Implementing structured data in Electronic Health Records

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Chapter 2

Eliciting end-user expectations to guide the implementation process of a new Electronic Health Record: a case study using concept mapping

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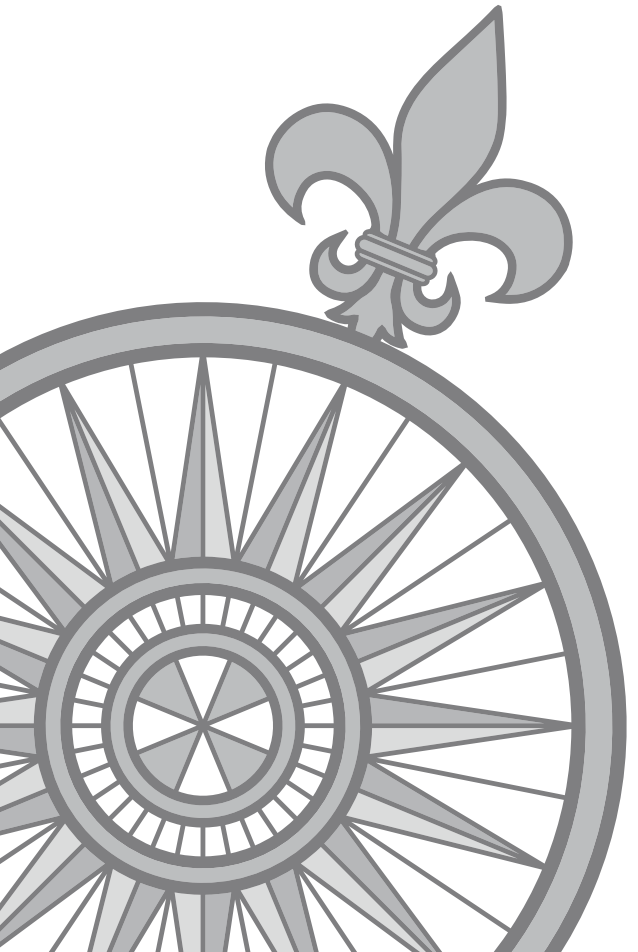

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Abstract

Objective

To evaluate the usability of concept mapping to elicit the expectations of healthcare professionals regarding the implementation of a new Electronic Health Record (EHR). These expectations need to be taken into account during the implementation process to maximize the chance of success of the EHR.

Setting

Two university hospitals in Amsterdam, The Netherlands, in the preparation phase of jointly implementing a new EHR. During this study the hospitals had different methods of documenting patient information (legacy EHR vs. paper-based records).

Method

Concept mapping was used to determine and classify the expectations of healthcare professionals regarding the implementation of a new EHR. A multidisciplinary group of 46 healthcare professionals from both university hospitals participated in this study. Expectations were elicited in focus groups, their relevance and feasibility were assessed through a web-questionnaire. Nonmetric multidimensional scaling and clustering methods were used to identify clusters of expectations.

Results

We found nine clusters of expectations, each covering an important topic to enable the healthcare professionals to work properly with the new EHR once implemented: usability, data use and reuse, facility conditions, data registration, support, training, internal communication, patients, and collaboration. Average importance and feasibility of each of the clusters was high.

Conclusion

Concept mapping is an effective method to find topics that, according to healthcare professionals, are important to consider during the implementation of a new EHR. The method helps to combine the input of a large group of stakeholders at limited efforts.

2.1 Introduction

Electronic Health Records (EHRs) store medical information of the patient and provide functionalities such as computerised physician order entry and decision support that assist physicians in providing care of good quality. Earlier studies showed that implementing a new EHR can result in both improved [40, 41] as well as decreased quality of care [42].

The implementation of a new EHR is not merely a technical project, but rather a socio-technical project involving the EHR itself, the end-users, and the organisation [33]. The end-users and the working processes of the organisation have to be taken into account thoroughly to maximize the chance of success during this change process [43]. To realize full user adoption end-user involvement, and monitoring and managing of end-user expectations is critical [35]. Therefore it is advisable to elicit the expectations of users in the local situation before the start of an actual implementation. Based on the outcomes the hospital can plan interventions which improve involvement and support of end-users during the implementation. Having positive and realistic expectations from the start of the implementation process can help to reach high acceptance of the new EHR in later phases.

