

User Satisfaction with Recently Deployed Electronic Health Records

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Abstract. The high investments in deploying a new Electronic Health Record (EHR) make it necessary to understand its effect on usability (effectiveness, efficiency, and user satisfaction). This paper describes the evaluation process related to user satisfaction over data gathered from three Northern Norway Health Trust hospitals. A questionnaire gathered responses about user satisfaction regarding the newly adopted EHR. A regression model reduces the number of satisfaction items from 15 to nine, where the result represents user EHR Features Satisfaction. The results show positive satisfaction with the newly introduced EHR, a result of proper EHR transition planning and the previous experience of the vendor with the hospitals involved.

Keywords. Electronic Health Records (EHR), usability, user satisfaction, human factors, Computerized Clinical Decision Support Systems (CCDSS)

1. Introduction

Norway's second wave of digitalization in healthcare during the 2010s involved implementing a new Electronic Health Record (EHR) system based on open standards. The requirements for better interoperability, scalability, and information governance [1] took much work to achieve with this first generation of EHRs.

In this regard, in 2012, the Norwegian authorities procured a new EHR that could quickly escalate its information architecture to new domains using open standards and terminologies [2]. The company DIPS was selected to implement a new EHR based on open standards (openEHR) to fulfil these requirements. The investment in the system has been over 90 million euros, which makes it necessary to understand the impact of the system holistically to assess its value for money. Several dimensions are involved in evaluating health information systems [3]. Some of these dimensions are long-term and economic outcomes [4], while others measure the actual value in daily practice [5].

The new EHR, DIPS Arena, was deployed in all hospitals in Northern Norway in 2021. This paper aims to assess the impact of the new EHR on usability, satisfaction, and user experience. The study has a twofold objective: to understand the effect of the EHR transition and to analyse which dimensions of the survey have the highest impact on user

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satisfaction for improving the National Implementation-research Network eHealth (NINE) questionnaires for the incoming years.

2. Methods

Setting: We approached clinical users from the newly implemented EHR at the Northern Norway Regional Health Authority: University Hospital of North Norway (UNN), Nordland Hospital (NLSH), and Finnmark Hospital (FSH). All hospitals had been involved in the transition from their previous system, DIPS Classic, into the new system, DIPS Arena.

Data collection: All hospital employees were invited by email with no exclusion criteria and those who did not work with patients was excluded. Of 603 participants, 221 EHR users completed the survey, including 25.8% physicians, 36.2% nurses, and 38.0% from other professions. The hospital sent two reminders from September to December 2021.

Questionnaire: The survey followed the ISO standard (9241-11) [6] of usability: effectiveness, efficiency, and satisfaction. It was developed based on past research using a previously validated questionnaire [7] and measured user satisfaction in three categories: EHR Function satisfaction (11 items; Q1-Q11), EHR Generic satisfaction (four questions; G1-G4), and EHR Overall satisfaction (one question). Login attempts and EHR malfunctions measured interruptions. A 5-point Likert scale ('Completely disagree', 'Partially disagree', 'Neutral', 'Partially agree', 'Completely agree') and the survey tool LimeSurvey (LimeSurvey GmbH, Hamburg, Germany) were used.

Analysis and statistical methods:

For analysis, frequency was used for discrete variables, chi-square test for comparing professions across hospitals, and One-way Analysis of Variance (ANOVA) to compare satisfaction means. The significance level was set at $p=.05$, and SPSS 25 (IBM Corp., Armond, NY) was used for analysis. Missing values were addressed with the Missingness Completely At Random (MCAR) assumption [8], confirmed with Chi-Square ($\chi^2=972.41$, $df=952$, $p=.316$), and then imputed using Expectation-Maximization (EM) analysis. Due to profession-dependent questions, overall there were $n=616$ (24.4%) missing values. When adjusting for questions that were not relevant and related to profession or role (users had answered "not applicable"), the relevant portion of missing values for this study was $n=321$ (12.7%).

