1. Overview. (This is a couple of paragraphs - no more - that summarizes the content of the report. It must be comprehensible to someone who has not read the rest of the report.)

2. Introduction. (The scope of the project, setting the scene for the remainder of the report.) This should include: a. Scope:What is the general scope of the project? E.g. “This project is designed to help people understand issues of how access to drinking water affects health in different parts of the world”. b. Users/Audience: Who is the audience or stakeholders? This will help in determining how appropriate the data tools are. For example, if your visualization is aimed at helping policy makers determine how health spending and infrastructure relates, then you will be working with different data and reports than if you are providing visualization tools for engineers who need cost projections and distance metrics to determine best approaches.

3. Problem/Domain Questions. What are the specific questions your audience can ask of the tool you have begun to build? That defines what your design choices are. For example, a specific question related to water access might be: a. “How does access to drinking water differ in countries, and is there a relation to specific health markers (infant mortality, disease, etc)”? b. has access to drinking water changed over the last time periods? c. Does access to drinking water depend on income ? Etc.

4. Data. Describe your data . This includes: a. Sources (datasets, host organizations) b. Dimensions you are using ,and types of these dimensions c. Any “cleaning” or other manipulations you have made. You will almost certainly have selected only a subset of the available data, and perhaps you have combined data from two different sources to show wha the visual analytics WOULD support if you had the right data. Remember that the data do not have to be COMPELTELY REAL as long as they are representative, but you DO need to explain anywhere you have done this. For example: “Because we did not have location for emergency vehicles across BC, we substituted simulated locations using the centre of each community”.

5. Visualization design. Show your system of visualizations. Describe the interactions. Justify your design choices (NOT proves, but choice of visual feature and idiom). a. How do they relate to your problem questions? E.g., we used a line graph to enable users to see patterns over time. b. How do they work together? E.g. the user can slide a control over the line graph to see individual snapshots of data in connected views, such as bar graphs for comparison or scatter plots for correlation.

6. Further work. a. What did you intend to do, but did not manage to complete? A description can at least tell us what your design was meant to achieve. b. What didn’t work? Having made and implemented a design choice, what was not successful about it? What would you do differently? How did you find this out? c. What would you do in the next version? How could your work could be continued or developed? Be imaginative but realistic.

7. Conclusions. (This is similar to the abstract. The difference is that you should assume here that the reader of the conclusions has read the rest of the report.)

8. References and appendices.

* Summary: - Think about the use of space, more specifically how you're distributing the texts and tabs in your main vis. - Remember that every vis starts with a question, so you have to think about what is your question - Think about your audience, what is the first thing the hospital manager needs to see? Current bed status and where are the gaps? - Don't overcomplicate your project!
* **12:28 PM**

The focus is not on the real data analysis, the VA system needs to support the discovery of patterns, you're the designer, not the analyst!

For those of you who have NOT attended classes where we went over the project scope, please remember:

The focus of the project is not to analyse the data sets.**THE FOCUS OF THE PROJECT IS TO DEVELOP A VISUAL ANALYTICS TOOL THAT CAN HELP PEOPLE ANALYSE THE DAT**A. You are not domain experts, so your skills in analysing the data are less applicable.

Of course you need to understand how people think analytically to develop support, and you need to start with the kinds of questions your system should support and allow. But i am not looking for a summary analysis of the data using the system.  I am looking for a visual analytics design that will justify the choice of interactive visualizations and combinations that help analysts explore those questions. This is a critical difference. Insights that you glean from the use of this system are interesting and enrich the potential promise of the tool, but  are not the all.

That is why identifying your audience is so important. It will change the way in which you choose and structure the visualizations and define the questions.

**Overview**

Availability of beds in a hospital is a key measure to maximise patient care and effective cost management. One of the major problems many hospitals face today is the inefficient management of beds or the inefficient bed tracking systems that are available [1]. Hospital beds left unoccupied as a result of waiting for the staff members to service the beds and to get it ready for the next patient is a significant cost to the Health Industry [3]. The *Bed Turnaround Time (BTAT)* in question extended from the time discharge instructions were given to the patient to the time a new patient arrives [2]. Many people are involved in the process of discharging a patient and preparing the bed for the next admitted patient. However, most of the process is currently manual which involves physically checking the rooms to check the availability, assigning staff for servicing them based on the status, etc.

The proposed dashboard will be designed to improve the bed turnaround time through visualization of various measures like average turnaround time, admission and discharge rates as well as able to quickly spot the bed statuses and identify beds that needs to be prioritized for cleaning. The visuals will also aid the users to explore other measures like occupancy rate and waiting time that might influence bed turnaround time. The dashboard design will address most of the requirements by Bed coordinators, Unit Managers and House-keeping Supervisors through status graphs and charts in managing the patient flow efficiently. It will also allow the users to interactively explore various measures and dimensions through filters and selection and will aid in locating the bottlenecks in the operation and will aim to improve the overall process.

