

EHR Usability Test Report of axiUm 7.04

Report based on ISO/IEC 25062:2006 Common Industry Format for Usability Test Reports

Product: axiUm CE

Version: 7.04

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Note: The following study was developed using the NISTIR 7742 template as a guide for reporting our findings: *Customized Common Industry Format Template for Electronic Health Record Usability Testing.*

Executive Summary

A usability test of axiUm CE 7.04, a complete enterprise level EHR was conducted throughout the month of November 2018 by Exan Software Group, Inc. The purpose of this test was to test and validate the usability of the current user interface, and to provide evidence of usability. During the usability test, 10 Dental healthcare users served as participants and used the EHR in simulated, but representative tasks.

This study collected performance data on 16 tasks typically conducted on an EHR. The tasks conducted were related to the following:

- CPOE – Laboratory
- CPOE – Diagnostic Imaging
- Demographics
- Problem List
- Medication List
- Medication Allergy List
- Clinical Decision Support
- Implantable Device List
- Clinical Information Reconciliation and Incorporation

Prior to the 60 minutes usability test, each participant was selected by the administrator and asked to review and sign an informed consent/release form (included in Appendix). Participants had prior experience with the EHR.

During the 60 minutes usability test, the administrator introduced the test, and instructed participants to complete a series of tasks (given one at a time) using the EHR. During the testing, the administrator timed the test and, along with the data logger, recorded user performance data on paper. The administrator did not give the participant assistance in how to complete the task.

The following types of data were collected for each participant:

- Time to complete each task
- Number and types of errors
- Path deviations
- Participants verbalizations
- Tasks completed in the allotted time.
- Participant's satisfaction ratings of the system

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. Following the conclusion of the testing, participants were asked to complete a post-test questionnaire. The following is a summary of the performance and rating data collected on the EHR.

Various recommended metrics, in accordance with the examples set forth in the NIST guide to the Processes Approach for Improving the Usability of Electronic Health Records, were used to evaluate the usability of axiUm 7.04 CE. Following is a summary of the performance and rating data collected on the axiUm 7.04 CE.

Task	Participants	Task Success	Deviations		Task Time		Errors		Task Ratings 5=Easy
			(Observed / Optimal)	Average (Observed / Optimal)	Mean (SD)	Deviations (Observed / Optimal)	Total (Failures)	Mean (%)	Mean (SD)
1. Add Patient demographic information	10	10	13/12	1.08	130	27/42	0	0%	4.6
2. Add Patient Gender Identity and Sexual Orientation	10	9	6/5	1.2	50	11/18	1	10%	3.9
3. Add a Medical lab order	10	9	9/9	1	100	21/33	1	10%	4.6
4. Add a Radiology order	10	9	6/6	1	70	14/27	1	10%	4.6
5. Add a Medical Problem	10	7	6/5	1.2	70	14/23	3	30%	3.6
6. Add an Implant to a Patients Chart	10	8	4/4	1	35	8/12	2	20%	4.8
7. Add the CDS interventions and view triggered interventions	10	9	6/6	1	45	9/20	1	10%	4.9
8. Update Patient demographic information including Gender Identity and Sexual Orientation	10	10	17/17	1	100	21/40	0	0%	4.7
9. Update a Medical lab order	10	10	6/5	1.2	85	18/36	0	0%	4.4
10. Update a Radiology order	10	10	3/3	1	40	8/32	0	0%	4.9
11. Add a CCDA file to the Patient's chart	10	10	7/7	1	75	15/29	0	0%	4.4
12. Reconcile the Allergies, Medications and Problems from the CCDA to the Patient's Chart and view the Triggered CDS interventions	10	9	14/14	1	120	24/23	1	10%	4.1
13. View the Patient's active/inactive problems	10	10	4/4	1	60	11/17	0	0%	4.1
14. Update a Medical Problem	10	10	3/3	1	50	10/15	0	0%	4.6
15. Update the Patient's implant	10	10	5/5	1	40	8/10	0	0%	4.7
16. Create a Transition of Care file for the Patient	10	9	9/8	1.13	100	20/34	1	10%	4.5

The results from the System Usability Scale ¹ scored the subjective satisfaction with the system based on performance with these tasks to be: 67.5%