3. Results

3.1. Baseline data and interruptions

Of the EHR users who completed the questionnaire, $n=221$ (82.5%) participated, with 70.1% females, mean experience of 17.4 years ($sd=11.0$), and mean age of 45.9 years ($sd=11.6$). Mental health and substance abuse (30.8%), medical (29.4%), surgical (19.0%), and other (20.8%) fields were represented. Physicians, nurses, and other professionals accounted for 25.8% ($n=57$), 36.2% ($n=80$), and 38.0% ($n=84$), respectively. Participants were from FSH (28.5%), NLSH (40.7%), and UNN (30.8%). Login interruptions occurred at a mean rate of 12.5 per day, with system crashes at 3.7 (one every three weeks).

3.2. EHR satisfaction

EHR Function satisfaction. Overall, 52.2% of respondents were satisfied, 34.0% were neutral, and 13.8% were dissatisfied with EHR Function satisfaction (Q1-Q11). Q5 had the highest satisfaction rate (78.7%), and Q11 had the lowest (13.1%). Satisfaction rates for Q4 and Q6 were 71.0% and 72.9%. Q2, Q3, and Q9 have reasonable satisfaction rates, between 55.2% to 62.9%. Q8 and Q11 (54.3% and 38.9%) have the highest dissatisfaction rates, see Figure 1. There were no significant differences in satisfaction rates by profession or hospital.

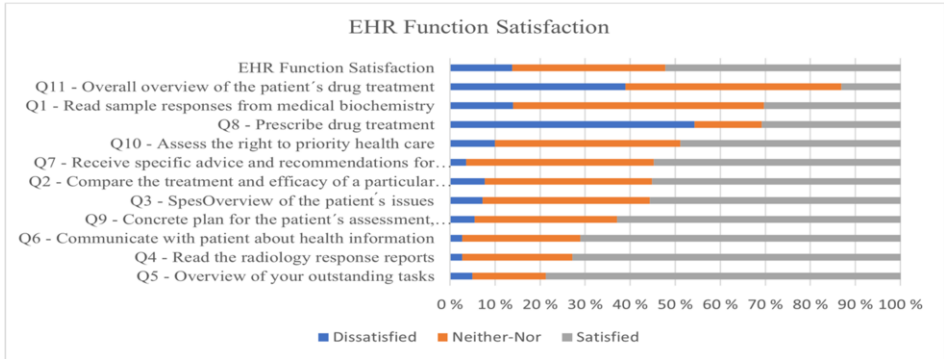


Figure 1. Total and alle items for EHR Function Satisfaction.

EHR Generic satisfaction. Generic satisfaction (G1-G4) measures effectiveness, quality, worth of time and effort, and user-friendliness: 48.1% of respondents were satisfied, 37.7% were neutral, and 14.3% were dissatisfied. Quality received the highest satisfaction rate of over 60%, while user friendliness had the highest dissatisfaction rate of 21.3%, see Figure 2. No significant differences were found by profession or hospital.

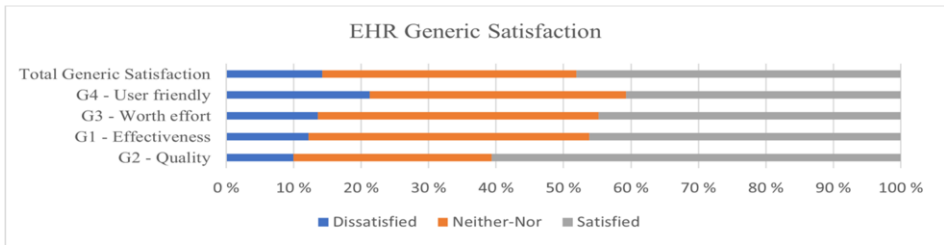


Figure 2. Total and alle items for EHR Generic Satisfaction.

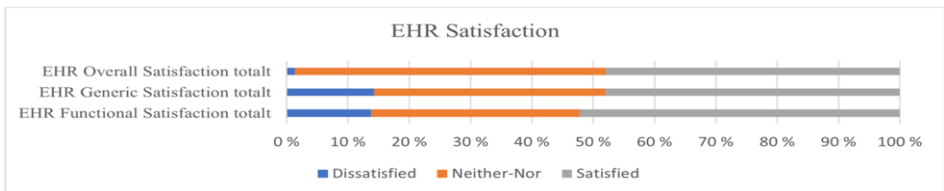


Figure 3. Total for Overall, Generic, and Function Satisfaction.