Future end-users of an EHR all have their own expectations of the new EHR. There is a distinction between expectations on EHR functions and on implementation processes. Functional expectations concern the requirements for the system itself and its functions (e.g. "I need a warning when I make a mistake"). Process expectations concern the implementation process and the way the system is embedded in the organisation (e.g. "I need training", or "I need to change my work processes"). In this study we focused on the process expectations before implementing a new EHR which can be seen independently from any specific EHR.

Two reviews [44, 45] have described barriers and facilitators that influence an EHR implementation according to the users. One of these [44] focused on physicians only, the other [45] included more types of end-users. Both reviews included qualitative studies, using mainly interviews, and quantitative studies, using primarily surveys and questionnaires. Gathering detailed information by performing, transcribing, and summarising interviews from a large group is time consuming. Using questionnaires, a larger group of participants can be reached, but the questions are determined in advance and they offer less possibilities to delve into context dependent details. Concept mapping is a method to determine and classify the expectations of a large diverse group of end-users that could overcome these limitations [46].

Concept mapping is a structured group conceptualisation method, resulting in a map of clusters containing statements concerning a specific theme. This method is a combination of qualitative and quantitative research. Performing focus groups with end-users results in a qualitative description of their opinions. Combining these results using statistical clustering methods leads to a quantitative summary of the general opinion of the group of users. Concept mapping has been used in the healthcare domain before, e.g. to design an indicator framework for addiction treatment centres [47], health planning and evaluation [48], and developing conceptual frameworks for complex constructs such as anxiety [49].

Two university hospitals in Amsterdam, The Netherlands, are in the process of jointly implementing a new EHR. We investigated the expectations of their personnel regarding the first phase of the implementation (before go-live) using concept mapping. The goal of this research was to evaluate the suitability of the concept mapping method to determine, from the end-user perspective, topics that enable working successfully with the EHR as soon as it is implemented.

2.2 Methods

This study was performed in the Academic Medical Center (AMC) and the VU University Medical Center (VUmc), both university hospitals located in Amsterdam, The Netherlands. Both hospitals have approximately 7000 staff members each working in patient care, research, and education. The AMC has 1003 beds and the departments work with either a set of computer programs, together forming the EHR, or a paper-based record, or a combination of both options. The VUmc has 733 beds and works predominantly with paper-based records, combined with computerized systems to view information from laboratories and radiology.

The implementation of the new EHR in the two hospitals was organised through a shared multidisciplinary team of medical and information management specialists. This team included a working group to measure the effects of the implementation on the personnel. Our research was performed in close collaboration with this working group.

For our concept mapping process we used the method of Kane and Trochim [46]. The method consists of 6 steps; preparation, generating ideas, structuring statements, concept mapping analysis, interpretation of results, and utilization of the results. The method and process are described in Ref. [50]. Concept mapping has several characteristics that can be relevant in healthcare [51]. The method takes advantage of multidisciplinary sessions. In the healthcare sector this is most likely a team of participants representing multiple roles and multiple medical fields. Using a diverse group of people in the discussion session enables people to interact with others' views on the subject. Additionally, the results of the concept mapping method are maps that can be interpreted by people who are not familiar with the method. This ensures proper diffusion of the results in the organisation.

Step 1: prepare for concept mapping

In this particular study we investigated the process expectations of the employees of the university hospitals in the pre-implementation phase of an EHR. The focus statement "To enable me to work properly with the new EHR once implemented, in the early stages of implementation I need ..." was used to start the discussion among the participants. We explicitly aimed to exclude statements concerning system's functionalities (e.g. "I need medication order sets to support my medication prescription") as functional requirement analyses were already performed. To exclude functionalities we added to the focus statement that the discussion should be limited to changes in work processes and the process of implementation.

The EHR implementation team contacted employees with information management or medical roles, who were already involved in the preparation of the EHR implementation. These contacts were asked to suggest possible participants to the concept mapping sessions. Some of these participants were already involved in the preparation of the EHR implementation, others have not had any role in the implementation before.

