Health Text Analysis – A Queensland Health Case Study

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Abstract: This paper reports on a cohort analytics process that used text mining on data collected from 64 interviews conducted in Queensland Health wards. The focus of the interviews was on implementing a technology. The cohort analytics helped 'normalise' the data view of patient care, and supported the development of a set of rules for the display of patient data in a form that is comprehensible to a range of carers in wards that have differing functional elements. The analytics helped to represent a visual view of the data using a touch screen panel, and the carers, such as doctors, nurses, allied health professionals and pharmacists were able to see and update different domain functionalities so that patient data was accurate and up-to-date. This culminated in efficient patient management, as well as effective generation of reports on bed utility.

Keywords: Health Service, Information Systems, Management of Technology

Background

Analytics is the process of developing insights or recommendations for actions from historical data (Sharda, Adomako Asamoah, & Ponna, 2013). Analytics represents a combination of management sciences, computer technology and statistical techniques to identify and solve real life issues. While there are many views to analytics, in the health domain, there are four major components discussed: descriptive analytics, prescriptive analytics, diagnostic analytics and predictive analytics (Banerjee, Bandyopadhyay, & Acharya, 2013). Descriptive analytics investigates what has happened and explores issues related to past events. Diagnostics analytics explores why an event has occurred and provides possible causes for such an occurrence. Prescriptive analytics provides reasons as to what should be done about what has happened or about an event occurrence. Predictive analytics discusses matters that are likely to happen.

The modern view of these four aspects of analytics may differ across interest groups, but these four components appear to be followed in many health organisations. While quantitative data has been used to anchor these views in the past, in recent years, especially in public health agencies, qualitative data may be used to complement quantitative data in decision-making processes. There appear to be two main reasons for the notion that qualitative data is also essential in major decision making processes. The first reason is the involvement of many stakeholders in commenting on various service quality provisions using social media, as well as internal data gathering forums. The second reason is that there is a general notion that the quantitative data collection process is quite restrictive and may not capture all aspects of stakeholder views.

In the health domain, due to electronic health records, data transmitted from medical equipment, content generated from patient care, pharmaceutical data, and web based health communities, both qualitative and quantitative data is generated, and the volume of this data is huge. This data is exclusive to genomic data. In 2012, the storage size of such data was estimated as 4 terabytes for each consumer, inclusive of imaging data. Analysis of such data is crucial in predicting various trends, especially in the population health domain. Even from an organisational point of view, analytics can help to understand what has happened, causes for such

happenings and the future planning processes. Therefore, analytics are of paramount importance in the health domain, due to the sensitivity and timeliness of the services offered.

As indicated earlier, in the healthcare domain, data is generated from many sources. Mobile technologies have provided a new way of capturing data through mobile applications and sensors. These emerging sources are able to provide physiological data over a specified time period. The advent of smartphones and text-based data entry using mobile phones facilitate social communications in digital forms, and many of these pertain to patient health conditions. There are multiple user forums to discuss cancer-related issues from a personal perspective, with many leading to support schemes. These heterogeneous sources are now used in analytics to forecast trends. In hospital domains, unstructured clinical notes are part of patient observation charts, and these are used for patient care assessments and bed utilisation trends. Medical imaging is another form of data that is not quantitative, and this is used in patient care assessments. Many organisations capture patient's behavioural data through several sensors, as well as their social interactions and communications, to support the assessment of patient conditions.

Therefore, the availability of non-quantitative data is an essential component in analysing and predicting trends in the healthcare domain. This requires special techniques beyond the standard statistical techniques that are currently used. This has created an opportunity for health text analytics.

Health Text Analytics

Traditionally analytics has focused on structured data found in many information architectures. However, recent advancements in mobile technologies and other sensor applications have resulted in data becoming available from non-traditional sources. The data from these sources are considered 'unstructured data'. While there is an assumed acceptance that these sources should generate 'big data', there is no need for data from such sources to be 'big'. Data may be smaller, coming from key sources, to inform key decision-making processes. An example is a set of open non-structured interviews in an organisation that collects information over a period of time, and may be used in assessing a particular specific context. Unstructured data is processed using analytical techniques such as text analytics rather than the type of analytics applied to SQL data.

Text analytics refers to deriving high quality information from text, usually using methods that involve structuring input text. For example, an unstructured data source can be made available to an application for analysis purposes, and a set of arbitrary patterns based on keywords can be developed, resulting in an output. This process is called Text Analytics, and typically involves tasks such as text categorisation, text clustering and concept extraction. While these processes have been followed in many text analyses, the major difference between text analysis and text analytics is the opportunity to unearth insights and extract value out of information. Unearthing insights requires a comprehensive understanding of the context, stakeholders, their emotional aspects, the problem or issue on hand, and the ability to articulate these as part of the analysis leading to text analytics.