EHR Overall satisfaction. Overall satisfaction was assessed with a single item, with 48.0% satisfied, 50.7% neutral, and 1.4% dissatisfied, see Figure 3. There were no

significant differences in overall satisfaction by profession or hospital. Satisfaction rates for nurses, physicians, and other professions were 51.2%, 49.1%, and 50.0%, respectively.

3.3. EHR Overall satisfaction predicted by Generic and Function satisfaction.

A regression analysis was conducted to determine whether interruptions, EHR function satisfaction, and EHR generic satisfaction are significant predictors of the EHR overall satisfaction. The normal probability plot from SPSS was inspected and show that normality can be assumed. Both enter and stepwise methods were used to estimate the final model.

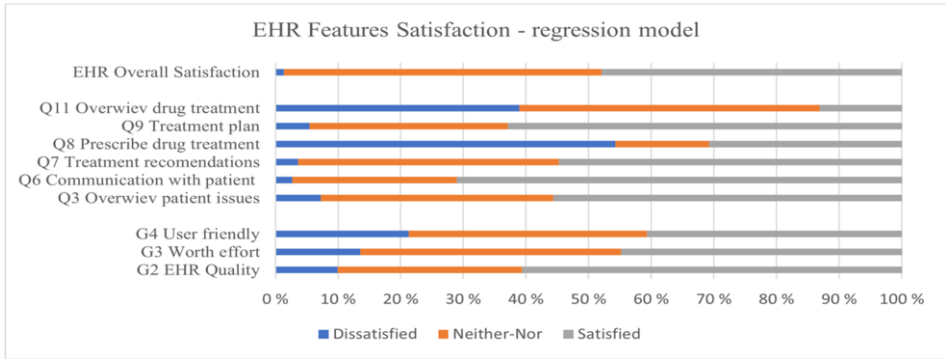


Figure 4. The regression model represents users EHR Features Satisfaction

A linear regression model was estimated correlating all satisfaction items with the overall satisfaction. The model $R^2=.83$ indicates that 83% of the variance in EHR Overall satisfaction is explained by the reminding nine items: six function satisfaction items (Q3, Q6-Q9, Q11) and three generic satisfaction items (G2-G4), see Figure 4. Interruptions had not significant effect over the EHR overall satisfaction.

4. Discussion

Most users were moderate to highly satisfied with functional, generic, and overall satisfaction of the newly implemented EHR, which is considered a moderate-to-high satisfaction level. Previous studies have reported high dissatisfaction among EHR users in adopting new EHRs [9]. One possible explanation for the moderate-to-high satisfaction level could be attributed to the well-planned implementation and effective handling of incidents during the transition phase. Additionally, the vendor's extensive experience working with these hospitals could have positively contributed to the successful adoption of DIPS Arena into the clinical workflow.

No significant difference was observed among user roles or hospitals. Interruptions did not contribute to the estimated model. Interruptions overlap with other variables that account for the same variance or this could be a response to the new system if the system seems more stable and reduces the number of logins. Some non-significant functional satisfaction items could be due to their specificity. Significant variables in the model are related to more generic functionality (i.e., used by all clinical roles). The Effectiveness

item (G1) was insignificant; further evaluation will be needed. Other items could cover the effectiveness item. Regarding the newly implemented EHR, effectiveness will evolve as users earn experience. The Work Effort item (G3) covers efficiency as the resources used concerning the results achieved.

The nine-item EHR Features Satisfaction model covers a high percentage of the variance in EHR overall satisfaction. However, the model could be further extended to address essential and overarching areas of an EHR satisfaction model following the ISO standard for Ergonomics of human-system interaction.

5. Conclusion

Satisfaction is an essential factor of systems usability measure. The findings in this study, is in line with the ISO 9241-11 usability standard, as we went from three to two satisfaction measures: Features Satisfaction and Overall Satisfaction. The overall high satisfaction rates could be due to a positive experience with the new system. Often, satisfaction will be reduced as the users get more experience with the system, and later, it will increase again. To verify this will require data from the years to come. This remains as future work.

The study authors recommend continuing the study by conducting further research to evaluate the long-term impact of the newly implemented EHR, expanding the satisfaction model, including additional variables, using a mixed-method approach, regularly evaluating user satisfaction to ensure the success of EHR implementation, and include user responses to make results more beneficial for the vendors.

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