Electronic Health Records User Satisfaction:

Experience after implementation of a new system in Northern Norway

[a] Ove Lintvedt, [b] Espen Nordheim, [c] Rune Pedersen

Norwegian Centre for E-health Research,
University Hospital of North Norway,
Tromsø, Norway

e-mail: [a]ove.lintvedt@ehealthresearch.no, [b]espen.solbakken.nordheim@ehealthresearch.no,
[c]rune.pedersen@ehealthresearch.no

***Abstract*—The study assessed user satisfaction with a new Electronic Health Record (EHR) system in the Northern Norway Regional Health Authority and compared it to a baseline. The baseline surveys were conducted in 2016 and 2018, and the survey after implementing the new HER system was done in 2021. A comparative analysis was performed, with the primary statistical method used for analysis being frequency (percentage) for discrete variables and mean for continuous variables. The one-way analysis of variance (ANOVA) was used to determine whether there are any statistically significant differences between the means of satisfaction for baseline data vs. the 2021 data. The results indicated an improvement in overall user satisfaction with the new system, with many users being either satisfied or neutral. The study also analyzed the generic satisfaction factors of the EHR system and found a positive shift from dissatisfaction to satisfaction or neutrality. The study revealed that specific functions of the EHR system still require improvement, with the lowest satisfaction ratings given to overview of drug treatment, prescribe drugs, and care planning. However, users were most satisfied with the functions of the overview of outstanding tasks and the overview of patient issues. The results also showed a reduction in system interruptions compared to the baseline, contributing to higher user satisfaction. Overall, the results suggest that the new EHR system has improved user satisfaction compared to the previous system, but further improvements are needed for enhanced user experience. Increased user satisfaction is an important finding considering theory of the installed base that states an expected decrease in satisfaction when implementing a new system.**

Keywords-Electronic Health Record (EHR); Usability; User Satisfaction; Computerized Clinical Decision Support Systems (CCDSS); Installed Base.

I. INTRODUCTION

The focus has been directed toward digitalization in an effort for more efficient ways to operate the healthcare system. Part of the digitalization process has been the increased adoption of Electronic Health Records (EHR) [1]. In the last twenty years, the rapid development of EHR systems has changed what is possible to do within an EHR system. The development has gone from merely creating and storing the patient's health records electronically to an integrated health information system that helps patients and healthcare workers in their daily life, with examples such as clinical decision support [2][3].

The Norwegian government has long been pushing for a new generation of EHR systems, mandated by the national white paper 9, 'One citizen – one Health Record [4]. Thus, in the last decade, there has been a planning process for considerable change in the EHR infrastructure in Norway. Three of four regional health authorities used the EHR system DIPS Classic, and the fourth region used DocuLive EHR. Norway's four regional health regions started implementing new EHR systems in 2021, which is still ongoing. DIPS Classic will be replaced with DIPS Arena, and DocuLive will be replaced with EPIC EHR. The first health region to implement DIPS Arena was the Northern Norway Regional Health Authority. DIPS Arena is a Norwegian-developed EHR built on an Open EHR platform, their third-generation journal system. The new system is expected to provide new possibilities while ensuring patient safety according to international standards and providing a modern user interface.

While there are mixed results, some research says that the EHR is suggested to improve the efficiency, quality of care, and create a better workflow [1]. It also might have some negative consequences, such as more time-consuming documentation [5] practices and increased burnout [6]. In addition to the usual undesirable aspects of EHR, implementing a new EHR system adds further obstacles, with barriers such as a lack of training and support, restrictions on resources, and a lack of literacy [1]. Prior research has shown that an EHR implementation going from one EHR system to another is difficult to accomplish [7]. The basic principle of an Information Infrastructure (II) is that it is never built from scratch; instead, it grows through the evolution of an installed base [8]. The Installed base grows and increasingly influences its environment during its revolution from being implemented to being replaced [7]. The evolution of an implementation process where generic systems replace essential parts of an II increases the risk of failure and unexpected side effects. Due to this, an implementation should build on the installed base instead of replacing it to succeed [9]-[11]. To optimize the utilization of the EHR system and further improvement, an in-depth understanding of user satisfaction is necessary. User satisfaction can be influenced by a multitude of factors [12], including but not limited to usability [13] and prior system experience [14].