In this study, we applied text analytics to a public health service in Queensland, Australia, to assess the success of a technology implementation. The assessment included the collection of both qualitative (interviews and focus groups) and quantitative (surveys) data. The scope of this paper is restricted to qualitative data.

Case Organisation

The scope of the study is restricted to Queensland Health and the implementation of a radically new technology called the 'Patient Journey Board'. The Patient Journey Board (PJB) is a touch screen technology, where patient data are consolidated so that carers such as doctors, nurses, and allied health professionals can see the data in an unambiguous manner. Data entries are updated on a progressive basis following patient assessment to maintain accuracy and currency.

The scope of the research involved three major components. The first component involved assessing the attitudes of a range of stakeholders from 41 wards with differing functional activities. The second component was focused on conveying these attitudes to the software team so that software specifications could be refined, and converted into codes and rules. The third component was to undertake a post assessment of technology implementation to assess user satisfaction.

The assessments – pre and post technology implementations – were both qualitative and quantitative. The qualitative aspects involved a set of open-ended questions, with interviews being conducted with ward managers as well as other key staff. In addition to these interviews, there were brainstorming sessions at the beginning to develop the set of questions, and focus groups to define the scope of interviews, mainly to understand functional aspects.

Academic researchers conducted the interviews with Queensland Health representatives (team members of this project) scheduling the interviews.

The study examined the following main objectives:

1. Whether the technology implementation would result in improved performance;
2. Whether the technology implementation would result in high levels of satisfaction; and
3. Whether the technology implementation would be able to provide high quality services.

Literature Review

A 2008 Queensland Health report (The NTF Group, 2008), titled 'Project FIDO Day in the Life' asserts that '… (ICT) capacity does not lead directly to significant benefits, nor solve the clinical and patient care challenges a hospital faces' (p.39). Despite the huge investment made over the past decade to procure technology necessary for health services, the adoption and the benefits of adoption in terms of better health care delivery, particularly to rural and remote Australia, appear to be underdeveloped. The 2008 report further states that 'Success depends on what

applications and activities mobility enables, and, more importantly, how the process of change management and process reform encourages clinicians and others to change their work practices to take advantage of the new technology' (p.39). In other words, it appears that the framework to manage the change is missing, and hence, the potential of technology is not being fully realised. The same report states that future implementation of technology in the Australian health sector should provide practical and timely access to clinical information that supports clinicians wherever they are required to provide healthcare, providing ICT systems that can 'push' information to clinicians. This statement implies there is an urgent need to create, in collaboration with the clinicians, a management framework for technology development.. In this way clinical information using ICT can be 'pushed' on to the clinicians to support them with more effective delivery of healthcare. Such a framework would ensure increased adoption: establishing the type of applications and services that can be effectively offered by technology in a cost effective manner will prove extremely beneficial for healthcare delivery, particularly in rural and remote Australia.

ICT has often been touted as a cost-effective way to provide services to consumers who live a significant distance away from health services or have difficulty getting access to services because of physical disabilities (XXXX, 2006). In recent years, two Australian studies have demonstrated savings from the technology assisted model of care in paediatrics and medical oncology, , in the case of large patient numbers. These studies showed a reduction in inter-hospital transfers, and enhanced savings to the health system.

Prior literature also indicates that the use of ICT, mainly telehealth services, for aged people result in significant benefits. For instance, a 60-day follow up of a home telehealth care program in Minnesota, using a videoconferencing system, resulted in significant positive outcomes in terms of usage (Finkelstein et al, 2011), and culminated in services being delivered with more efficient use of organisational resources. Another study in the domain of heart failure patients in the US indicated that clients were satisfied with telehealth services (Metzger, 2011). A 2011 UK study indicated that a minimum of £1,307 was saved using telehealth services in the Chronic Obstructive Pulmonary Disorder (COPD) domain, just by avoiding hospital admissions. The same study estimated that cost savings of up to £55,700 over a 90 day period were achieved by the council providing telehealth services to elderly clients.

Therefore, health administrators recognise the opportunity for technology to result in or assist in improving performance, satisfaction and service.

Methodology

A combined approach (mixed methodology) of qualitative and quantitative methods has been suggested to strengthen the study outcome. in terms of the human social and psychological factors (Remenyi et al., 1998). This study investigated human psychological factors using interviews and quantified these factors using a survey instrument. As stated earlier the scope of this paper is restricted to qualitative data only. Data was collected from workers in QH wards involved in client care and focused on their behavioural patterns of acceptance and usage of technologies, as well as their opinion on the usage of these technologies.

