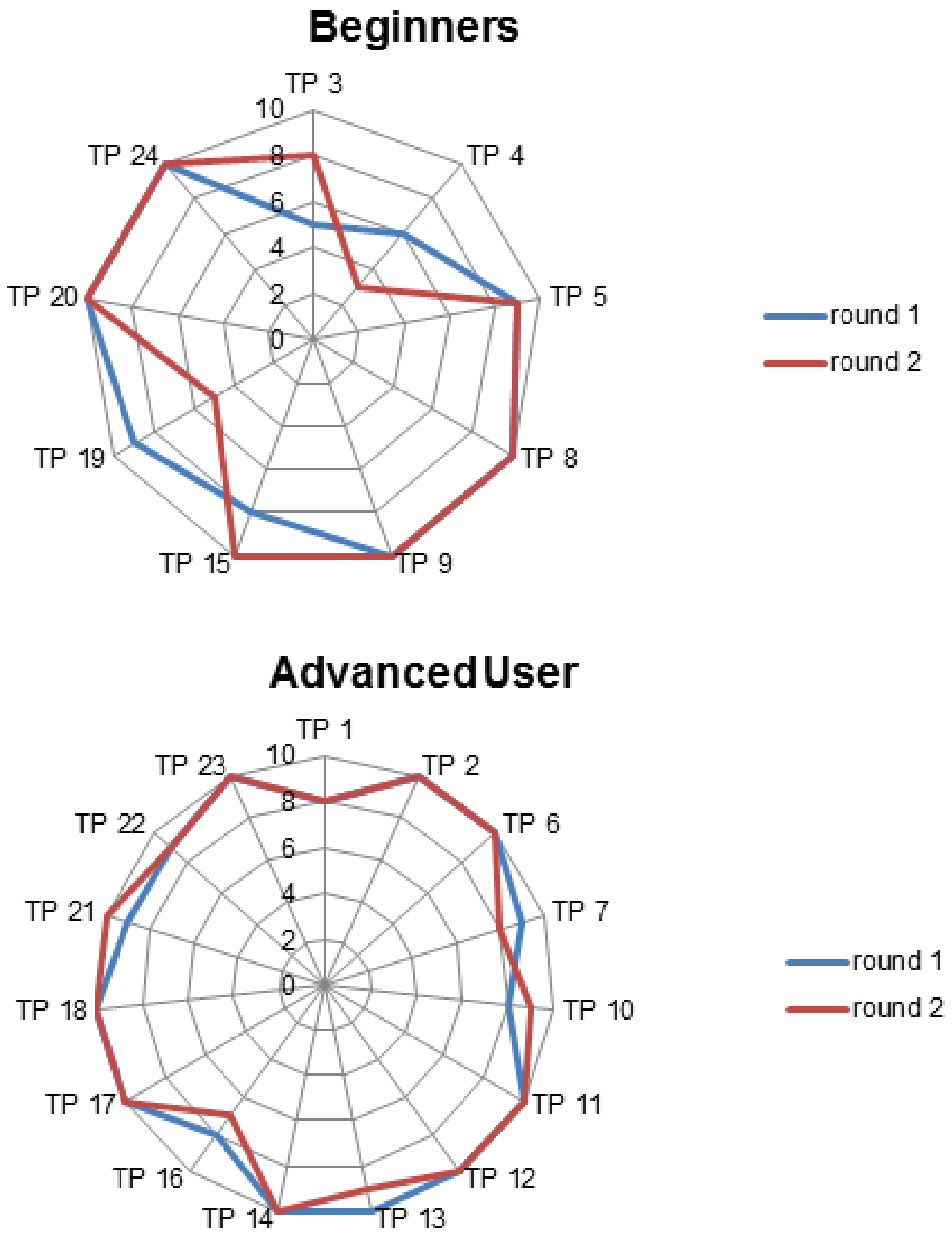



***Figure 14:*** *Star Plot of the category ‘SELF_CONFIDENCE’ in the Beginners and Advanced User-group;*

Item: ‘MANUAL_EASY’