Concept mapping works best when the group is heterogeneous [46, pp. 35-6]. Therefore we strived to include personnel of both hospitals, of multiple departments, in all roles that will be using the new EHR (nurses, physicians, supporting professionals), and who are both involved and not involved in the implementation. In total four sessions were organised with 8, 16, 9, and 13 participants.

Step 2: generating the ideas

After signing an informed consent form and being presented with the goal, rules and scope of the focus session, the participants were given approximately ten minutes to individually write down statements in accordance with the focus statement.

Subsequently, the chairman of the group session asked every participant to present one statement of their list. The chairman extracted the main point of each statement and checked with the participant whether this summary was correct. Each statement that contained more than one subject was split into single statements after consulting the participant. When the statement was clear to all participants it was typed into a computer and presented to the participants using a projector. The participant could thus directly check the transcription of the statement. During the discussion we excluded statements that were of a functional nature (e.g. "I need a large button to go to medication"). However, we have tried to identify the underlying issue in the employees work processes (e.g. "I need a good overview of the current medication").

After the statement was written down the next participant was asked to provide the first item on his/her list and the process was repeated. All participants were asked to keep their own list up to date by removing items that were already mentioned by other participants. After one round of statement gathering the process started again until none of the participants could add a new statement.

Step 3: structuring the statements

After the focus group sessions were completed, the statements were combined into one general statement list. Duplicates were removed and statements that described the same subject were combined to shorten the list to a workable number of statements. The method of Kane and Trochim [46, pp. 59-60] indicates that the number of statements should be less than 100 to still be feasible to cluster. The deduplication and combination of statements were performed independently by a researcher, a member of the working group, and an external concept mapping specialist. After the individual deduplication and combination the results were compared and discrepancies were solved by consensus.

The final list of statements was then uploaded to an online tool for concept mapping, The Concept System Global MAX [52]. This tool supported participants to cluster the statements based on similarity and rate each individual statement on importance (Likert scale 1-5, 1 = not important to 5 = very important) and feasibility (Likert scale 1-5, 1 = not feasible to 5 = very feasible). Feasibility was defined as the degree of being easily or conveniently done. Both importance and feasibility are reported as mean and interquartile range. Additionally we asked the participants to answer three general questions (in which hospital, department, and role do you work).

All participants of the four focus groups were invited via email to log in to the tool and perform the clustering and rating. The Concept Systems tool instructions were translated into Dutch and adapted for this specific research. After 14 days an email reminder was sent to those participants that had not yet logged in. It is common that not all participants from step 2 contribute in structuring the statements. A study of the reliability of concept mapping stated that the typically recommended sample size is 15 participants in the sorting step [53]. Step 3 is the last step where active involvement of the participants is needed.

Step 4: concept mapping analysis

The participant data were combined and analysed by the researchers in the analysis section of the Concept System Global MAX [52] system. Participants that did not finish at least the clustering step were excluded from the analysis. Additionally, we excluded participants when: (1) less than 75% of the items were grouped or rated, or (2) all statements were grouped in one category.

We generated the point map based on the clustering data using two-dimensional non-metric multidimensional scaling [46, pp. 93-7]. A similarity cut-off was based on the possible ambiguity of the statements and the group size. We calculated the stress factor to measure the "degree to which the distances on the map are discrepant from the values in the input" [46, pp. 97-8]. The cutoff value and stress are described in more detail in Appendix A.

Using the point map and agglomerative hierarchical cluster analysis [46, pp. 98-100] we created a cluster map. The analysis resulted in cluster maps with 20-2 clusters. Starting at 20 clusters in each following map two clusters are combined. For each iteration in which two clusters are combined the researchers (NdK, RC, EJ) judged whether the two clusters contained similar statements. Based on consensus the final number of clusters was determined. For each cluster in the final cluster map the average importance and feasibility was calculated.

Step 5: interpreting the maps

The cluster map was discussed with the researchers and members of the EHR implementation working group. Each member was asked to formulate a name for each cluster. Combining this input with the names provided by the participants of the concept mapping sessions the final names of the clusters were decided.