The participants were recruited specifically for this purpose. The recruitment and scheduling aspects were managed by QH through their regular processes.

The qualitative method employed in this study included semi-structured in-depth interviews to gain a sufficient understanding on the topic from QH professionals in their work settings. The aim of these interviews was to identify any unknown factors that may affect the adoption of technology. The data collection involved two specific stages. In the first stage the existing literature was reviewed in order to identify various issues impacting technology adoption. This was the 'exploratory' stage. The main purpose of this stage was to identify factors in order to derive an interview instrument. The second stage involved actual data collection through interviews. This was the 'evaluative' stage. These stages are explained below.

Stage 1 – Literature Review (exploratory)

An extensive literature review was carried out at this stage to integrate the materials available into the interview questionnaire in order to assess behavioural aspects of technology acceptance. The interview questionnaire consisted of over 16 themes and an information sheet was prepared after this comprehensive literature review. The purpose of this was to ensure that QH professionals were comfortable in answering the technical aspects of technology as appropriate to their working environment. This stage did not identify any mediating factors and only focused on the main factors influencing the acceptance of technology. The literature covered three main aspects: motivational aspects, experience aspects, and habit.

Motivational Aspects

Motivation is defined as the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use (Brown and Venkatesh 2005). Motivation (conceptualized as perceived enjoyment) has been found to have a direct influence on technology acceptance and use (e.g., van der Heijden 2004; Thong et al 2006). In this context, hedonic motivation (as a surrogate of motivation) has been found to be an important influence of technology acceptance and use (Childers et al. 2001). Thus, hedonic motivation was explored in the interview as a predictor of behavioural intention to use a technology.

Experience Aspects

Prior research on technology use has identified experience as an important factor in technology acceptance. Experience reflects an opportunity to use a target technology (Kim and Malhotra 2005). Experience is studied by measuring usage time from the initial use of a technology by an individual.

Habit

Habit has been defined as the extent to which people tend to perform behaviours automatically because of learning (Limayem et al. 2007). Kim et al. (2005) equate habit with automaticity. Habit, in this study, is viewed as prior behaviour (see Kim

and Malhotra 2005), and is explored as the extent to which an individual believes the behaviour to be automatic (e.g., Limayem et al. 2007).

There are two key distinctions between experience and habit. One distinction is that experience is a necessary but not sufficient condition for the formation of habit. A second distinction is that the passage of chronological time (i.e., experience) can result in the formation of differing levels of habit depending on the extent of interaction and familiarity that is developed with a target technology.

Different individuals can form different levels of habit depending on their use of a target technology, and their level of maturity in an organisation. This warrants investigation into prior use as a predictor of habit, and this can be explored either through their mental models based on current usage or a controlled experience with the target technology in their attempt to understand the impact of habit on technology use.

In the context of this study we explored each area in regard to pre and post implementation of technology.

Facilitating conditions also play a crucial role. In our study, QH provided the facilitating conditions, however, due to ward-specific functions, facilitating conditions varied across participants. In addition, due to the clinical nature of the work, clinical conditions were considered to be more relevant. Therefore, this aspect was explored in interviews, but not in great detail.

Stage 2 – Interviews (evaluative)

In order to extract opinions about technology in a specific domain such as QH, the selection of sample is crucial. It is important that the opinions expressed by QH professionals should be unbiased and pertaining to technology only — rather than the effects of technology on current workflows, especially within the scope of this study. The samples for this project consisted of four sets of people from QH. The first set comprised the senior managers, who have oversight of strategic operations. The second set is ward managers who have oversight of tactical aspects. The third set is ward professionals who have oversight on operational aspects. The last set of samples included others, and was comprised of people who did not fall under the first three categories.

While information systems research identifies a range of sampling techniques, such as random and clustering, the sampling technique used for this study may be classified as ‘purposive’ sampling. The study was conducted with QH to meet their immediate needs. As the assessment is ‘real’, extreme care needed to be exercised to preserve the integrity of QH values and standards. This warranted high levels of experience in conducting the assessment, and professional knowledge about the assessment aspects. In order to assure completeness in assessments, this approach of ‘purposive sampling’ was followed in this study.