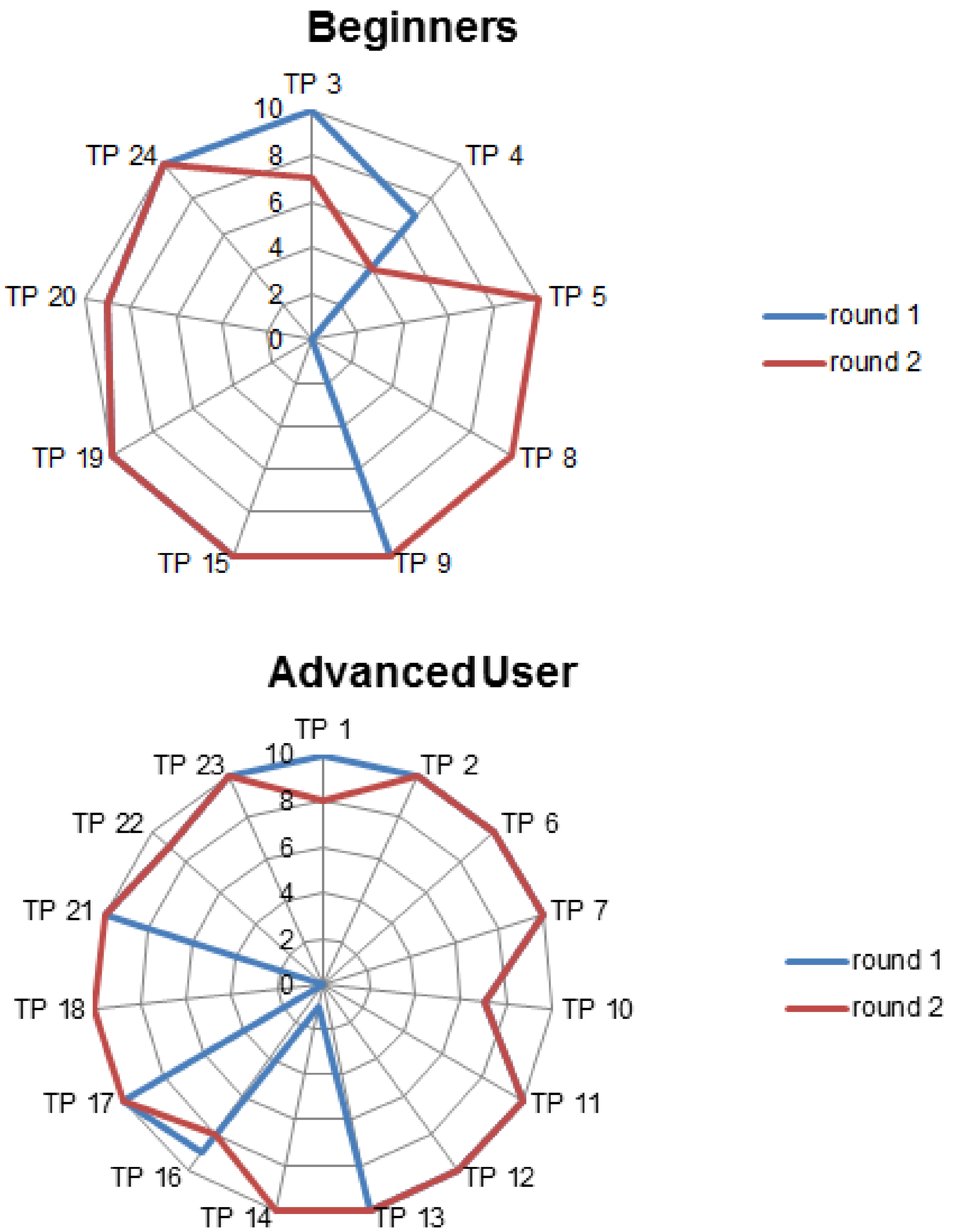



***Figure 15:*** *Star Plot of the category ‘MANUAL_EASY’ in the Beginners and Advanced User-group*

# 5 Discussion

The purpose of RISPad was, to store relevant clinical and medico-legal data, acquired during radiological routine work together with the corresponding examination. These data, such as images from interventional extracted specimen or informed consent sheets, usually cannot be stored quickly onsite, neither in the HIS nor in the PACS or RIS. Nevertheless, this information collected in routine work may be important for further medical examinations, could meet important statutory regulations or has to meet scientific needs. In this context the assessment revealed that RISPad enables a fast and easy documentation of the proposed information in the PACS. For this purpose RISPad implemented a clear structured and easy to understand GUI, which increased the daily routine working load only minimally. Accordingly, in the assessment evidence was found that the integration of an onsite documentation system as proposed by the described project obtains highest acceptance scores.

## 5.1 Computer Experience and Technology Affinity

Since the level of computer skills and experience was expected to vary considerably between the different test persons, who were recruited in a typical radiological department, in a first step the test persons were grouped into a beginners-, an advanced user- and an expert-group. The separation into the various groups was based on the self-assessment of computer skills performed by each test person prior to the further assessment. The maximum number of acquirable experience points in this assessment step was 40, where beginners awarded themselves significantly less points than did advanced users. The only expert assigned himself the maximum number of points, which was comparable to another test person of the advanced user group. Consequently, the only test person who declared himself as an expert user performed not significant different compared to the advanced users group in any of the tasks.

On the other hand, the significantly lower amount of self-awarded computer skill points in the beginners-group compared to the expert and advanced users suggests a more self-critical self-judgment of the test persons in the beginners group. Consecutively, the proposed grouping of the test persons seems rational, because at least concerning their self-confidence the test persons behaved differently. Only one discrepancy was noted concerning the grouping of the test persons, where one test person declared himself as a beginner, while disclosing a high technology affinity. A more general lack of personal self-confidence may explain this result best.

The self-assessment based grouping seemed to affect preferably the self-confidence the test persons showed, when confronted with RISPad for the first time, then their skills virtually necessary to complete the tasks. Accordingly, all test persons in all groups were able to work with RISPad nearly without any error. Therefore the self-assessment was considered to reflect self-confidence rather than knowledge and an effect on the ATTITUDE TOWARDS USING was assumed. This is underlined by the finding in the assessment that technology-friendliness appeared to significantly influence the item 'SELF-CONFIDENCE' in the first, but not in the second round. This could be attributed to the fact that in the second round the test persons already knew that they could manage the tasks and, therefore, their self-judgment about their technology skills did not play a role.

Concerning age, gender and profession, no further analysis, than descriptive statistics, could be performed, since the chosen assessment environment itself strictly determined the distribution of the data. Thus, the influence of these data on the acceptance and practicability testing of the RISPad-application was not assessable because a comparable department could be evaluated additionally. The major reason for this was the restricted time resources, which did not allow implementation of the RISPad-software in other departments. Also, this was owed to regulations of protection of data privacy.

## 5.2 Learning Success

Independent of their technology-friendliness based on the self-assessment of computer skills, all test persons were able to carry out the requested documentation using RISPad completely.

The test persons were asked to document an informed consent sheet using the RisPad-application in two rounds. In the first round the test persons were trained by a tutor, while in the second round, on average seven days after the first one, they had to work on their own. The whole documentation procedure was divided into certain working steps, which all got assigned a distinct item that described the success of the respective step. Each single step was rated by the tutor, who also noted remarks given by the test persons during the assessment. However, in the second round the tutor was absolutely strict not to give any hints during the documentation process.

The test persons had access to the manual in both test runs. All test persons were able to document the given informed consent sheet for the corresponding examination with RISPad, after receiving instructions by the tutor (round 1) and partially using the manual. Just as in round 1, all test persons could successfully complete a second documentation run, wherein the informed consent sheet was again stored together with the image data of the corresponding examination. While all test persons were able to finish their tasks in both rounds without any mistake, the only differences encountered in the assessment affected the item 'SCREEN SHOT READABLE'. All other achieved scores underlined the overall excellent user-friendliness of the GUI, which leads to the conclusion that the RISPad-application in total is easy to understand and to handle. This assumption is also supported by the fact that the manual was nearly not used in neither of the rounds.

The item with deviations from the best rating in the assessment was: 'SCREEN SHOT READABLE'. A close analysis of the circumstances, which led to the partial failure concerning this item, revealed that all test persons were able to take the screenshot, but few of them did simply not realize that the taken images were slightly out of focus. Thus, the failures could not be attributed to the category: 'SOFTWARE SKILLS', but were categorized in an own category: 'ATTENTION-RELATED' as a lack of attention during documentation process was assumed. In the beginner group only one test person documented an unfocused screenshot in round 1. In round 2, two test persons from the beginner- and three from the advanced user- group documented unfocused screen hots. Though, these test persons did, consequently, not achieve the full score of the learning success, the documentation of the informed consent sheet was performed otherwise correctly. Moreover, some test persons, even those who produced focused screenshots, made remarks, that they had difficulties to determine whether the captured image was focused or not. Interestingly, all test persons taking unfocused screenshots did not communicate any uncertainty about the quality of their image. Therefore, it was concluded that they did not notice this deficit. The observations noted by the tutors additionally revealed that especially test persons, who did not achieve a full score due to an unfocused screenshot needed more time for completion of the documentation process regardless of their rating in the computer skills self-assessment. As the assessment was carried out during daily routine work, it is imaginable that at least some test persons where under the pressure of time. This could probably explain the decreased quality of the image documentation in these cases best, as a lack of time to finish the work properly might have led to the reduced image quality. Another reason for the unawareness of the test persons for the unfocused images could be that the rather small image size of the screenshot on the control screen of the GUI was insufficient to judge the focus correctly. Accordingly, one of the test persons spontaneously recommended implementation of a magnifier-tool in later versions of RISPad.

However, the only minimal differences in score points obtained by the test persons with and without unfocused images in all three groups, where all other items were completely successfully mastered, did not prove significant in the statistical testing. In consequence, an excellent user- friendliness of the GUI and a maximum practicability of the RISPad-application can be assumed.

## 5.3 Feedback

After each of the documentation rounds the test persons where asked to give a feedback about their impression of the RISPad-application. For the feedback the test persons had to rate the requested tasks and the practicability of those in conjunction with the software using special feedback sheets. Additionally, free statements could be made on the sheets as well. A throughout positive rating of the assessment sheets: ‘Feedback 1 & 2’ clearly suggests a high practicability and high acceptance of the RISPad-application by the test persons.