- Major findings
 - No major findings were noted on the participants facial expressions or verbal responses to any of the tasks.
- Areas for improvement
 - There were three areas detected during the study that need to be reviewed for some workflow changes usability considerations. These areas were:
 - Adding an alert on a medical problem
 - Adding an Implant to a patient record
 - Reconciling CCDA files

¹ See Tullis, T. & Albert, W. (2008). Measuring the User Experience. Burlington, MA: Morgan Kaufman (p. 149). Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

Introduction

The EHR tested for this study was axiUm 7.4 CE, a complete enterprise level EHR. Designed to input and present Dental information to Dental providers in Dental healthcare settings, the system has evolved to allow practice users to maintain a list of a patient's medications, allergies and problems along with the integration of e-prescribing and the ability to enter and process Medical Lab orders and Radiology orders. The system has also been enhanced to support Clinical Decisions (CDS) which includes alerts/notifications and access to online health information library. The usability testing attempted to represent realistic exercises and conditions.

The purpose of this study was to test and validate the usability of the current user interface and provide evidence of usability in the EHR. To this end, measure of effectiveness and efficiency (time to perform tasks; total number of deviations; total number of errors; etc.) were captured during the usability testing.

Method

Participants

A total of 10 participants were tested on the EHR system (axiUm 7.4 CE). Participants in the test were individuals that work within an ambulatory dental healthcare & academic environment. Participants were contacted by Exan Enterprises, Inc staff to participate in the study. In addition, participants had no direct connection to the development of the EHR. Participants were not from Exan Software Group, Inc. Participants were given the opportunity to have the same orientation and level of training as the actual end users would have received. All participants had the same level of training as all other actual end users.

The following is a table of participants by characteristics, including demographics, user role, and computer experience. For the test purposes, end-user characteristics were identified and translated into a recruitment screener used to solicit potential participants. Participant names were replaced with Participant IDs so that an individual’s data cannot be tied back to individual identities. A summary of the participant demographics can be found in the Appendix.

Participant ID	User Role	Highest Level of Education	Product Experience (Years)	Computer/Tablet Experience (Years)	Professional Experience (Years)	Age
UCD201801	Dental Informatics	Post Grad(MD/PhD etc.)	12	26-35	36	50-59
UCD201802	Dentist, clinical faculty	Post Grad(MD/PhD etc.)	7.5	26-35	40	60-69
UCD201803	Dentist	Post Grad(MD/PhD etc.)	5	26-35	40	60-69
UCD201804	Dentist	Post Grad(MD/PhD etc.)	17	26-35	38	50-59
UCD201805	Analyst	College Graduate	17	26-35	38	50-59
UCD201806	Information Systems Analyst	Post Grad(MD/PhD etc.)	8	26-35	8	40-49
UCD201807	Student	College Graduate	3	11-25	0	20-29
UCD201808	Student	College Graduate	3	11-25	0	20-29
UCD201809	Student	College Graduate	3	11-25	0	20-29
UCD201810	Student	College Graduate	3	11-25	0	20-29

100% of all participants recruited for the test showed up to participate in the test.

Participants were advised that the test would take 50 minutes; but to allocate 60 minutes for the test. The 10 minutes was to provide enough time for administrator instructions and time between tasks. A spreadsheet was used to track participant schedules and included each patient's demographic characteristics.

Study Design

Overall, the objective of this test was to uncover areas where the application performed well – that is, effectively, efficiently, and with satisfaction – and areas where the application failed to meet the needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same EHR and/or comparison with other EHRs provided the same tasks are used. In short, this testing serves as both a means to record or benchmark current usability, but also to identify areas where improvements must be made.

During the usability test, each participant interacted with 1 EHR. Each participant was provided the same set of instructions. The system was evaluated for effectiveness and efficiency as defined by measures collected and analyzed for each participant.

- Time to complete each task
- Number and types of errors
- Path deviations
- Participants verbalizations
- Tasks completed in the allotted time.
- Participant’s satisfaction ratings of the system

Tasks

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, including:

Task	Criteria	Risk
Update the Patient's implant <ul style="list-style-type: none"> • Involved accessing the device description, identifiers, and attributes • Includes changing the UDI Status 	170.315(a)(14) Implantable Device List	Med
Add an Implant to a Patients Chart	170.315(a)(14) Implantable Device List	Med
Add a Medical lab order	170.315(a)(2) CPOE – Laboratory	Low
Update a Medical lab order	170.315(a)(2) CPOE – Laboratory	Low
Update a Radiology order	170.315(a)(3) CPOE – Diagnostic Imaging	Low
Add a Radiology order	170.315(a)(3) CPOE – Diagnostic Imaging	Low
Add Patient demographic information <ul style="list-style-type: none"> • Involves adding Preferred Language, Date of Birth, Sex, Race and Ethnicity 	170.315(a)(5) Demographics	Low