In the second stage of the research a set of 64 interviews were scheduled to assess user views on the technology in a real world environment. It should be noted that the technology had not been implemented prior to the interviews so as not to affect participant views in regard to embracing the technology. This approach,

though not desirable, was used in order to assess the views as to how technology would be received by health professionals, and to accommodate various constraints associated with developing a technology that had a common shell and 41 varying ward needs,. To ensure the interviews were conducted on time, QH staff scheduled visits, and organised a rostering system for staff to participate in the interviews. Appropriate ethics approvals were sought and obtained through QH ethics committee based on National Principles.

The interviews were conducted so as to minimize any disruption to participants' work schedules, ensure comfort in answering questions, minimize any travel time by interviewees, synchronise the 'interview' language with participants and to prompt participants when unfamiliar questions were encountered by participants.

The instruments of this research consisted of two broad categories of questions. The first category related to the adoption and use of technology. The second category consisted of 'influencing' variables. The influencing variables are those that have an influence on the technology adoption, but beyond the technology itself. For example, these variables can be organisational issues or procedural issues. Open-ended questions were included in the instrument to obtain unbiased and non-leading information. Prior to administering the questions, a complete peer review and a pilot study were conducted in order to ascertain the validity of the instrument.

Qualitative Data Analysis

The qualitative data analysis consisted of two phases. The first phase involved generating a set of initial analytics to determine the direction of extracting evidence, and the second phase involved providing the evidence.

In terms of initial analytics, the data was analysed in three different ways. The first set of analytics involved a word frequency cloud using the interview transcripts. The purpose of this analytic process was to assure that we explored relevant and appropriate themes, and the word cloud provided assurance through a keyword search. The second set of analytics was undertaken to develop a pictorial representation of the interview data, representing major themes explored. The interconnection between key themes, and the links between the themes provided visual assurance that relevant and appropriate themes were considered in the interviews. The third set of analytics involved exploring the occurrences of keywords in terms of frequency distribution. This provided a pseudo statistical validity.

<u>Word Frequency Cloud:</u>

The Word Frequency Cloud is a technique in NVivo that documents the most frequently appearing words in a transcript. For the purpose of this study, the number of most frequent words was fixed at 100, and the transcripts of all interviews were run en-block.

The procedure basically analyses words based on their occurrence, their distance, and their context, and develops a frequency table of occurrence and percentage. Once this was established, words that did not appear more than a certain

arbitrarily chosen number in the overall context were assumed to be less significant in the overall context of the study and removed from the word frequency run procedure. This procedure was repeated many times to remove any words that did not make sense or add value to the analysis (for example words such as 'yes', 'I", etc). The following diagram is a screen shot of the 'word cloud' to provide an initial view point for further in-depth qualitative analysis.

Using NVivo, researchers generated a word frequency map to assure that keywords were addressed in the interviews. The following word frequency Cloud indicates keywords extracted from interview transcripts and provides an initial direction for further exploration.

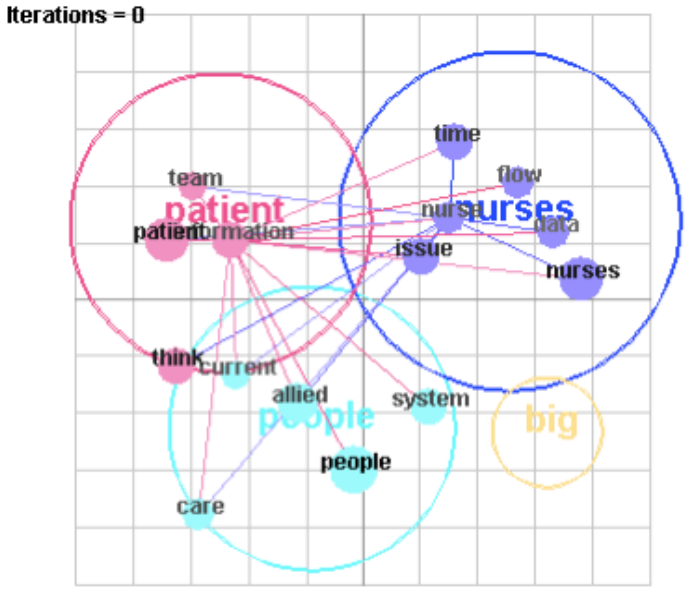
The above word cloud demonstrates that many key concepts were included. For example, patient, board, ward, good, information etc were the words used by interviewees and represented the gamut of topics discussed. The topics were discussed with the interviewer (in this case the researcher) and this provided another level of reliability to ensure that each participant had the same opportunity to discuss these terms. The proximity and the size of the words represents the importance and connection between keywords.