Step 6: utilization

After discussing the outcomes and creating the final concept map the resulting map was used during the EHR implementation process and within research projects to monitor end-users beliefs about working with a new EHR.

2.3 Results

Step 1: prepare for concept mapping

We hosted four focus group sessions with a total of 46 employees from multiple departments and multiple roles from both hospitals (see Table 2.1 for characteristics).

Step 2: generating the ideas

In total each session consisted on average of three rounds of statement collection. The sessions lasted on average 70 min. The sessions ended with lists of 60, 53, 56, and 60 statements respectively (total 229).

Step 3: structuring the statements

The list containing all statements from the four focus groups was reduced to 89 unique statements (see Table 2.2 for the top 10 statements sorted on mean importance and Table 2.3 for

Table 2.1: Characteristics of participants.

	Included in focus sessions (n)	Contributed in online part (n)
Organisation		
AMC	28	15
VUmc	18	9
Gender		
Male	9	2
Female	37	22
Role		
Physician	7	1
Nurse	20	11
Supporting[a]	12	7
Non-medical treatment[b]	7	5

[a] Includes care coordinators, management, and secretarial staff.
[b] Includes counsellors, dieticians, and social workers.

the top 10 sorted on mean feasibility). A table showing all statements is added in Appendix B. The list of statements contains 35 statements that were mentioned only once during the sessions and 54 statements that were mentioned in at least two sessions.

In total 24 participants finished at least the clustering step in the online tool (clustering n = 24, importance rating n = 23, feasibility rating n = 20). The data of participants that did not participate in the online part of the research (n = 13) or did not finish the clustering step (n = 9) were excluded from the analysis.

Step 4: concept mapping analysis

All validated responses were included in the analysis and a cutoff value of 1 was chosen. The final stress using a cutoff value of 1 was 0.2109. Stress [46, pp. 97-8] is a number between 0 and 1 where 0 is a perfect map. A meta-analysis of multiple concept mapping studies estimates an average stress of 0.285 (SD 0.04) [53].

Based on the grouping data of the participants a point map was calculated (Figure 2.1). Clustering the points led to the final cluster map as shown in Figure 2.2. This map consisted of nine clusters: usability, data use and reuse, facility conditions, data registration, support, training, internal communication, patients, and collaboration. A table showing the statements per cluster is available as an online supplement.

The rating of the statements on importance and feasibility is shown in Table 2.2 and 2.3, and Figure 2.3. The average rating on feasibility ranged from 2.75 for statement 35 (clear information on future of job types) to 4.35 for statement 34 (space in file for non-medical disciplines). For importance the average rating ranged from 3.30 for statements 49 (link with insurers possible), 18 (policy for patients that do not want to be included in electronic file), and 56 (involve employees with low computer experience in improvement of system) to 4.87 for statements 1 (fast system) and 52 (system in line with work processes). The importance and feasibility ratings were moderately correlated (Pearson's r = 0.52).

Table 2.2: Top 10 statements sorted on mean importance.

nr	Statement	Mean Imp.	(Q1-Q3)	Mean Feas.	(Q1-Q3)
1.	Fast system	4.87	(5-5)	3.90	(3-5)
52.	System in line with work processes	4.87	(5-5)	3.60	(3-4)
28.	Proper training superusers	4.83	(5-5)	4.15	(4-5)
64.	Adequate computers/hardware	4.83	(5-5)	3.85	(3-5)
47.	Emergency procedures available for system blackout	4.83	(5-5)	3.85	(3-5)
79.	Good overview of patient status on one screen	4.74	(5-5)	3.75	(3-5)
69.	Correct transfer of old data to new system	4.74	(5-5)	3.60	(3-4)
23.	Sufficient computers/hardware	4.70	(4-5)	3.90	(3-4)
53.	Free up time and money for training during entire process	4.70	(4-5)	3.45	(3-4)
65.	Enough access rights, set by care professionals (not IT)	4.61	(4-5)	3.85	(4-4)

Table 2.3: Top 10 statements sorted on mean feasibility.