**Introduction**

The goal of this project is therefore to optimise the Bed Turnaround process through visualization of resources in an efficient way, and to look out for any trends in the dataset with regards to patient discharges and admissions, with an ultimate aim of improving the Bed Turnaround Time.

Our Visualisation dashboard will be useful both to the Bed Coordinators and the other stakeholders involved. The intended audience are listed below.

**Users:**   
Primary: Unit Managers, Central Bed Coordinators   
Secondary: Hospital Managers, House-keeping Service Managers

We wanted our dashboard to answer some of the questions that the users will come across in their day-to-day operations of bed management and optimising house-keeping resources. Some of the research questions that could be answered are:

* + What’s the occupancy rate in each Units? How’s it influencing the admissions and discharges?
  + What’s the Bed Turnaround rate by Unit? Where are the delays? And is there any relation to discharges?
  + What’s the current status of beds in each unit? Where to deploy the house-keeping staffs and to prioritize cleaning?
  + What’s the Admissions, Discharges and Transfer trends over the months? And How’s it helpful in planning the bed capacity?

**Data:**

For our design, we are assuming a fictitous hospital with 5 units. And each units have specific number of beds. The name of the Units and the number of beds in each Unit that are assumed are shown below

(General – 1N : Beds 15, Surgical – 1S: Beds 10, Intensive Care Unit - 1W: Beds 10, Special Care Unit- SCU: beds 4, Maternity -BP: Beds 5)

A sample Bed Turnaround Time (BTAT) metrics like Patient departure time and next Patient Arrival Time were provided by Fraser health. But the data is modified to suit the hospital units and beds that’s been used for dashboard design.

Other data like admissions, transfers are simulated using metrics from Canadian Institute of Health Information (CIHI) Discharge and Admission Dataset (DAD).

Since getting real samples of hospital data is challenging due to confidentiality and sensitivity, we used online tool <https://mockaroo.com/> to generate data from the known metrics. Some of the datasets that are simulated for the dashboard design are

* Patient log with details such as admission, Transfer details and discharge datetime. (data is generated for May 2019-June 2019)
* Occupancy rate for each of the units.

Dimensions in our design:

* Units (1N,1S,1W, SCU, BP)
* BedNum (101,102,103….SCU1,SCU2,…,BP201,BP202..)
* PatientID
* AdmitDateTime
* DischargeDateTime
* TransferDateTime

Measures:

* TurnaroundTime
* Total Occupied
* Bedstatus
* Number of Admissions
* Number of Discharges
* Number of Transfers

We used Excel sheets and Tableau Prep builder to join datasets like Units, Bed numbers with Patient log to create a complete dataset.

Turnaround Time is calculated by calculating the difference in time between discharge and the next patient arrival time.

All the data in Comma Separated files (CSV) are converted to JSON format for uploading to D3 and Javascript files using online CSV to JSON convertor tool.

**Visualization design:**

The Hospital Bed Management dashboard is divided into 3 sections, Left , Right and the Middle. The layout at start up gives the **overview** of all units first which will be helpful for Hospital Managers and Central Bed Coordinator to see statuses across the entire hospital units.

To see each individual units or compare between units, we have added Unit filters which will allow individual Unit Managers to concentrate on their own Unit and see statuses.

**Left Section**: Provides the current Admissions, Discharges and Transfer numbers by Unit (side by side bar chart) and the trends seen over the past 2 months(Stacked Area chart). This chart could be compared with the Occupancy chart on the right side to answer the question related to occupancy rate and the impact on Admissions.

Stacked Area chart is designed using D3 tool and allows selection of Admissions, Discharges and Transfers individually. Also the dates could be zoomed in by rectangular selection to see patterns over a specific time period. Double clicking on the chart will revert back to its original position.

Color coding on the left section indicate Admissions, Discharges and Transfers events.

**Right Section:** Gives the overview of Bed occupancy rates across Units ( stacked bar chart) and the bed status map of the hospital.

Stacked bar chart gives the number of occupied beds vs unoccupied beds by Unit. Unit filter can be used to see the numbers to specific Unit.

Bed status map layout is designed using D3 Treemap layout. With the hospital as the root node in the hierarchy, Units are designed as children. Each Unit has its own children nodes which represent the bednumber.

Units are aligned to represent the original hospital layout, for example 1N is placed in the top North corner. The color coding of each beds indicate the occupancy status and dirty beds. Tooltips allow to browse through the status of individual beds.

This will be useful to Unit clerks, Bed Coordinators to communicate with House-keeping staffs to quickly attend to services where needed.