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Previous studies have looked at measuring user satisfaction [15] and functionality [16] with the EHR systems in Norway. This study seeks to examine if this trend continues with the implementation of a new EHR system, as we were able to measure user experience shortly after the implementation. Thus, this study aims to evaluate user satisfaction in the implementation phase of the new EHR system and compare it with user satisfaction from the former EHR system to see if there is any change in satisfaction.

This paper's overall structure contains five sections: Section II explains the applied quantitative methods. Section III presents the study's results on satisfaction and discusses ethical considerations and limitations. In Section IV, we discuss comparing the data and the findings. In the last part, Section V, we conclude with the results and suggest how to increase satisfaction for suppliers, health workers, and policymakers.

II. METHODS

In this section, we focus on the questionnaire, statistical methods, and data collection.

A. Setting

Norway's four regional health authorities govern the hospital sector: SouthEast, West, Central, and North. All the regions were in the year 2021 in a transition phase, preparing to implement a new EHR system. Northern Norway Regional Health Authority hospitals transitioned from DIPS Classic to DIPS Arena in 2021. Region West was the next to implement the same system in 2022. Region SouthEast has decided to implement the new system by 2025. The Central Region started a transition from DocuLive EHR to EPIC EHR system in 2022. This process is ongoing, and some hospitals still use the old system. All the regions are transitioning from an already existing electronic health record.

This paper will compare data before and after implementing the new EHR system in the Northern Norway Regional Health Authority. The data collection was done in 2021 as they were the first and only region to start implementing the new system. The hospitals include the University Hospital of North Norway (UNN), Nordland Hospital (NLSH), and Finnmark Hospital (FSH).

B. Data collection

This paper makes use of three surveys among EHR users in Norwegian hospitals. The first survey from 2016 included physicians only [12]. The EHR system in use was DIPS Classic. A total of 402 physicians were enrolled from three Norwegian hospitals, and 208 physicians (52%) submitted a fully answered questionnaire. Data from the largest hospital (Oslo university hospital) was included in this study. Exclusion criteria were no patient contact or if they had been employed for less than three months. Up to 10 reminders were sent in case of no response.

The second survey was administered in the autumn of 2018 [11]. The hospitals contributed with employers' email addresses, and a random-number generator selected the participants. EHR systems in use were DocuLive and DIPS Classic. For this survey, both physicians and nurses were included. A total of 506 clinicians were invited for the survey. You had to work full-time at one of the included hospitals to be included. A total of 299 persons completed the questionnaire, where 60 (20.1%) had a profession as nurses, and 239 (79.9%) were physicians. Response rates were 35.0%, 22.0%, and 29.0% for physicians, nurses, and all clinicians. Ten reminders were issued between September to December 2018.

The latest and present survey was conducted in the autumn of 2021 after implementing the new EHR system. The hospitals wanted to administer the participant recruitment themselves. The invitation was sent to all hospital employees. The EHR system in use was the new DIPS Arena. A total of 603 employees started the survey, and 221 (36.5%) completed the survey. These respondents were EHR users of different professions. Physicians, nurses, and other professionals accounted for 25.8%, 36.2%, and 38.0%, respectively. The three hospitals had 5,393 full-time equivalent positions in 2021, of which 1,606 (30.0%) were doctors, and 3,787 (70%) were nurses. The studied population of doctors and nurses represented 2.5% of the total number of full-time equivalent positions, with 3.6% of all doctors and 2.1% of all nurses. The sampling method is not ideal due to the lack of control over who got the survey. This may have affected which groups answered the survey, and it may lead to a bias where those who are more interested in the topic or have a stronger opinion may be more likely to respond. In this data collection, the hospital administration issued two reminders to the respondents from September to December 2021.

As data included in this paper regards hospitals using DIPS Classic (2016 and 2018 surveys) and DIPS Arena (2021 survey), this excludes one hospital from the 2018 survey as they used another EHR system (DocuLive EPR). From the 2021 survey, only nurses and physicians were included in the data analysis to compare the clinical roles from the 2016 and 2018 data collection. In this sense, survey data from 2016 and 2018 serves as a baseline compared to the results after implementing the new DIPS Arena in 2021.