nr	Statement	Mean Imp.	(Q1-Q3)	Mean Feas.	(Q1-Q3)
34.	Space in file for non-medical disciplines	4.30	(4-5)	4.35	(4-5)
29.	Help function in system available	4.39	(4-5)	4.25	(4-5)
12.	Superusers sufficiently available on department	4.57	(4-5)	4.20	(4-5)
2.	Understandable manual available	4.52	(4-5)	4.20	(4-5)
46.	Data traceable	4.48	(4-5)	4.20	(4-5)
28.	Proper training superusers	4.83	(5-5)	4.15	(4-5)
24.	Information on training schedule	4.04	(4-5)	4.15	(4-5)
59.	Make specific fields in the file obligatory	4.13	(4-5)	4.11	(4-5)
72.	Control/approval by two people with important processes	4.52	(4-5)	4.10	(3-5)
86.	Test setup available on department to practice with system before go-live	4.48	(4-5)	4.10	(4-4)

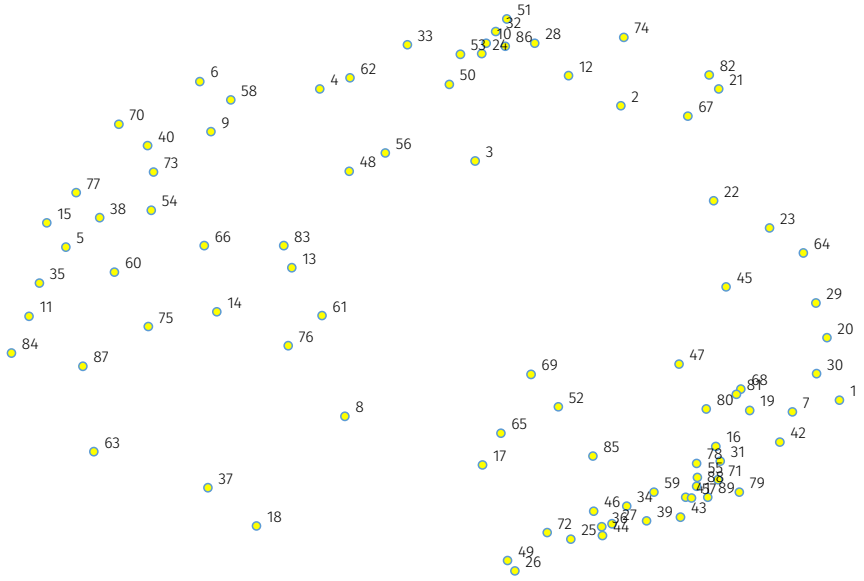

Figure 2.1: Point map.

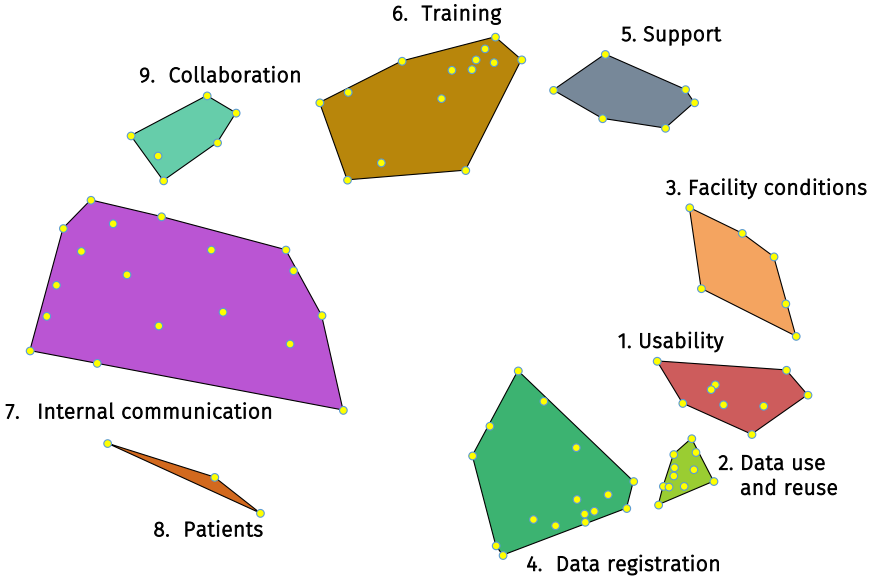

Figure 2.2: Final Concept Map showing the nine clusters.