Add Patient Gender Identity and Sexual Orientation	170.315(a)(5) Demographics	Med
Update Patient demographic information including Gender Identity and Sexual Orientation <ul style="list-style-type: none"> Also involved updating Preferred Language, Date of Birth, Sex, Race and Ethnicity Viewed the updated Preferred Language, Date of Birth, Sex, Race, Ethnicity, Gender Identity and Sexual Orientation 	170.315(a)(5) Demographics	Low
View the Patient's active/inactive problems <ul style="list-style-type: none"> Viewed the historical problem list 	170.315(a)(6) Problem List	Med
Update a Medical Problem	170.315(a)(6) Problem List	Low
Add a Medical Problem	170.315(a)(6) Problem List	Med
Add the CDS interventions and view triggered interventions <ul style="list-style-type: none"> For the following CDS interventions problem list, med list, med allergy list, labs, Vitals (blood pressure), Demographics (preferred language) and Problem list w/ demographics (Age and Medical Problem) Viewed intervention/resource information via Infobutton for problem list, med list and demographic 	170.315(a)(9) Clinical Decision Support	Med
Add a CCDA file to the Patient's chart	170.315(b)(2) Clinical Information Reconciliation and Incorporation	Med
Reconcile the Allergies, Medications and Problems from the CCDA to the Patient's Chart and view the Triggered CDS interventions <ul style="list-style-type: none"> Viewed CDS interventions for problem list, med list, med allergy list from the data that came from the CCDA file Viewed the bibliographic citation, developer, funding source, release/revision date for the intervention based on the Problem List 	170.315(b)(2) Clinical Information Reconciliation and Incorporation 170.315(a)(9) Clinical Decision Support	Med
Create a Transition of Care file for the Patient	170.315(b)(2) Clinical Information Reconciliation and Incorporation	High

Tasks were selected based on their frequency of use, criticality of function, and those that may be most troublesome for users. The risk level category was assigned to each task prior to the test based on an assessment of risk involved in the task.

Procedures

Upon arrival, participants were greeted, and their identity was verified and matched with the participant's name on the schedule. Participants were then assigned a participant ID. All participants signed an informed consent form prior to the testing.

To ensure that the test ran smoothly, two Exan Software Group staff members participated in the administration of the test. The test administrator provided the instructions for each test and noted all comments from the participants; while the data logger noted all times, deviations and errors.

Participants were instructed to perform the tasks:

- After listening to the instructions from the testing administrator
- As quickly as possible making as few errors and deviations as possible.
- Without assistance; administrators were allowed to give immaterial guidance and clarification on tasks, but not instructions on use.
- Without using a think aloud technique.

Task timing began after the completion of the verbal instructions from the administrator; and after an acknowledgement from the participant that they were ready to begin. The task time was stopped once the participant indicated they had successfully completed the task.

Following the test, the administrator gave the participant the post-test questionnaire; and then thanked them for their time.

The Exan Software Group staff member responsible for logging data recorded all participants' demographic information, task success rate, time on task, errors, and deviations into a spreadsheet.

Test Location

The test was administered in a setting where participants were in an isolated location for this study. Only the test administrator and logger were with the participants while the study was being administered. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range.

Test Environment

The computers used for the testing were PCs running on Windows 10. Users also used a mouse and keyboard while interacting with the EHR. The axiUm 7.4 CE application is a

client-server based solution; so all computers were running on within an intranet and were fully wired in (i.e. no wireless computing).

All participants indicated that system performance during the test was what they were used to seeing during their typical work day.

Test Forms and Tools

During the usability test, various instruments and documents were used, including:

- Informed consent
- Moderator guide
- Post-test questionnaire

Examples of these documents are to be found in the Appendix section.

Participant Instructions

The Administrator read the following instructions aloud to each participant:

“Thank you for participating in this study. Your input is very important. Our session today will last about 60 minutes. During that time you will use an instance of axiUm 7.04. I will ask you to complete a few tasks using this system and answer some questions. You should complete the tasks as quickly as possible making as few errors as possible. Please try to complete the tasks on your own following the instructions very closely. Please note that we are not testing you we are testing the system, therefore if you have difficulty all this means is that something needs to be improved in the system. I will be here in case you need specific help, but I am not able to instruct you or provide help in how to use the application.