The comparison of the first and second round assessment sheet ‘feedback’ showed a low negative score trend in the different categories. After evaluation of the feedback sheet no significant difference between the two tests runs could be determined. The beginner group showed the most changes in the feedback sheet. The different categories were generally rated with a lower score by the beginners compared to the advanced users. Especially test person #4 gave a worse rating in all categories during the second test run, compared to the rating of the first test run. The test person, who assessed themself as expert, gave top scores in both rounds. The item ‘MANUAL_EASY’ rating did increase in both of the groups, beginners and advanced user. This indicates the manual was better comprehensible during second reading. Compared to the first informed consent document storage, the help of the manual was needed by a higher amount of test persons of the beginner and advanced user group. Test persons, who needed the manual during second documentation run, gave a lower rating for the manual, compared to persons, who needed the manual during first documentation run. An overall statement can be made, that there was only a minor change in rating, independent of the particular group.

Comparison of ‘TECHNOLOGY AFFINITY’ and ‘CONFIDENCE’ revealed a weak, but significant correlation of the two categories in the first test run. This indicates, that test persons, who had a higher ‘TECHNOLOGY AFFINITY’ stated, that they felt more confident in regards to the documentation process. During second test run this correlation was not significant any more. Both runs showed that ‘AGE’ and ‘CONFIDENCE’ have a negative correlation to each other. Therefore elder test persons felt less confident during documentation of the informed consent sheet. Overall results indicate, the older the test person, the lower the rating, due to the decreased confidence during the second documentation run, of the informed consent sheet.

## 5.4 Relation between Assessment and TAM

According to the TAM by Davis F., there are external variables, which have an impact on the ‘perceived usefulness’ and the ‘perceived ease of use’ and therefore have consequences onto the ‘intention to use’. TAM2 defines these external variables, which have an impact onto the ‘perceived usefulness’ in a more detailed way. These variables were finally used for the RISPad assessment. The variable ‘experience’, as described in the TAM2 model, which has a direct impact onto the ‘Intention to use’ and a direct impact onto the ‘perceived usefulness’, was represented via self-assessment of the test persons computer skills, their ‘TECHNOLOGY AFFINITY’ and their ‘CONFIDENCE’. The test persons were divided into the group’s beginners, advanced user and experts by their answers of their self-judgment and asked for their ‘TECHNOLOGY AFFINITY’, which correlates with their self-assessment. Their ‘CONFIDENCE’, which seems related to the variable ‘TECHNOLOGY AFFINITY’ had to be rated by the test persons in the feedback sheet of the assessment. Test persons with a higher level of computer experience and a high ‘TECHNOLOGY AFFINITY’ stated a higher ‘CONFIDENCE’ in their feedback sheet.

‘Output quality’ and ‘result demonstrability’ which are linked with the ‘perceived usefulness’ were examined in the second step of the assessment. The single steps of the informed consent documentation process with RISPad were rated and displayed with a total score. The fact, that all test persons could complete the documentation process successfully in both rounds completely, results in a high ‘output quality’, which has a positive effect on feedback and therefore the ‘perceived usefulness’.

Under the circumstance, that all test persons were informed about the main goals of RISPad, the autonomous documentation of an informed consent sheet and the knowledge about the duty, to document relevant clinical data, inside the radiological workflow, the variable ‘job relevance’, as described in TAM2, could be retrieved via the item ‘RELEVANCE’ of the assessment. ‘Job relevance’ postulates a direct effect onto the ‘perceived usefulness’. It is supposed, that persons think, that an application, which is relevant for their daily work, is useful, which results in a higher ‘intention to use’.

‘Perceived ease of use’, which has an direct impact onto the ‘perceived usefulness’ and the ‘intention to use’ was described, subsequently to the documentation, by the category ‘APPLICATION’ within the feedback sheet. For this purpose, questions concerning the most important steps of the documentation were created. The high success rate during the documentation of the informed consent sheet resulted in a high rating inside the category 'APPLICATION' and therefore a positive effect onto the usage behavior of the test persons.

Overall it can be stated, that a high 'experience', 'output quality', 'ease to use' and 'job relevance' where decisive for a positive rating of the 'perceived usefulness' of the RISPad-application and furthermore beneficial in terms of the intention to use and the user behavior.

## 5.5 Limitations

The fact that RISPad could be run in only one radiological department appears to be a major limitation to draw a general conclusion. RISPad was especially designed for the needs of the department, where the software was installed and assessed. Furthermore, it would have been necessary to convince the internal IT department, to ensure a quick and successful implementation. But experience showed, that earlier projects in potentially available departments were significantly hampered by the fact, that non-routine IT-applications were treated very restrictively by the responsible IT-technicians, as they were seen as an additional, and not necessary work-load.

Only persons, with comprehensive knowledge of the radiological workflow were tested. Because of this services of not radiological personal (for example secretary, typing assistance, etc.) could not be assessed in RISPad usage. Furthermore, persons, who were involved in RISPad development and implementation on a large scale, were excluded from the assessment. Therefore, the quantity of possible test persons was diminished further, and it is possible, that the results do not show a representative average for other departments. The implementation of the RISPad software in multiple radiological departments, as a large-scale approach to get a more detailed overview and an increased statistical quality, was not possible due to limited resources and the prospected time schedule. Therefore, only an implementation period of six month in only one radiological department, was performed, which limits the final statement about the acceptance of the RISPad-application.

Another limitation restricting the interpretation of the data arises probably from the fact that tutor and test persons of the department knew each other for years, and therefore the feedback could have been biased by subjective personal points of view. For instance, in other departments the necessity to convince the test persons that the documentation of medical and statutory information, like an informed consent sheet, is necessary and useful at all could have emerged. In consequence acceptance of RISPad could have been much lower in this situation.

# 6 Conclusion

According to the TAM proposed by Davis F. the results indicate a high grade of acceptance and practicability of the RISPad-application among the tested persons at a radiological department [1]. Especially, the user-friendliness of the GUI appears high, since already after one instruction nearly 100% of the test persons were able to successfully work with the RISPad-application. This supports the assumption that RISPad offers and a high performant and state-of-the-art approach to store clinical evidence documents and captures of relevant material together with a correlated examination in the PACS. Only few short comings of the software were noted, but as all TAM derived descriptors scored high in the assessment, it is concluded that RISPad potentially reaches an intensive actual system use.

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# Abbreviations

| | |
|---|---|
| DICOM | … Digital Imaging and Communications in Medicine |
| DTK | … Dunnett-Tukey-Kramer |
| EHR | … Electronic Health Records |
| ELGA | … Elektronische Gesundheitsakte |
| GCP | … Good Clinical Practice |
| GUI | … Graphic User Interface |
| HIS | … Hospital Information System |
| IT | … Information Technology |
| MAD | … Median Absolute Deviation |
| MTA | … Medical-Technological Assistents |
| PACS | … Picture Archive and Communication System |
| PC | … Personal Computer |
| RIS | … Radiology Information System |
| RISPad | … Radiology Information Storage Notepad |
| RT | … Radiology Technologist |
| TAM | … Technology Acceptance Model |
| TP | … Test Person |
| TRA | … Theory of Reasoned Action |
| USB | … Universal Serial Bus |
| UVC | … USB Video Class |

# List of Figures

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# Appendix

## A. Manual



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# Master Course Digital Healthcare

1st Term

DHC05

Name of the Lecturer: Helmut Ritschl

# The RISPad-
# Handbuch

Authors: Ganster Barbara and Nasel Christian

Date: 2016.12.23

# Table of Content

# 1. Beginn der Dokumentation

Diese Vorbereitung ist jedenfalls durchzuführen, da sonst ein Bildversand über RISPad nicht möglich ist.