The above word cloud and word frequency table provided an initial path for further analysis, as the cloud indicated that key words were captured in the interview process, thus indicating 'reliability'. Further, the research team conducted over 60 interviews and the themes were found to be saturated around the twelfth interview, indicating that the qualitative process employed in this study was reliable and appropriate. In fact, after the sixth interview, most of the technology related issues were saturated in the interview process, thus indicating a very high level of reliability.

<u>Pictorial Representation of Interconnections:</u>

While the word cloud provides keywords and their relationships, it does not represent the major themes. In order to generate major themes, the research team used Leximancer, a text analytics application. The interview transcripts were

submitted to this application, and the parameters were set for 1000 iterations so that major themes and their relationships could be understood. The following diagram is a pictorial representation of what was accomplished.



From the diagram, the analytics application returned three major themes – patients, nurses and people. The three circles are overlapping with almost the same thickness for the perimeter, indicating the equal importance of these three themes. Main issues within the themes are shown as 'text' labels, for example 'time' in the nurse circle, indicating this is an issue among nurses. Similarly, labels such as satisfaction, allied, care etc indicate the range of sub themes among the main theme discussed. The lines between these sub themes indicate relationships between the themes.

Keyword Occurrence:

The keyword occurrence is a technique used in this study to understand how many times a keyword features during the interview as a way of assessing the importance of the keyword. NVivo produced a frequency distribution and allocated a weight to each keyword so that the strength for each keyword could be assessed. The following is a list of keywords extracted from a cross section of the interview transcripts.

Concept	Absolute Count	Relative Count
people	25	100%
patient	21	84%
nurses	20	80%
think	19	76%
issue	17	68%
time	15	60%
board	15	60%
technology	14	56%
allied	14	56%

team	13	52%
system	13	52%
care	13	52%
information	12	48%
training	11	44%
current	11	44%
nurse	11	44%
should	10	40%
anonymous	10	40%
process	10	40%
flow	10	40%
medical	9	36%
work	9	36%
day	9	36%
data	9	36%
computers	9	36%
issues	8	32%
terms	8	32%
big	8	32%
hours	8	32%
problem	7	28%
person	7	28%

A full list of keywords for the transcript is provided below:

Word	Count	Weighted Percentage (%)
interviewer	367	2.05
think	267	1.49
patient	220	1.23
just	202	1.13
board	193	1.08
know	193	1.08
one	174	0.97
epjb	172	0.96
information	172	0.96
people	166	0.93
good	144	0.80
journey	137	0.76
like	133	0.74
get	131	0.73
actually	130	0.73
see	129	0.72
got	123	0.69
going	122	0.68
really	121	0.68
need	111	0.62
staff	103	0.58
put	100	0.56
time	100	0.56
ward	94	0.52
things	91	0.51
yes	91	0.51
find	86	0.48
thing	83	0.46
patients	82	0.46

system	82	0.46
process	81	0.45
well	79	0.44
data	78	0.44
discharge	78	0.44
handover	74	0.41
want	73	0.41
use	72	0.40
lot	71	0.40
now	71	0.40
look	70	0.39

The above analytics provided a glimpse of the total picture, and highlighted trends to be explored in more detail. The purpose of conducting these three initial steps was to ensure that the research was exploring what it intended to explore, and that interviews were conducted in a way so as to answer the main objectives established at the beginning of the study. These three analytics provided adequate reliability and confidence to further explore the text data.

The research team conducted manual analyses based on the word query facility within the software application to explore main themes. At this stage, interview transcripts were split into PRE technology implementation and POST technology implementation. The following two sections provide a summary of interview comments on the main issues identified during the text analysis process.

PRE - Main Issues:

Patient Flow: Our current patient flow is flawed. We have been using whiteboards and they've been all ruled up, and allied health, and it's supposed to be multi-disciplinary, the reality is it's not multi-disciplinary. The nurses don't/won't use the journey board. Confidentiality is an issue because the patient journey board we currently have is in the main flow of traffic.

Processing: As far as processes go it would be very useful if it was utilised by the multi-disciplinary team because we would all know what was happening. But it's not used, so therefore not functional. The technology - it's a whiteboard with sticky metal dots saying, 'yes', 'no' or 'still underway'. The technology is very, very archaic. Absolutely. Our average lengths of stay to what they should be, is completely out of whack.