Overall, we are interested in how easy (or how difficult) this system is to use, what in it would be useful to you, and how we could improve it. All of the information that you provide will be kept confidential and your name will not be associated with your comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.”

I will read the instruction to you and let you know when to begin, when you feel like you finished the task please say you are done.”

Participants were then given 16 tasks to complete. Tasks are listed in the appendix under tasks.

Usability Metrics

According to the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records, EHRs should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction. To this end, metrics for effectiveness, efficiency and user satisfaction were captured during the usability testing.

The goals of this test were to assess:

1. Effectiveness of axiUm 7.04 CE by measuring participant success rates and errors
2. Efficiency of axiUm 7.04 CE by measuring the average task time and path deviations

Data Scoring

The table below details how each task was scored.

Measure	Rationale and Scoring
Effectiveness Task Success	A task was considered a success if the participant completed the task in the allotted time. To calculate the task success rate, we simply divided the total number of successful tasks by the total number of tasks completed. The time designated for each task was determined by taking the optimal time to complete the task and multiplying it by a factor of 1.25 to allow for those users that may not have been fully trained on the application.
Effectiveness Errors	The task resulted in an error if the participant: failed to finish the task in the allotted time; or, if they became 'stuck' and could not proceed without asking for assistance. Task time was not counted when the task resulted in an error. We calculated the error % for each task by taking the total number of errors for each task and divided that number by the total attempts at the task.
Efficiency Path Deviations	Path deviations were recorded as actions taken during the task that were not part of the necessary actions needed to complete the task. We calculated path deviations by taking the total number of observed deviations and dividing that number by the total number of steps taken using an optimal path.
Efficiency Task Time	Timing started when the administrator said 'Begin'. The time ended when the participant said 'Done'. In the event that the participant

Measure	Rationale and Scoring
	finished, and did not say 'Done', the administrator stopped the clock when it was clear the participant had completed the task. Task times were only counted if the participant completed the task in the allotted time. The average time per task was calculated for each task.

Results

Data Analysis and Reporting

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above. The testing result for axiUm CE is detailed below and identifies the tasks performed and the performance level for each task.

Task	Participants	Task Success	Deviations		Task Time		Errors		Task Ratings
			(Observed / Optimal)	Average (Observed / Optimal)	Mean (SD)	Deviations (Observed / Optimal)	Total (Failures)	Mean (%)	5=Easy Mean (SD)
1. Add Patient demographic information	10	10	13/12	1.08	130	27/42	0	0%	4.6
2. Add Patient Gender Identity and Sexual Orientation	10	9	6/5	1.2	50	11/18	1	10%	3.9
3. Add a Medical lab order	10	9	9/9	1	100	21/33	1	10%	4.6
4. Add a Radiology order	10	9	6/6	1	70	14/27	1	10%	4.6
5. Add a Medical Problem	10	7	6/5	1.2	70	14/23	3	30%	3.6
6. Add an Implant to a Patients Chart	10	8	4/4	1	35	8/12	2	20%	4.8
7. Add the CDS interventions, select a patient to view the interventions	10	9	6/6	1	45	9/20	1	10%	4.9
8. Update Patient demographic information including Gender Identity and Sexual Orientation	10	10	17/17	1	100	21/40	0	0%	4.7
9. Update a Medical lab order	10	10	6/5	1.2	85	18/36	0	0%	4.4
10. Update a Radiology order	10	10	3/3	1	40	8/32	0	0%	4.9
11. Add a CCDA file to the Patient's chart	10	10	7/7	1	75	15/29	0	0%	4.4
12. Reconcile the Allergies, Medications and Problems from the CCDA to the Patient's Chart and view the Triggered CDS interventions	10	9	14/14	1	120	24/23	1	10%	4.1
13. View the Patient's active/inactive problems	10	10	4/4	1	60	11/17	0	0%	4.1
14. Update a Medical Problem	10	10	3/3	1	50	10/15	0	0%	4.6
15. Update the Patient's implant	10	10	5/5	1	40	8/10	0	0%	4.7
16. Create a Transition of Care file for the Patient	10	9	9/8	1.13	100	20/34	1	10%	4.5

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be: 67.5

Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average

Effectiveness

Overall based on the data the system is effective workflow wise. There are three areas that have an opportunity for improvement for a more effective user experience. The areas for improvement are;

- Medical Alerts Entry
- CCDA files Entry
- Implant Entry

Efficiency

Participants in the study, for the most part, followed the optimal paths to complete the assigned tasks. However, the major exception involves the Medical Alerts entry, CCDA files features and implant entries. The Medical Alerts entry and Race/Ethnicity entry went through significant changes and it was expected that users may not be fully accustomed to the presented workflows/designs when performing the tasks.