Zunächst muss zumindest ein Bild der zu dokumentierenden Untersuchung auf den Dicom-Knoten: „Perfusion II" geschickt werden. Dies ist notwendig, um dem RISPad-server die Untersuchung anzuzeigen. Wählen Sie am Computer der Untersuchungsmodalität in der Patientenliste den entsprechenden Patienten und dessen Untersuchung. Anschließend wählen Sie ein beliebiges Bild, eine beliebige Studie oder Serie der Untersuchung und senden diese auf „Perfusion II". Abschließend sollte die betreffende Untersuchung auch im RIS (Radiology Information System) quittiert werden.

# 2. Benutzeroberfläche öffnen

Fall nicht bereits in Betrieb, starten Sie jenen Computer an dem die Dokumentenkamera (Bild 1) angeschlossen ist.

**Bild 1:** Dokumentenkamera

Melden Sie sich mit Ihren Zugangsberechtigungen an, um zur Benutzeroberfläche von RISPad zu gelangen. Öffnen Sie danach den Internet-Browser „Mozilla Firefox" durch Doppelklick mit der linken Maustaste auf das entsprechende Symbol (Bild 2).

**Bild 2:** Internet-browser: Mozilla Firefox

Anschließend wählen Sie in der Menüleiste im Reiter „Lesezeichen“ die Seite „RISPad“ aus. Alternativ kann auch in der Adressleiste Folgendes direkt eingetragen werden: „turadp484:9080“ (Bild 3).

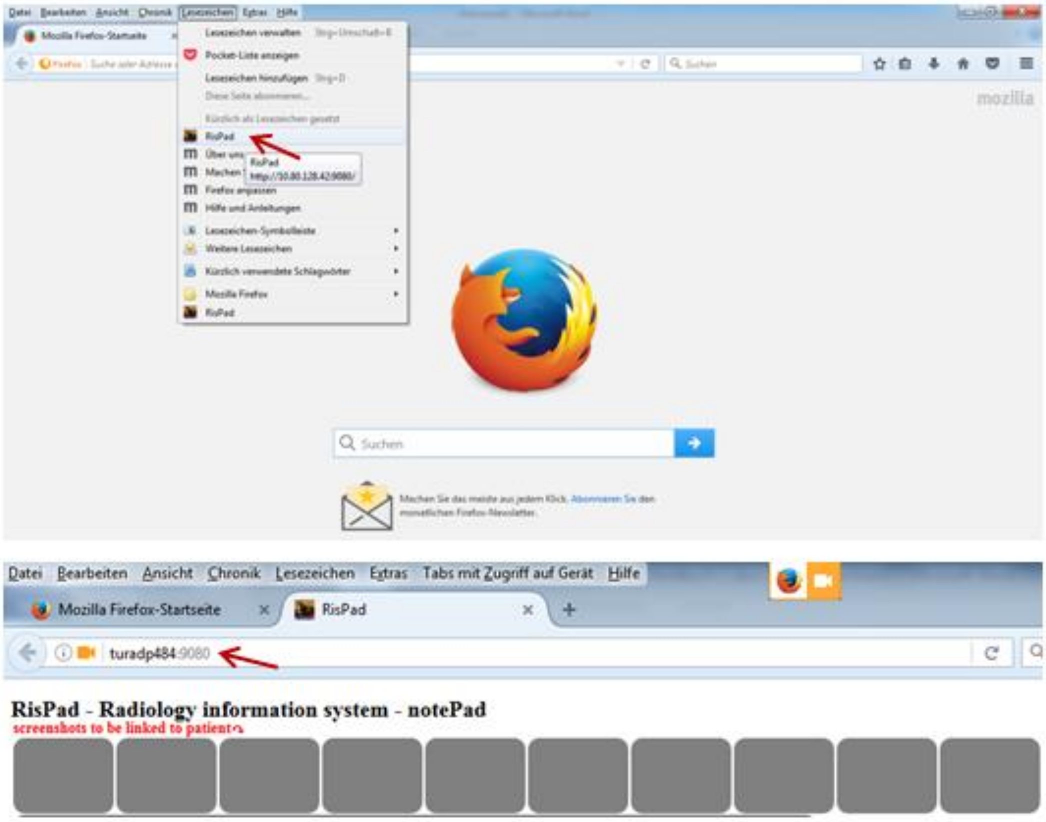


**Bild 3:** Reiter: „Lesezeichen“ und Adressleiste

Es erscheint nun ein Dialogfenster zur Authentifizierung, wo Sie Ihren Benutzernamen und das jeweilige Passwort eingeben. Sofort nach der erfolgreichen Anmeldung am RISPad-server werden Sie aufgefordert den lokalen Computerzugriff auf die Dokumentenkamera zu erlauben. Hier bestätigen Sie die Zugriffserlaubnis. Um die Kamera zu aktivieren, müssen Sie den Button „Zugriff auf ausgewähltes Gerät erlauben“ drücken. (Bild 4). Erfolgt die Erlaubnis nicht oder zu langsam, wird dieses Dialogfenster automatisch geschlossen und Sie müssen den Internet-Browser: „Mozilla-Firefox“ schließen und erneut starten. Beachten Sie, dass nun auch wieder die RISPad-Seite wie oben beschrieben neu aufgerufen werden muss (siehe Bild 3: Reiter: „Lesezeichen“ und Adressleiste). Ebenso ist eine erneute Eingabe Ihres Benutzernamens und des jeweiligen Passwortes notwendig.

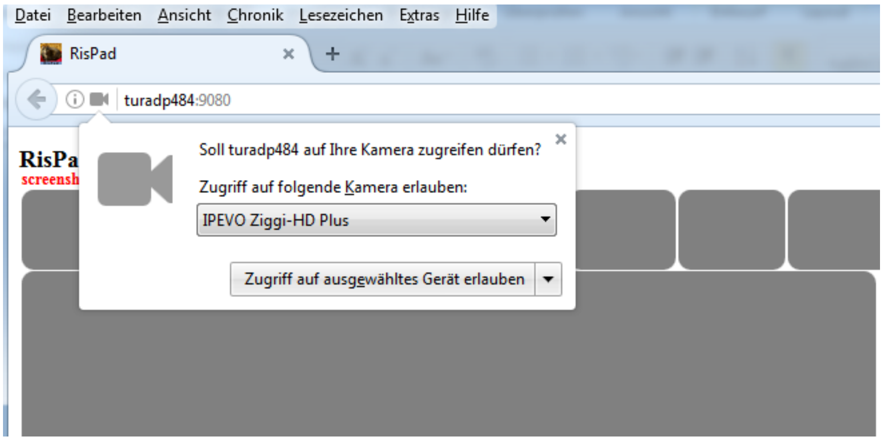


**Bild 4:** Zugriffsbestätigung auf Dokumentenkamera

Falls Sie gleichzeitig gefragt werden, ob Ihre Zugangsdaten (Benutzer und Passwort) gespeichert werden sollen, lehnen Sie dies aus Sicherheitsgründen ab. Speichern Sie NIEMALS Ihre Zugangsdaten auf lokalen Computern!