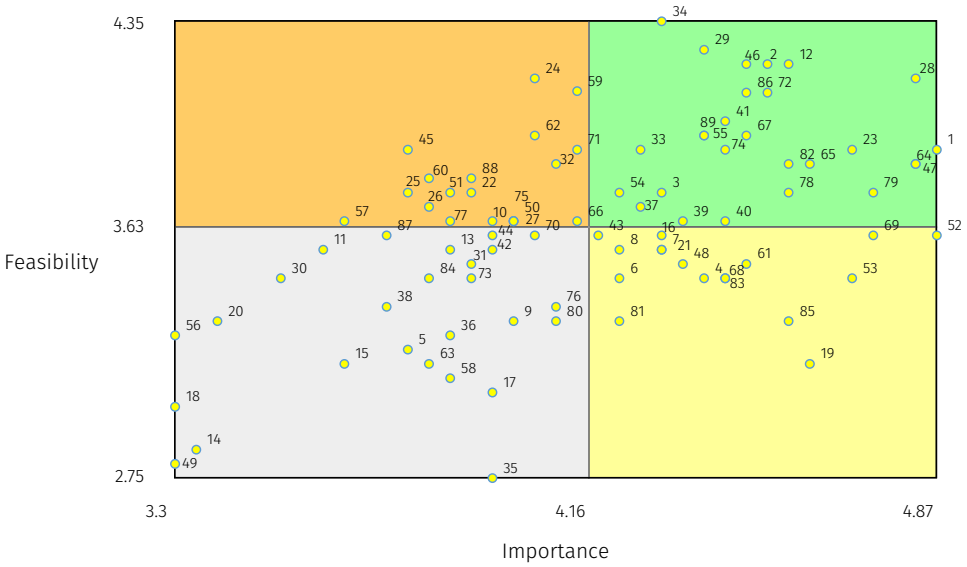

Figure 2.3: Go-Zones showing the scores on feasibility and importance for each statement. Scoring was on a 5 point Likertscale (1 = not important/feasible, 5 = very important/feasible).

Step 5: interpreting the maps

In Table 2.4 the clusters are listed with their average importance and feasibility rating, and an explanation of their contents. Average importance of the clusters ranged from 3.79 (for cluster 8) to 4.42 (for cluster 5).

Step 6: utilization

Within the working group and the general implementation team the results of the concept mapping were used as exploratory research results. Based on this analysis interventions were set up to manage the expectations of the employees in both hospitals. For example more awareness was generated on subjects such as planning and training through additional newsletters.

Furthermore, the resulting topics from the concept map were used to create an organisation-wide questionnaire. This questionnaire will be used to measure changes in the end-users expectation over time (during the EHR implementation and deployment) in order to identify determinants of end-user acceptance. The first of three questionnaires has been performed and the preliminary results have been published [54, 55].

Table 2.4: Clusters, sorted on importance.

Cluster	Number of Statements	Average Importance	Rank of Importance	Average Feasibility	Rank of Feasibility
5. Support: *Having enough support (e.g. helpdesk) during and after implementation.*	6	4.42	1	3.94	1
1. Usability: *Creating a system that is user friendly and supports the workflow of the employees.*	9	4.29	2	3.50	6
2. Data use and reuse: *Designing an EHR structure that enables the reuse of data.*	11	4.20	3	3.77	3
4. Data registration: *Creating a data registration workflow that supports the employees in correct registration of patient data.*	16	4.19	4	3.66	5
3. Facility conditions: *Providing the necessary environment to enable correct use of the EHR (e.g. enough workstations).*	6	4.13	5	3.83	2
6. Training: *Providing sufficient training in working with the new EHR.*	14	4.13	5	3.75	4
9. Collaboration: *Learn from other centres, external experts, and each other.*	6	4.04	7	3.43	7
7. Internal communication: *Making sure there is sufficient communication between all stakeholders and provide honest information on the influence of the EHR.*	18	3.89	8	3.43	7
8. Patients: *Create policies on patient related issues and involve patients in decisions on EHR transition.*	3	3.79	9	3.28	9