Satisfaction

Overall the usability study participants that had used our system and hadn't used our system seemed to be satisfied with the workflow and usability of the axiUm 7.4 CE.

Risk Evaluation

The tasks that resulted in the highest amount of errors (although it was categorized as medium risk) was adding the Medical Problems. Our users are from a Dental Academic setting, so they had two issues. First conceptually a problem has a slightly different definition than the one defined for certification. This resulted in the second issue where they would go to a different area to enter the problem.

From talking to our clients, that use our certified software, in practice we found that once the user understands what the concept of a Medical Problems is, they can enter the Medical Problems without issues. Additionally, our system also has a mechanism to ensure the Medical Problem is still properly captured. In the cases that problems are entered in the incorrect area a trigger will automatically create the data in the right Medical Problem section.

Overall additional training seems to greatly reduce the error rate. In the rare case that the error occurs the Medical Problem data still ends up in the right area. From this we conclude that the risk to Patient safety from this error is minimal.

Major Findings

There were no major findings discovered.

Areas for Improvement

There were three areas detected during the study that need to be reviewed for some workflow changes usability considerations. These areas were:

- Adding an alert on a medical problem
- Adding an Implant to a patient record
- Reconciling CCDA files

We will be reviewing these areas to propose some potential workflow changes and run it by our client advisory board for approval.

Appendices

The following appendices include supporting data for this usability study.

1. Sample Consent Form: Exan Software Group, Consent and Data Release From

I _____ agree to participate in the study conducted and data recorded by Exan Software Group Inc. (Exan) on Thursday, November 15th, 2018.

I understand and consent to the use and release of the data recorded by Exan. I understand that the information and data recorded is for research purposes only and that my name and image will be kept anonymous and will not be used for any other purpose. I relinquish any rights to the data/information gathered and understand the data gathered may be copied and used by Exan Group without further permission.

My participation in this study will include performing specific tasks within axiUm 7.4 CE and completing a short survey following the study. The study will take approximately 50 minutes.

Please sign below to indicate that you have read and you understand the information on this form and that any questions you might have about the question have been answered.

By signing below, I agree to participate in the study.

Name of Participant	
axiUm User Level	
Experience w/axiUm (Yrs)	
Dental Professional Experience	

Date: _____

Please print your name: _____

Please sign your name: _____

Thank you!

We appreciate you participation.

3. Tasks

#	Task	Max Time (s)	Time Taken (s)	# Deviations	Errors	Rating (5=easy)
1	Add Patient demographic information	130				
2	Add Patient Gender Identity and Sexual Orientation	50				
3	Add a Medical lab order	100				
4	Add a Radiology order	70				
5	Add a Medical Problem	70				
6	Add an Implant to a Patients Chart	35				
7	Add the CDS interventions and view triggered interventions	45				
8	Update Patient demographic information including Gender Identity and Sexual Orientation	100				
9	Update a Medical lab order	85				
10	Update a Radiology order	40				
11	Add a CCDA file to the Patient's chart	75				
12	Reconcile the Allergies, Medications and Problems from the CCDA to the Patient's Chart and view the Triggered CDS interventions	120				
13	View the Patient's active/inactive problems	60				
14	Update a Medical Problem	50				
14	Update the Patient's implant	40				
15	Create a Transition of Care file for the Patient	100				

4. Participants Demographics

Education Level	
High School	0
Some College	0
College Graduate	4
Post Grad	6

Occupation	
Dentist	2
Dental Informatics	1
Analyst	1
Admin	2
Student	4

Age

20-29	4
40-49	1
50-59	3
60-69	2

Computer Exp	
0-5 Years	0
6-10 Years	0
11-25 Years	4
26-35 Years	6

Gender	
Female	5
Male	5
Unknown	0