Nach Bestätigung des lokalen Kamerazugriffs schaltet sich diese automatisch ein und zeigt den Livebildschirm an (Bild 5: Bereich 1). Warten Sie einige Sekunden bis die Kamera das Bild scharf anzeigt. Sollte sich das Kamerabild nicht automatisch scharf stellen, halten Sie kurz ihre Hand unter die Kamera. Anschließend sollte die Kamera erneut versuchen, das Livebild scharf anzuzeigen. Warten Sie wieder einige Sekunden bis die Kamera das Bild scharf gestellt hat.

# 3. Benutzeroberfläche

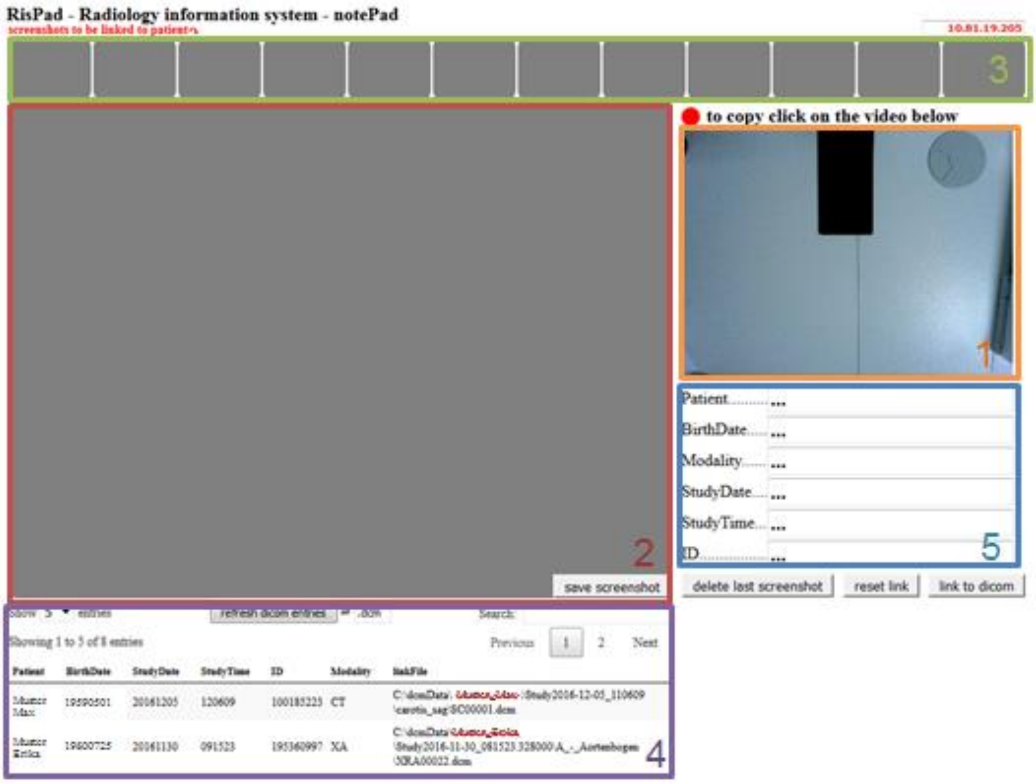


**Bild 5:** Die RISPad – Steuer- und Eingabebereiche:

1: Livebildschirm der Dokumentenkamera

2: Kontrollbildschirm

3: Screenshotleiste: Übersicht der gespeicherten Bilder

4: Patientenliste mit Suchfunktion

5: Patientendatenübersicht

# 4. Aufnahmeobjekte erfassen

Positionieren Sie Ihr Aufnahmeobjekt unter der Kamera und kontrollieren Sie dessen Position mit Hilfe des Livebildschirmes (Bild 5: Bereich 1) auf der Benutzeroberfläche. Wenn das Objekt im Livebildschirm scharf dargestellt wird, klicken Sie mit der linken Maustaste einmal auf diesen, um ein Kontrollbild (screenshot) zu erstellen. Der Screenshot wird nun groß auf dem Kontrollbildschirm (Bild 5: Bereich 2) dargestellt, wodurch Sie dieses Bild nochmals auf etwaige Unschärfe überprüfen können. Bei großer Unschärfe kann durch wiederholtes Klicken auf den Livebildschirm jederzeit ein neuer screenshot erstellt werden.

Wiederholen Sie diesen Vorgang solange, bis Sie mit der Aufnahme zufrieden sind. Sollte sich die Kamera nicht automatisch scharf stellen, halten Sie, wie beschrieben, ihre Hand wieder unter die Kamera. Anschließend sollte die Kamera erneut versuchen den Livebildschirm scharf anzuzeigen. Warten Sie jeweils einige Sekunden bis die Kamera das Bild scharf anzeigt.

Um den Screenshot speichern zu können, muss der „save screenshot“- Button (Bild 6) in der rechten unteren Ecke des Kontrollbildschirms grün unterlegt sein. Sobald Sie mit der Qualität ihres screenshots am Kontrollbildschirm zufrieden sind, klicken Sie den „save screenshot“-Button oder Sie klicken einfach einmal auf den Kontrollbildschirm, um das Bild zu speichern. Gespeicherte Bilder werden kleinformatig in der Screenshotleiste (Bild 5: Bereich 3) dargestellt.

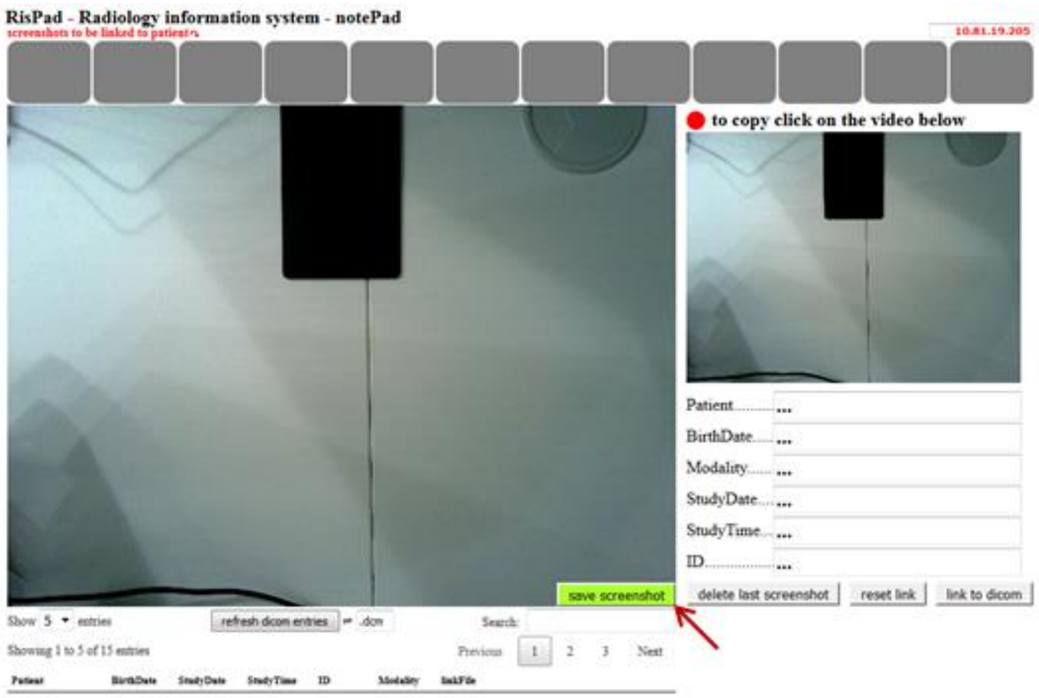


**Bild 6:** „save screenshot“- Button

Ein bereits gespeicherter screenshot kann nicht nochmal in der Screenshotleiste gespeichert werden. Wenn Sie nach dem Speichern des screenshots erneut auf den Kontrollbildschirm klicken und dabei der „save screenshot“-Button NICHT grün unterlegt ist, werden Sie darauf hingewiesen, dass die erneute Speicherung nicht möglich ist (Bild 7). Diese Meldung quittieren Sie mit dem „OK“-Button, um weiter arbeiten zu können.