Teamwork: So, there are a lot of problems with allied health involvement. I don't think that allied health see the urgency for patient flow from the same perspective. The other thing of course, for example, with pharmacists, and physical therapists, particularly, we don't have enough. There's not enough. We're at the end of the food chain up here and we do not have enough physios and pharmacists. The other allied health people I think are probably okay, they don't see the urgency for patient flow. When it first came in Allied Health (AH) really came on board with it but then because of the rotation with new AH staff there was sort of inconsistencies with how they wanted their referrals and everything done. Because the idea that I sort of had was – the staff before, so if there was like night staff they would actually populate the EPJB for who they needed to refer AH to you know like physios and stuff like that and then come 8am the physios would come up and talk to the TL look at the EPJB say 'yes got the referral' and change it.

Communication: And the issue of communication between those fields. Until a nurse gets time to physically pick up a phone, and you're probably ringing ten (10), twelve (12) times.

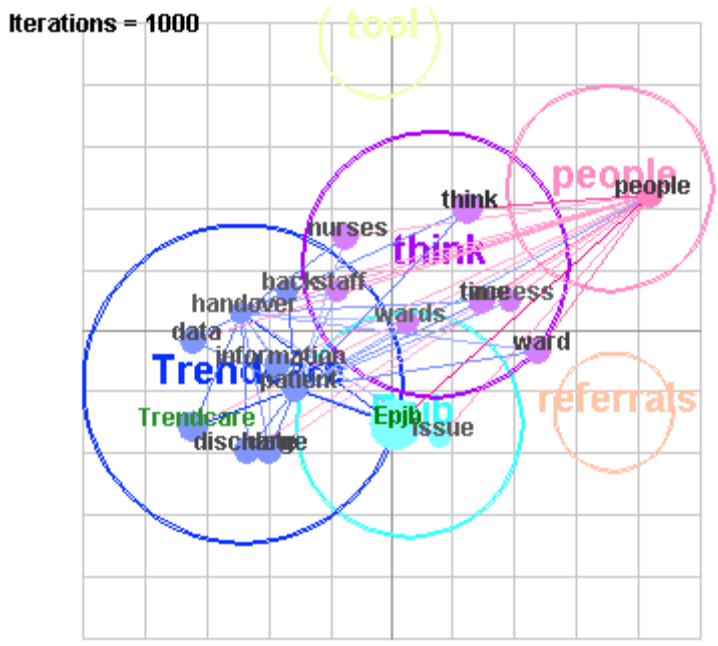
Time Availability: There has to be a better way. Speaking from being a nurse on the floor, if you're trying to coordinate the ward and look after your patients, to take that time to ring all those services - even just for one patient - that might be five (5) different services you've got to try and get a hold of. That takes a lot of time.

Computer Access: There are two (2) issues. One (1) is you physically don't have computers in the right locations. Physically there are three (3) in coronary care and four (4) in medical three (M3); which works very well if it's after hours because that's enough. But 'in' hours it's bedlam. The doctors don't have dedicated computers. Allied health don't have dedicated computers.

The research team examined the issues, and provided comments to the software team responsible for managing changes. The changes included program code, hardware procurement, placement, functional routines, workforce issues and team communication aspects. These aspects were further verified for compliance and execution.

The following details pertain to post analysis technology implementation interviews.

POST Analysis



Factor Loading: POST

Concept	Absolute Count	Relative Count
Epjb	163	100%
Trendcare	74	45.3%

think	65	39.8%
people	51	31.2%
ward	42	25.7%
time	39	23.9%
discharge	39	23.9%
nurses	35	21.4%
date	35	21.4%
data	34	20.8%
patient	31	19%
information	29	17.7%
system	27	16.5%
staff	26	15.9%
issue	26	15.9%
back	26	15.9%
handover	25	15.3%
health	22	13.4%
process	22	13.4%
access	22	13.4%
wards	21	12.8%
training	20	12.2%
issues	19	11.6%
tool	18	11%
find	18	11%
patients	17	10.4%
work	16	9.8%
happening	16	9.8%
referral	16	9.8%
pull	15	9.2%
terms	15	9.2%
referrals	14	8.5%
give	14	8.5%
day	13	7.9%
call	12	7.3%
coming	10	6.1%
hard	10	6.1%

Main Themes:

Ease of Use: Well we used to have the EPJB as a whiteboard and that's just replaced it and it's much easier. They only have to - they're probably not putting in so much as it's pulling other information from other places, they're not having to put in as much as they did before. They seem to be ... I haven't heard any complaints, there's nobody whingeing or griping you know. it's just having the time for them to do it and the EPJB just makes it convenient because it's done on that main screen. It's done with 6 types of a key, the dates in; it's easy enough when they're handing over like I said to do it as they're speaking. I usually sit there in there of a morning and do it. They might say she's not going home Wednesday now she's been extended till next Friday so then you just enter that date and there's just more consistency with it and if that's what they want us to do as they hounded us for that to put in length of discharges or stays or whatever.