C. Questionnaire

The survey is based on a previously validated questionnaire [17]. Changes were made in 2021 to the full questionnaire as it was too time-consuming. However, the items regarding satisfaction remain equal to the previous studies. This new questionnaire is an early effort to develop ISO-based indicators for user satisfaction among clinical EHR users.

TABLE I. DATASET, BASELINE AND 2021 DATA

Health Region (Survey year)	Clinical profession		
	Physicians, n	*Nurses, n*	*Total, n (%)*
West (2018)	34	12	46 (12.3%)
South-East (2016)	152	0	152 (40.7%)
North (2018)	22	17	39 (10.4%)
North (2021)	57	80	137 (36.6%)
Total	265 (70.9%)	109 (29.1%)	374 (100.0%)

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Two different survey programs were used to conduct the survey: in 2018, Questback (Questback, Oslo, Norway), and in 2016 and 2021, Limesurvey (LimeSurvey GmbH, Hamburg, Germany). All questionnaires were anonymous and constructed dynamically, hence that the respondents would only answer relevant questions that were relevant to them. Before conducting the surveys, they were piloted through interviews to get the necessary feedback.

The questionnaire mainly used a 5-point Likert scale ('Completely disagree,' 'Partially disagree,' 'Neutral,' 'Partially agree, 'Completely agree'). Some questions were only rated as agree/disagree or asking for a numeric response. Three sub-categories are used to measure user satisfaction; EHR Function satisfaction (11 items; Q1-Q11), EHR Generic satisfaction (four items; G1-G4), and EHR Overall satisfaction (one item; O1).

D. Analysis/statistical methods

The main statistical methods used for analysis were frequency (percentage) for discrete variables and mean for continuous variables. The one-way analysis of variance (ANOVA) was used to determine whether there are any statistically significant differences between the means of satisfaction for baseline data vs. the 2021 data. The significance level was considered p=.05. The statistical software SPSS 25 (IBM Corp., Armond, NY) was used for the analysis. In the process of cleaning data, we had to address missing values. There was a high number of missing values for satisfaction items, n=616 (24.4%), as some questionnaire items depended on profession (e.g., nurse do not prescribe drugs). Several imputation techniques have been suggested when missingness is completely random (MCAR) and when there are no systematic reasons for missingness [18]. We addressed missing values by applying the MCAR assumption by Little [19]. The results confirmed that the missingness is MCAR (χ^2 =1564.299, df=1493, p=.10). Then, we let SPSS impute our missing values based on the expectation-maximization (EM) analysis that estimates the means, correlations, and covariances.

E. Ethics

The Regional Committee for Medical and Health Research Ethics South-East Norway has been consulted. According to national regulations and ethics, approval was not required because the study did not involve biomedical research, and all data were anonymized.

III. RESULTS

A. Baseline data

The number of participants that completed the 2021 questionnaire and were EHR users was n=221 (82.5%). From this sample, 70.1% were female; the mean experience was 17.4 years (*sd*=11.0); the mean age was 45.9 years (*sd*=11.6). The clinical field with the highest number of participants was the aggregation of those treating conditions related to mental health and substance abuse (30.8%), medical (29.4%), surgical (19.0%), and other (20.8%). Physicians, nurses, and other professionals accounted for 25.8% (*n*=57), 36.2% (*n*=80), and 38.0% (*n*=84), respectively. Participants from the hospitals, FSH, NLSH, and UNN accounted for 28.5% (n=63), 40.7% (n=90), and 30.8% (n=68), respectively.

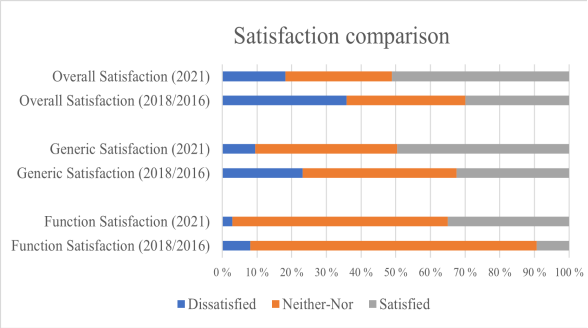

Figure 1. Comparison between changes in satisfaction for the three types of satisfaction.