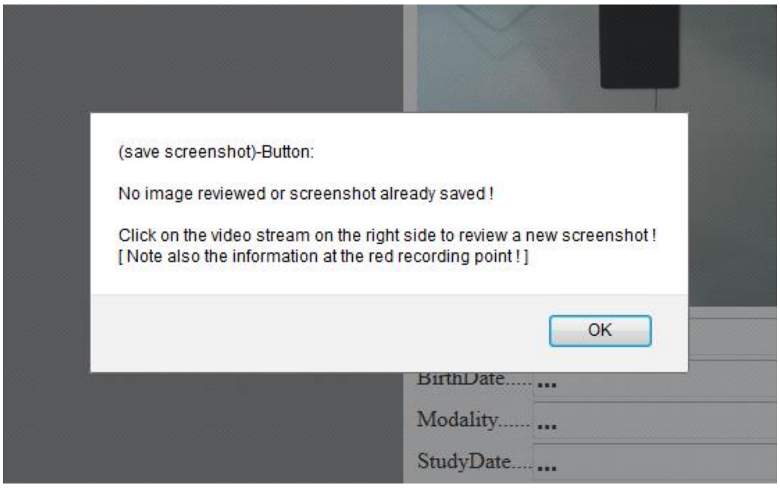


**Bild 7:** Beim Versuch bereits gespeicherte screenshots erneut abzuspeichern, erscheint eine entsprechende Fehlermeldung. Nur wenn der „save screenshot“-Button grün unterlegt ist, kann der im Kontrollbildschirm dargestellte screenshot gespeichert werden.

Wiederholen Sie die oben beschriebenen Vorgänge mit beliebigen Aufnahmeobjekten bis Sie maximal 12 screenshots in der Screenshotleiste gespeichert haben.

# 5. Bildzusatzfunktionen

Sobald der erste screenshot in der Screenshotleiste erstellt wurde, wird der „delete last screenshot“-Button (Bild 8) rot unterlegt. Wenn Sie diesen Button drücken, öffnet sich ein Dialogfenster, mit der Frage, ob Sie den zuletzt gespeicherten screenshot tatsächlich löschen möchten (Bild 9). Bestätigen Sie das Löschen mit dem „OK“-Button, wenn Sie diesen screenshot unwiderruflich löschen möchten, oder brechen Sie den Vorgang mit dem „Abbrechen“-Button ab. Es kann nur jeweils der zuletzt gespeicherte screenshot in der Screenshotleiste löschen werden. Drücken Sie mehrmals den „delete last screenshot“-Button um seriell mehrere screenshots und damit auch einen weiter zurückliegend gespeicherten screenshot zu löschen.


**Bild 8:** „delete last screenshot“-Button

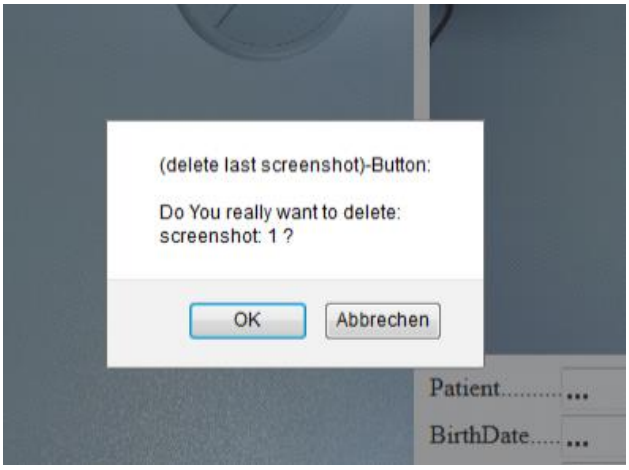


**Bild 9:** Wird der „delete last screenshot“-Button angeklickt, erscheint ein Dialogfenster, mit der Frage, ob Sie den entsprechenden screenshot tatsächlich löschen möchten.

Um einen bereits in der Screenshotleiste abgelegten screenshot nochmals am Kontrollbildschirm anzuzeigen, klicken Sie den gewünschten screenshot in der Screenshotleiste mit der linken Maustaste an. Der gewählte screenshot erscheint dann am Kontrollbildschirm. Somit können Sie alle screenshots aus der Screenshotleiste nochmals kontrollieren. Der „save screenshot“-Button wird bei diesem Vorgang NICHT grün unterlegt, da dieselben screenshots kein weiteres Mal gespeichert werden können. Der Versuch diese bereits gespeicherten screenshots erneut zu speichern führt zu einer Fehlermeldung, welche sie mit dem „OK“-Button bestätigen werden müssen, um weiter arbeiten zu können.

# 6. Patientenlistensteuerung

Zur Verknüpfung mit den erstellten Bildobjekten verfügbare Patienten werden in der Patientenliste angezeigt (Bild 5: Bereich 4).

Sie können die Anzahl der jeweils aufgelisteten Patienten in der Patientenliste mit dem pull-down Menü: „show entries“ auf Werte zwischen 1 und 5 einstellen.

Die Patientenliste kann durch klicken auf den „refresh dicom entries“-Button aktualisiert werden. Die Dateierweiterungsanzeige sollte auf der Standardeinstellung: „.dcm“ belassen werden. Diese Anzeige funktioniert als Filter, welcher ausschließlich nach Dateien mit der ausgewiesenen Dateierweiterung in den Patientenordnern sucht.

Mit den Funktionen des Navigationsbereichs kann nun die Patientenliste durchgesehen werden (Bild 10). Es wird immer nur eine eingeschränkte Anzahl von Patienten, entsprechend der „show entries“–Einstellung angezeigt. Die einzelnen Listenseiten werden mit Nummern rechts oberhalb der Patientenliste angezeigt. Diese können direkt durch Anklicken der jeweiligen Seitennummer dargestellt werden. Mit dem “Next”-Button wechseln Sie zur nächsten möglichen Seite. Mit dem „Previous“-Button wechseln Sie zur vorherigen möglichen Seite.

Alternativ kann auch der Patientenname direkt in das Suchfeld rechts oberhalb der Liste eingetragen werden, um nach den Patientennamen zu suchen. Geben Sie dazu den Namen oder die Anfangsbuchstaben des Patienten in das Suchfeld ein. Die Suchfunktion gibt in der Liste sodann alle diesem Namensfilter entsprechenden Einträge der Liste an.