**Middle Section**: Lists out the BTAT statistics by Unit , by hour and over the past months.

Design Choices:

* Screen displays are made easy to understand with simple encodings like bars, lines and dots so that information such as statuses and alerts is quickly identifiable by non-tech staffs (users)
* All the relevant charts are rearranged and fitted to a single page layout to allow for easy comparisons and eliminate scrolling and switching between tabs.
* Bed statuses are indicated using color coding which follows traffic signal light color (Red-Dirty, Amber-Cleaning, Green-clean & Ready)
* Use of familiar charts like bar chart to represent quantity comparison.
* To show the patterns and trends over time period , line charts, Area charts are used.
* Use of filters makes it easy to see the status by Units and focus on desired units.
* Brushing with dates makes it easy to concentrate on specific date range.
* Size of the (dots) in BTAT by hour chart indicate the turnaround time. Bigger the size, higher the turnaround time. This will be helpful in spotting the delay quickly and explore the reasons causing the delay.

Interactions:

1. Filters: by Unit
2. Selection: Date picker, brushing
3. Slider: Hour slider
4. Zomm Area (Admissions, Discharges,Transfers trend)
5. Tooltips to annotate and highlight bed status and to show quantities.

**Limitations:**

* Since the data is simulated using random methods, patterns and trends might not reflect the original status, but is used to see the relative trends.
* Availability of limited dataset, hence other explorations like impact of wait time on bed turnaround could not be implemented.

**Future Work:**

Though we could provide the interactions through filters and selection, we couldn’t provide the user with links to compare between different charts interactively. This is because of the data source being diverse and included different dimensions and unable to understand the domain requirements. Future work will involve obtaining complete dataset and working to understand the relations between dimensions required for this problem statement.

Also, would like to integrate the original hospital layout as SVG file and provide the bed status in real time. This task requires detailed understanding of the technique involved and couldn’t be completed within the time frame.

And finally, we also wanted the dashboard to display potential anticipated discharges and transfers status across units which will be helpful in bed capacity planning.

**Evaluation:**

Since the project aims to improve the process around bed management, evaluation will include working with the Users and stakeholders involved. As pointed out by Schneiderman & Plaisant [9] that a well-designed ethnographic notions of user observation, surveys, interviews and automated user logging activities are becoming the norm for User-centered designs. Some of the identified approaches for this research design are:

**Formative design evaluation**

* will include understanding the **current process** of bed management through **closed group** meeting with Stakeholders involved like central Bed Coordinator (Access Coordinator), Unit Managers, Nurses etc.,
* If available, Analyzing the **communication logs** between units, or field observations if permitted.
* Taking samples of the metrics like bed turnaround for a period.

**Summative Protype Testing**

* Walking through the design with users and understanding user feel.
* Monitoring performance using prototype –process improvement, task completion time. (user satisfaction, ease of use)
* Comparing the data collected with the original process, using statistics to prove results.

Conclusion:

Our dashboard visualization will provide Unit managers, Bed coordinators in a hospital to quickly identify bed statuses and allocate resources like house-keeping staffs in a timely manner. It will also be helpful to see the patterns in admissions and discharges and plan for bed capacity accordingly. When used with real-time data , this dashboard Visualization will also reduce the communication delays between units and will aid in improving the bed turnaround time.

References

1. X. Chen, L. Wang, J. Ding, and N. Thomas, “Patient Flow Scheduling and Capacity Planning in a Smart Hospital Environment,” IEEE Access, vol. 4, pp. 135–148, 2016, doi: 10.1109/ACCESS.2015.2509013.
2. E. C. Brown and J. Kros, “Reducing Room Turnaround Time at a Regional Hospital,” Quality Management in Health Care, vol. 19, no. 1, pp. 90–102, Mar. 2010, doi: 10.1097/QMH.0b013e3181ccbd50.
3. L. B. Chartier, L. Simoes, M. Kuipers, and B. McGovern, “Improving Emergency Department flow through optimized bed utilization,” BMJ Open Quality, vol. 5, no. 1, Sep. 2016, doi: 10.1136/bmjquality.u206156.w2532.
4. “Discharge Abstract Database metadata (DAD) | CIHI,” Jan. 16, 2020. https://www.cihi.ca/en/discharge-abstract-database-metadata (accessed Apr. 15, 2020).
5. <https://www.tableau.com/learn/webinars/tableau-mapping-healthcare>
6. Y. Holtz, “Stacked area chart template for d3.js.” <https://www.d3-graph-gallery.com/graph/stackedarea_template.html> (accessed Apr. 15, 2020).
7. E. Meeks, “Interactive Applications with React & D3,” Medium, Jul. 13, 2019. https://medium.com/@Elijah\_Meeks/interactive-applications-with-react-d3-f76f7b3ebc71 (accessed Apr. 15, 2020).
8. “d3/d3-3.x-api-reference,” GitHub. https://github.com/d3/d3-3.x-api-reference (accessed Apr. 15, 2020).
9. B. Shneiderman, “The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations,” p. 8.
10. Shneiderman, Ben, and Catherine Plaisant. "Strategies for evaluating information visualization tools: multi-dimensional in-depth long-term case studies." Proceedings of the 2006 AVI workshop on Beyond time and errors: novel evaluation methods for information visualization. ACM, 2006.
11. “CSV to JSON - CSVJSON.” https://csvjson.com/csv2json (accessed Apr. 15, 2020).