2.4 Discussion

Main findings

Concept mapping is an effective and efficient method to elicit the expectations of healthcare professionals regarding the implementation of a new EHR. By using concept mapping we found that the personnel of a university hospital in the pre-implementation phase of a new EHR believes that the following nine topics are important to enable them to work properly with the new EHR once implemented: usability, data use and reuse, facility conditions, data registration, support, training, internal communication, patients, and collaboration.

The method has three main advantages. First, we could include input from a large multidisciplinary group of people at a low cost. In a short time frame we were able to include qualitative input from 46 different stakeholders and analyse the results. Second, the method combines qualitative and quantitative methods. After the qualitative round of focus sessions, we used statistical methods to aggregate all the information into maps that could be reported back to the stakeholders. Third, the result of concept mapping is a clear map that can be interpreted by the end-users themselves. The methodology is able to present a complex range of ideas in an understandable format.

Figure 2.3 shows that the lower limit of importance was 3.29, and the lower limit of feasibility was 2.75. From those numbers it can be derived that the participants considered all statements neutral to important (rating > 3). This means that the participants did not strongly disagree with their colleagues even on the importance of the statements they did not identify themselves. Additionally, most statements were considered to be neutral to feasible (rating > 3) meaning that the participants did think that the statements should be feasible to integrate into the implementation process.

Relation to other literature

Two reviews identified topics of importance to end-users during an EHR implementation [44, 45]. The included studies primarily used labour intensive methods, such as interviews, or methods which lack the possibility to delve into context-dependent details, such as questionnaires. The categories of topics that these reviews found were similar to our results, for example interoperability, patient interaction, and organisational issues. In addition to our results the reviews found financial and legal concerns, and design issues. These topics were not present in our study as these were beyond the scope of this study as was explicitly mentioned during the focus group sessions.

Studies in other domains have also found that the concept mapping methodology is an efficient way to generate a clear framework that can be used in practice and in research [56]. It can handle much information from a large group of people in a short amount of time and provide a clear structured representation of complex ideas [57].

Meaning of the study

Hospitals in transition to a new EHR should consider including their end-users as early as possible in the project [35]. A dialogue should be initiated to identify the end-users positions on the most important issues. Using lists of issues identified in literature is important but not sufficient. The particular needs of users during an implementation need to be assessed in the local situation [44, 45]. In a limited resource setting for example, topics might include

infrastructural items such as power supply which is self-evident to the end-users of our two western university hospitals and was therefore not mentioned in our study. We found that concept mapping provides an efficient method to identify the expectations of end-users that requires less resources than traditional methods and presents useful results.

Strengths and limitations of the study

A strength of our study is that we were able to perform our concept mapping exercise in two different university hospitals with different recording traditions (EHR vs. paper-based patient record). Additionally our group of participants was multidisciplinary across roles and medical fields. Both factors positively influence the result of the concept mapping leading to a broad and inclusive concept map. These factors also make the results more generalizable to other university or teaching hospitals. Another strength was that we could involve many stakeholders. The fact that 229 statements could be reduced to 89 statements showed saturation of ideas of the participants. Therefore we considered the number of group sessions and participants sufficient for our study.

However, a limitation of our study is that the number of participants that finished the complete method was too low to be able to create separate cluster maps for different roles or hospitals. Additionally the number of physicians that participated in the online part of the concept mapping was very low. The non-medical treatment staff was overrepresented among the respondents which might have influenced our results.

2.5 Conclusion

Concept mapping is a suitable method to identify the expectations of healthcare professionals regarding the implementation of a new electronic health record. Based on concept mapping the nine topics that end-users find important during the implementation of a new EHR are: usability, data use and reuse, facility conditions, data registration, support, training, internal communication, patients, and collaboration. Average importance and feasibility of each of the topics was high. Further research should be performed in other settings to further proof the effectiveness of the concept mapping method.