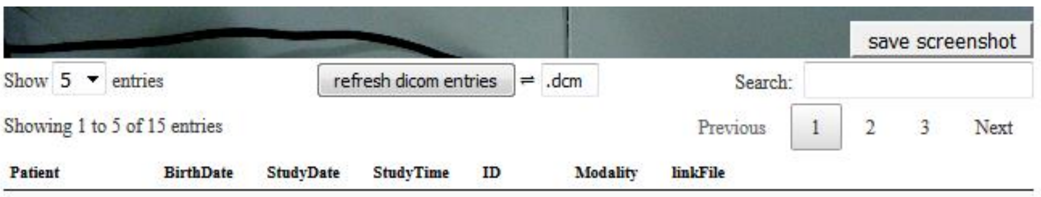


**Bild 10:** Patientenliste: Navigationsbereich

# 7. Patientendaten wählen

Sobald der gesuchte Patient und dessen Untersuchung in der Liste erschienen sind, klicken Sie mit der linken Maustaste einmal auf den Patienten, um ihn auszuwählen. Achten Sie dabei auf die angegebene Untersuchungsmodalität und das Studiendatum in der Patientenliste. Die Patientendaten erscheinen im Anschluss in der Patientendatenübersicht (Bild 5: Bereich 5). Damit werden der „reset link"-Button pink und der „link to dicom" -Button türkis unterlegt (Bild 11). Kontrollieren Sie nochmals die Patientendaten, die angegebene Modalität und das Studiendatum in der Patientendatenübersicht.

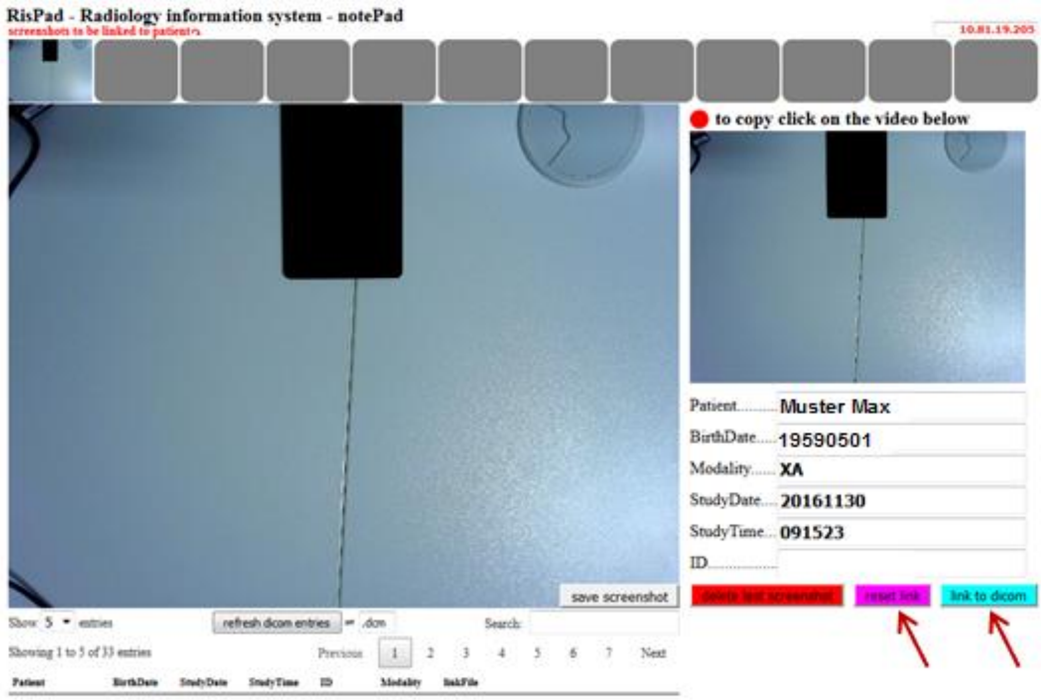


Bild 11: „reset link"-Button und „link to dicom" -Button

Durch Auswahl eines anderen Patienten aus der Patientenliste können die Patientendaten in der Patientendatenübersicht einfach gewechselt werden. Verwenden Sie den „reset link"-Button, um die Daten aus der Patientendatenübersicht zu löschen. Nach dem Löschen eines Patienteneintrags, erscheinen sowohl der „reset link"-Button als auch der „link to dicom"-Button wieder Grau hinterlegt.

Finden Sie den gewünschten Patient nicht in der Patientenliste, aktualisieren Sie nochmals die Patientenliste mit dem „refresh dicom entries"-button und/oder vergewissern Sie sich, dass Sie ein Bild der zu verknüpfenden Untersuchung auf den „Perfusion II"-dicom-Knoten gesandt haben (siehe Punkt 1).

# 8. Screenshots in das Picture Archiving and Communication System (PACS) senden

Um screenshots ins PACS senden zu können, müssen die gewünschten screenshots in der Screenshotleiste und die dazugehörigen Patientendaten in der Patientendatenübersicht richtig angezeigt werden. Der „link to dicom“-Button muss türkis unterlegt sein. Versichern Sie sich nun nochmals, dass die aufgenommenen screenshots zu dem ausgewählten Patienten und der ausgewiesenen Untersuchung gehören. Klicken Sie auf den „link to dicom“-Button. Im sich nun öffnenden Dialogfenster (Bild 12) werden nochmals die Patienten- und Untersuchungsdaten angezeigt. Kontrollieren Sie diese Daten sorgfältig und bestätigen Sie erst dann den Versand in das PACS mit dem „OK“-Button. Sollte die Anzeige nicht die gewünschten Einträge enthalten, kann der Vorgang mit dem „Abbrechen“-Button beendet werden. Wurden die Bilder erfolgreich versendet, wird die Benutzeroberfläche geleert und es erscheint nur das Livebild.

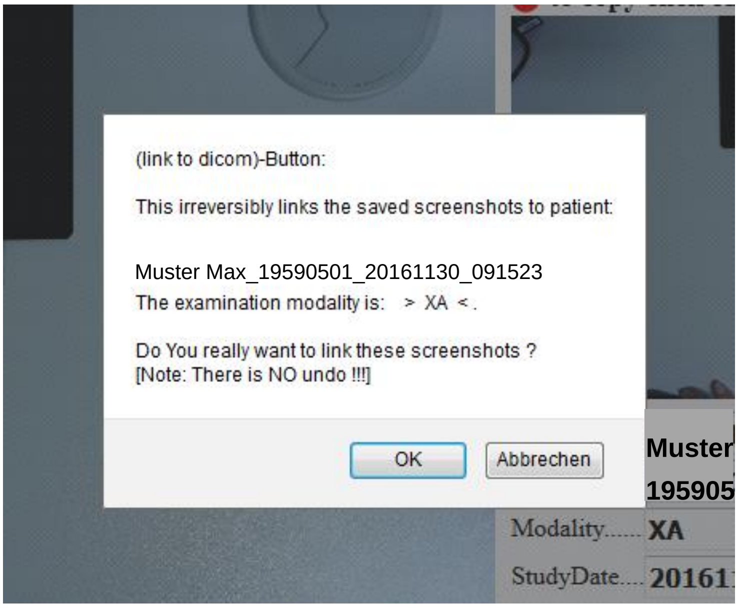


**Bild 12:** Wird der „link to dicom“-Button angeklickt, erscheint ein Dialogfender, welches nochmals die Patienten- und Untersuchungsdaten anzeigt.

# B. Testing Procedure

**Evaluierung Masterprojekt „RisPad"**

Vielen Dank für die Teilnahme an der Evaluierung des Masterprojektes „RisPad" für den Masterstudiengang Digital Healthcare. Die erhobenen Daten dienen zusätzlich der Masterthesis zum Thema „ Assessment and practicability testing of a low-level data collection system in radiological routine workflow ". Die statistische Auswertung erfolgt selbstverständlich anonym.