Table I summarizes the baseline data by year, health region, and participants' clinical role. The clinical field with the highest number of participants was the aggregation of those treating conditions related to mental health and substance abuse (30.8%), medical (29.4%), surgical (19.0%), and other (20.8%). Physicians, nurses, and other professionals accounted for 25.8% (*n*=57), 36.2% (*n*=80), and 38.0% (*n*=84), respectively. Participants from the hospitals, FSH, NLSH, and UNN accounted for 28.5% (*n*=63), 40.7% (*n*=90), and 30.8% (*n*=68), respectively.

Table I summarizes the baseline data by year, health region, and participants' clinical role. The clinical field with the highest number of participants was the aggregation of those working in the medical field, with n=169 (45.2%). The following fields with the highest number of participants were

TABLE II. ANOVA RESULTS FOR SATISFACTION ITEMS

Satisfaction items	ANOVA		
	F	*df*[a]	*p*
Q1 Read medical reports	70.439	1	.000[b]
Q2 Compare treatment and efficacy	9.351	1	.002[b]
Q3 Overview patient issues	22.071	1	.000
Q4 Read radiology reports			n.s.
Q5 Overview outstanding tasks	11.935	1	.001
Q6 Communicate with patients	33.099	1	.000
Q7 Advise further treatment	56.128	1	.000
Q8 Prescribe drugs	142.034	1	.000
Q9 Plan for treatment and care	271.343	1	.000
Q10 Assess right to priority health care	20.962	1	.000
Q11 Overview drug treatment	24.929	1	.000[b]
G1 Effective patient work	7.306	1	.007
G2 EHR Quality	23.021	1	.000
G3 Worth effort	5.865	1	.016
G4 User friendly	18.017	1	.000
O1 Overall Satisfaction	21.037	1	.000

a.df within groups = 372. b. 2021 satisfaction is lower than baseline.