Time Savings: Yes, because what we did to reduce time was basically instead of each nurse handing over, we've gone to just the TL handing over the whole ward. The oncoming TL is to have the EPJB up and click on the next name as they're speaking and then they're to go out of
that handover and then they sight their patients. The TL's liked it from the TL handover sheet it showed them who the physios were already on, stuff like that.

Uptake: I'd probably say 70 - 80%. I think they really like it, put it this way they wouldn't like to go back to the old way of writing it up on the board.

Currency of Information: Before we had the EPJB we never had to enter discharge dates. We used to get in trouble for it and we would try to and you'd go in there and it's locked by another user and it would be just be good if Trend could pull that information from the EPJB.

Old White Board vs EPJB: well how are they going to do it to if we're to go back to the old white board it's just so messy and so untidy and a lot of the time wasn't getting updated but this way they have to update it because it's a handover sheet do you know what I mean? It's the patient's journey basically.

Training Needs: No it doesn't take long for them to learn because everything's there. You've just got to tick things and you've got your drop down's like if someone's had a fall if it's high medium or low and there's forms to fill out which we teach them what to do. It all goes in the UR notes, everything's there. It's not like we have to write too much and that's a good thing. If we don't have to write then the nurses will do it. We've basically got train the trainer now. Enough of our staff can train the new ones

Positive Impact: The EPJB has made a huge difference to the impact on our length of stays and a huge impact on giving the staff a lot more knowledge as to where we're at with our patients. They know where we're up to with our patient care - they know that the physio's seen them, they don't have to go to the UR chart and flick through and say 'Oh, I think a physio's seen them' whereas now we can look at the EPJB - 'physio's seen them' we know that for sure

Access: Yes that's right because out on the ward they've got their computers and they can do exactly what they want and then it comes to me on here so I know who's gone home and who's going home tomorrow. . So bed management - so if name says 'we need some beds' she can sit on there and look. . I don't have to get out of my chair to go and run and find the nurses and say 'hey, what's going on out here?' It's good having a comments section down here.

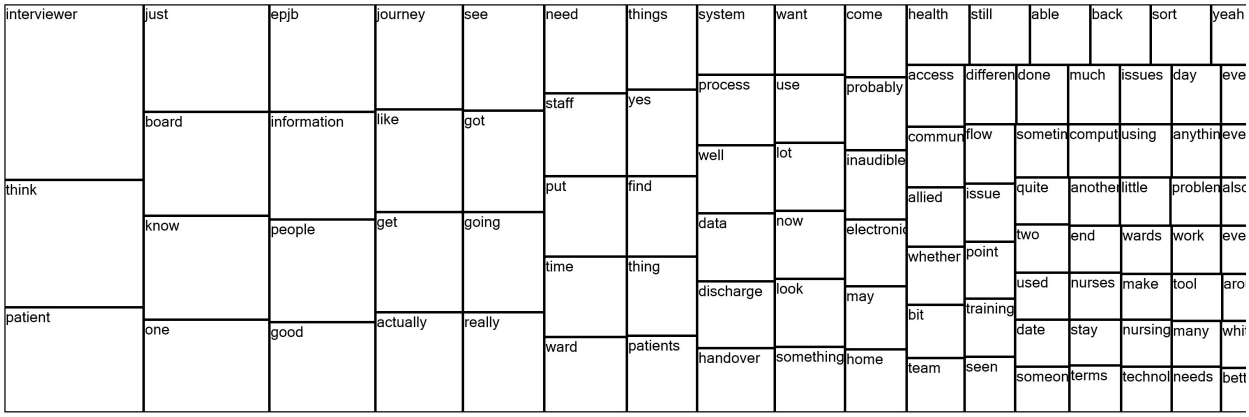
Attitude: I feel they're coming to like it the more they use it, the more they realise it is a good system so I'd mark it probably another 8.

The research team also conducted a tree map to verify reliability of the themes in a pictorial manner.