Zeitplan für die Evaluierung:

| Schritt | Zeitpunkt | Beschreibung |
|---|---|---|
| 1 | Tag 1 | Fragebogen zur Technikfreundlichkeit |
| 2 | Tag 1 | Praktischer Anschauungsunterricht |
| 3 | Tag 1 | Selbstständige Eingabe eines Testpatienten und Dokumentation von etwaigen Problemen |
| 4 | Tag 1 | Feedback-Bogen |
| 5 | Tag 2* | neuerliche selbstständige Eingabe eines Testpatienten und Dokumentation von etwaigen Problemen |
| 6 | Tag 2* | neuerlicher Feedback-Bogen |

*Tag 2 erfolgt ca. 5-10 Tage nach Tag 1

# C. Assessment Sheet: Technology Affinity

## Fragebogen zur Technikfreundlichkeit

Datum: ___________ Teilnehmerzahl: _____

**Bitte geben Sie Ihr Alter an:**
❒ 20-29 Jahre
❒ 30-39 Jahre
❒ 40-49 Jahre
❒ 50-59 Jahre
❒ älter

**Bitte wählen Sie Ihr Geschlecht:**
❒ weiblich ❒ männlich

**Bitte wählen Sie ihren Beruf:**
❒ MTF
❒ RT
❒ Arzt

**Wie schätzen Sie ihre Computerkenntnisse ein:**
❒ Anfänger
❒ Fortgeschrittener
❒ Experte

**Ich arbeite gerne mit Computern:**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trifft nicht zu | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | trifft zu |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |

**Ich arbeite viel mit Computern:**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trifft nicht zu | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | trifft zu |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |

**Ich benutze auch privat Computer:**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trifft nicht zu | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | trifft zu |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |

**Ich integriere Computer in meine Freizeitaktivitäten (mobile-apps etc.):**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trifft nicht zu | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | ❒ | trifft zu |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |

# D. Assessment Sheet: Learning Success

## Lernerfolg 1

Datum: ___________ Teilnehmerzahl: _____

| Variable | property | points |
|---|---|---|
| dcmSend RisPad - modality | category(1,0) | |
| start up-PC | category(1,0) | |
| start browser | category(1,0) | |
| start rispad | category(1,0) | |
| authentication | category(1,0) | |
| start camera | category(1,0) | |
| document position | category(1,0) | |
| screen shot taken | category(1,0) | |
| screen shot readable | 1 point per page | |
| thumbnail | 1 point per page | |
| search patient | category(1,0) | |
| correct patient | category(1,0) | |
| dcmSend RisPad - RisPadDoc | category(1,0) | |
| **Gesamtergebnis** | | |

## Eingabe der Testpatienten 1

Datum: ___________ Teilnehmerzahl: _____

Problemerfassung:

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

## Lernerfolg 2

Datum: ___________ Teilnehmerzahl: _____

| Variable | property | points |
|---|---|---|
| dcmSend RisPad - modality | category(1,0) | |
| start up-PC | category(1,0) | |
| start browser | category(1,0) | |
| start rispad | category(1,0) | |
| authentication | category(1,0) | |
| start camera | category(1,0) | |
| document position | category(1,0) | |
| screen shot taken | category(1,0) | |
| screen shot readable | 1 point per page | |
| thumbnail | 1 point per page | |
| search patient | category(1,0) | |
| correct patient | category(1,0) | |
| dcmSend RisPad - RisPadDoc | category(1,0) | |
| **Gesamtergebnis** | | |

## Eingabe der Testpatienten 2

Datum: ___________ Teilnehmerzahl: _____

Problemerfassung:

_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________

# E. Assessment Sheet: Feedback

## Feedback 1

Datum: ___________ Teilnehmerzahl: _____

**Ich finde die Anwendung insgesamt:**
schlecht ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ gut
1 2 3 4 5 6 7 8 9 10

**Die Übertragung eines Bildes auf Perfusion2 sollte automatisch erfolgen:**
trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu
1 2 3 4 5 6 7 8 9 10

**Das Programm kann einfach in Betrieb genommen werden:**
trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu
1 2 3 4 5 6 7 8 9 10

**Die Benutzeroberfläche ist leicht verständlich:**
trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu
1 2 3 4 5 6 7 8 9 10

**Das Erstellen eines screenshots ist einfach:**
trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu
1 2 3 4 5 6 7 8 9 10

**Die Patientenliste ist leicht bedienbar:**
trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu
1 2 3 4 5 6 7 8 9 10

**Die Patientenauswahl ist übersichtlich:**
trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu
1 2 3 4 5 6 7 8 9 10

**Das abschließende senden der screenshots an das PACS ist gut abgesichert:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Das Handbuch ist leicht verständlich:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Ich habe das Handbuch für das selbstständige Eingeben der Testpatienten benötigt:**

❒ ja ❒ nein

**Wenn ja:**

**Das Handbuch hat mir beim selbstständigen Eingeben der Testpatienten geholfen:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Der praktische Anschauungsunterricht war ausreichend:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Ich fühle mich nach dem selbstständigen Testen sicher genug um die Anwendung zu einem späteren Zeitpunkt wieder durchführen zu können:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Bemerkungen:**

_____________________________________________________________

_____________________________________________________________

_____________________________________________________________

_____________________________________________________________

_____________________________________________________________

# Feedback 2

Datum: __________ Teilnehmerzahl: _____

**Ich finde die Anwendung insgesamt:**
schlecht ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ gut
1 2 3 4 5 6 7 8 9 10

**Die Übertragung eines Bildes auf Perfusion2 sollte automatisch erfolgen:**
trifft nicht zu ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ trifft zu
1 2 3 4 5 6 7 8 9 10

**Das Programm kann einfach in Betrieb genommen werden:**
trifft nicht zu ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ trifft zu
1 2 3 4 5 6 7 8 9 10

**Die Benutzeroberfläche ist leicht verständlich:**
trifft nicht zu ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ trifft zu
1 2 3 4 5 6 7 8 9 10

**Das Erstellen eines screenshots ist einfach:**
trifft nicht zu ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ trifft zu
1 2 3 4 5 6 7 8 9 10

**Die Patientenliste ist leicht bedienbar:**
trifft nicht zu ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ trifft zu
1 2 3 4 5 6 7 8 9 10

**Die Patientenauswahl ist übersichtlich:**
trifft nicht zu ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ ❐ trifft zu
1 2 3 4 5 6 7 8 9 10

**Das abschließende senden der screenshots an das PACS ist gut abgesichert:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Das Handbuch ist leicht verständlich:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Ich habe das Handbuch für das selbstständige Eingeben der Testpatienten benötigt:**

❒ ja ❒ nein

**Wenn ja:**
**Das Handbuch hat mir beim selbstständigen Eingeben der Testpatienten geholfen:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Der praktische Anschauungsunterricht war ausreichend:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Ich fühle mich nach dem selbstständigen Testen sicher genug um die Anwendung zu einem späteren Zeitpunkt wieder durchführen zu können:**

trifft nicht zu ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ trifft zu

1 2 3 4 5 6 7 8 9 10

**Bemerkungen:**

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________