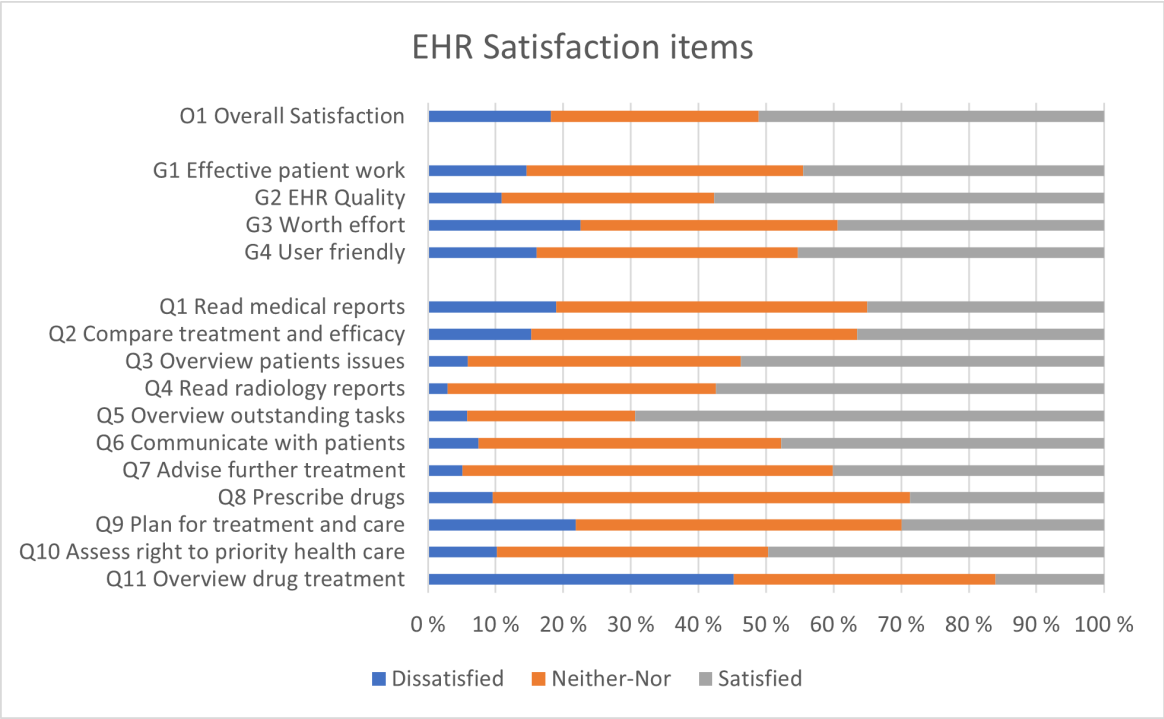

Figure 2. The satisfaction items with response categories

related to surgical, psychiatry, and others, with n=130 (34.8%), n=36 (9.6%), and n=39 (10.4%), respectively.

B. Questionnaire results and interuptions

Two questions related to interruptions of the clinical workflow while using the EHR. The first one regarded interruption caused by login requests; results range from 4 to 50 interruptions per day (outliers removed). The mean number of interruptions for physicians and nurses per day is 15.13. The corresponding number from the 2018 and 2016 data was 17.21 and 17.15, respectively.

The second interruption regarded interruption due to the EHR hanging or crashing. The median number of interruptions is four, corresponding to one per month in the scale used. The corresponding numbers from the 2018 and 2016 data were three, once a week, for both studies. Only 12.3% of respondents reported interruptions that occurred once or more per day, 36.1% reported weekly interruptions, and 51.5% reported interruptions that ranged between once a month and none. The corresponding numbers from the baseline data were 35.1%, 37.7%, and 27.3%, respectively.

C. User satisfaction

The aggregated results for the three types of satisfaction significantly increased after the implementation of the new system, see Figure 1. There was a statistically significant effect on the satisfaction from the 2021 survey, except for item Q4 (See Table II). Items Q1, Q2, and Q11 show a significant decrease in satisfaction. An overview of the single items for satisfaction is in Figure 2.

EHR Function satisfaction. For overall function satisfaction (questiQ1-Q11), 35.0% of respondents reported being satisfied, 30.7% neither satisfied nor dissatisfied, and 18.2% dissatisfied.

The highest satisfaction was reported for Q5 (overview of outstanding tasks), where 69.3% of respondents were satisfied. This item has the lowest indifferent rating, 24.8%, and the third lowest dissatisfaction rating, 5.8%. In addition, functions for Q5, Q3 (overview patients' issues), and Q4 (read radiology reports) all have high satisfaction rates, all above 50%. For Q4, there is no significant change from the baseline measurements.

The lowest satisfaction was measured for Q11 (overview drug treatment); only 16.1% of the respondents were satisfied. Compared with baseline data, this function has a significant decrease in satisfaction. At the same time, this function has the highest dissatisfaction rating, 45.3%. Less than 30.0% were satisfied with the functions for Q11, Q8 (prescribe drugs), and Q9 (plan for treatment and care).

The function with the highest indifferent rate was Q8, 61.8%. This function scores low both on satisfaction (9.6%) and dissatisfaction (28.7%).

Three of the functions score are in the mid-range for satisfaction, Q6 (communicate with patients), Q7 (advise further treatment), and Q10 (assess right to priority health care), with satisfaction scores in the range of 40.1% to 49.6%. These items also have a low dissatisfaction score (7.5%, 5.1%, and 10.2%, respectively) and indifferent scores in the mid-range (44.8%, 54.7%, and 40.1%, respectively).

Items Q1 (Read medical reports), Q2 (Compare treatment and efficacy), and Q11 show a significant decrease in satisfaction. No significant differences were found in EHR Function satisfaction among hospitals or user categories.

EHR Generic satisfaction. Generic satisfaction refers to effectiveness, high quality, the worth of time and effort, and user-friendliness; overall, 49.6% of respondents were

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satisfied; 40.9% were neither satisfied nor dissatisfied; 9.5% reported being dissatisfied.

Generic satisfaction for Quality (G2) was reported as high by 57.7%. The other factors have reasonable satisfaction rates, between 39.4% and 45.3%. The dissatisfaction is highest for Worth the Effort (G3), with 21.3%, while the other items have dissatisfaction rates between 10.9% and 16.1%. All four generic items have a significantly higher satisfaction rate in the 2021 survey vs. baseline. No significant differences were found in EHR Generic satisfaction among hospitals or user categories.