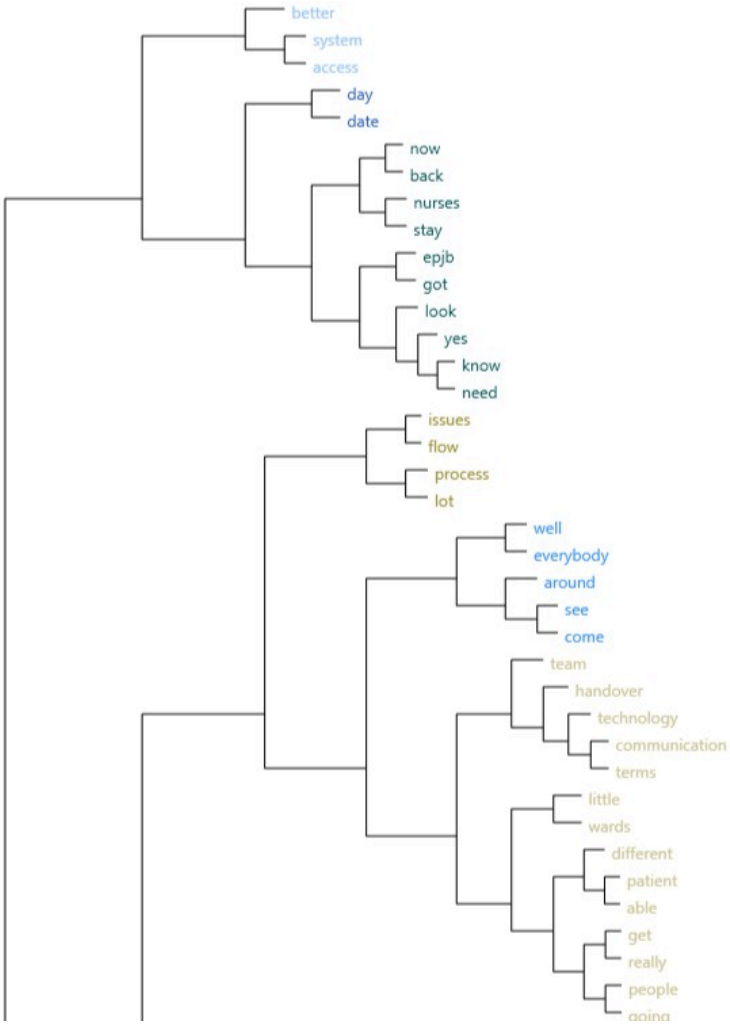
Tree Map

The next stage in the data analysis process was generating a tree map. The purpose of the tree map was to ascertain that the themes that were extracted adequately

met the objectives and were represented by the key words. In generating the tree map, the visual provision indicates the weight of the key words as shown by the size of the rectangle allocated to the keywords.



In the above word frequency table, prominent words depicting this study appear on the left side of the diagram. As shown, these words, while indicating frequency and relative importance, also indicate the main theme of the study. This was further confirmed with a cluster analysis as shown below.



Results of the analytics

The study examined the following three aspects using text analytics:

1. Whether the technology implementation would result in improved performance;
2. Whether the technology implementation would result in high levels of satisfaction; and
3. Whether the technology implementation would be able to provide high quality services.

From the analytics and manual analysis of available data, it was possible to develop the following table of key factors.

PRE Implementation Factors	**Comments**	**POST Implementation Factors**	**Rate of Change**
Patient Flow	Flawed	Easy to use	Yes
Processing	Not Functional	Saves time	Yes – handovers
Team work	Not working	Good Uptake	Staff like it
Communication	Slow and inefficient	Satisfactory	Yes

Time Availability	Minimum	Training Required	Minimal
Access to Computers	Problematic	Positive Impact	Yes
		Communications	Improved
		Access to Computers	Satisfactory
		Attitude: Rating – 8/10	High level of acceptance

The above table highlights that users confirmed the technology as being easy to use, reduces time and improves communications. When these three factors are viewed in unison, it is possible to assert that the first objective is accomplished.

Similarly, it is clear that users were satisfied with the technology, and the text data indicates a high level of acceptance. Therefore, it is possible to assert that the second objective has been accomplished.

From the interviews, users were not able to assert regarding the level of quality of services. While there were positive references to this effect, the research did not generate sufficient data to assert this objective.

Conclusion

The text analytic process was useful for understandingthe direction to be taken in conducting qualitative analysis of open-ended semi structured interviews used to gather interview data. Due to the type of data being collected, it was difficult to collect data in a strictly unified way due to the volume and variation in user functional aspects..

The research team used various techniques such as word cloud, frequency map and intelligence iterative analysis to guide the data analysis process. Further, text analytics helped the research team to verify whether the interviews were conducted properly, and whether the interview data would adequately address the range of themes the research sought to explore.

With this initial direction established, NVivo was used to create themes and nodes and create other structures for analysing and categorising the data. These structures helped with identifying the strength of the themes and exploring their inter-relationships. The research team did not expand further upon this aspect of analysis as it is adequately addressed with standard qualitative analysis. This paper discusses and reports on the three analytic processes that were the focus of this particular research .

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