EHR Overall satisfaction. A single item assessed overall satisfaction, where 51.1% of respondents were satisfied, 30.7% were neither satisfied nor dissatisfied, and 18.2% reported being dissatisfied. The general satisfaction item has a significantly higher satisfaction rate in the 2021 survey vs. baseline. No significant differences were found in EHR Overall satisfaction among hospitals or user categories.

IV. DISCUSSION

The study evaluated user satisfaction with a new EHR system in hospitals in Northern Norway health authorities and compared it with a baseline based on the old system. The results indicated that many users were either satisfied or neutral. Compared to data from the baseline, a significant improvement in user satisfaction was observed in the present study. One explanation for this change can be that the previous system was not perceived as good enough and that the difference (e.g., user interface) was enough to improve users' satisfaction. On the other hand, it can be interpreted that the implementation of the new EHR system was well-planned, the process was incremental and that the user was given enough training on the new system, hence overcoming a usual barrier of implementing a new EHR [1].

Generic satisfaction (effectiveness, high quality, the worth of time and effort, and user-friendliness) looks further into some core aspects of usefulness that contribute to the satisfaction of the system. The results revealed a positive and significant change in generic satisfaction, with a decrease in overall dissatisfied users. This study found that the percentage of users dissatisfied with the system at the baseline has changed positively, shifting from dissatisfaction to either satisfaction or neutrality. Quality (G2) had the highest reported number of satisfactions, but it also included Worth the time effort (G3), which had the highest number of reported dissatisfactions. An interpretation of this development is that the vendor and the user had experience with the previous EHR system, DIPS Classic, which could have contributed to an easier transition when implementing DIPS Arena.

When analyzing specific functions of the EHR system, overall improvements in functional satisfaction were observed, but some functions still required improvement. The functionality related to overview of drug treatment (Q11), prescribe drugs (Q8), and care planning (Q9) received the lowest satisfaction ratings. The exact reason why these functions received low satisfaction is not apparent in the data. Still, these are central features of the clinical work, and the low satisfaction rating raises concerns for the vendor. However, these are complex features that several actors are trying to solve, including the government (Shared Digital Medication List). Overview of outstanding tasks (Q5), an overview of the patient's issues (Q3), and read radiology reports (Q4) were the functionality with the highest user satisfaction. This finding can be interpreted as the vendors having enhanced the new system's design, making it more user-friendly and efficient.

Also, the data showed a reduction in the frequency of system interruptions, such as crashes or hangs, compared to the baseline data. This finding can be interpreted that vendors have simplified and stabilized the new system. This improvement can contribute to higher satisfaction among users.

The results of this study suggest that the new EHR system has been well-received by users and has improved user satisfaction compared to the previous system. The notion of Information Infrastructure and the concept of the installed base is confirmed in our results [9]-[11]. The approach of the change between EHR systems where parts of the installed base have been kept can explain the implementation success. The socio-technical ensemble of systems is kept among the users, same system vendor, and slow incremental implementation process where structure data elements are the next implementation step. A further follow-up will be necessary for a prolonged conclusion. However, certain functions still need further improvements to enhance the overall user experience. The findings in this study will support the work regarding developing standardized indicators for usability in general and user satisfaction in particular.

V. CONCLUSION

In conclusion, the study aimed to assess user satisfaction with a new EHR system in Northern Health Authorities and compared it to a baseline. The results showed that many users were either satisfied or neutral, indicating a significant improvement in user satisfaction compared to the baseline data. An analysis of generic satisfaction showed positive changes in the system's effectiveness, quality, the worth of time and effort, and user-friendliness, with a decrease in overall dissatisfied users. Although specific functions still require improvement, the new EHR system has been well-received by users. It has improved the overall user experience, which is significant considering the many known barriers when implanting a new EHR building on the theoretical concepts of an Information Infrastructure and the installed base. Further research should continue monitoring user satisfaction and consider complementing quantitative findings with qualitative research for in-depth knowledge of why user reports are satisfied.

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