NHS SCOTLAND

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Section A: Forecasting Evaluation

a) These four factors NHS Scotland should consider when measuring the success of forecasting technique
- using a variety of operational indicators and external inputs
- measuring effectiveness at a fine-grained level
- ways to automate the process
- external factors and impending market shifts

b) challenges that NHS Scotland could face in the application of forecasting approaches are
- lack of qualitative analysis of the raw data
- there is no proper such tool to measure historical trends
- different assumptions made by managers because there is no standard system product or process for forecasting and every manager forecast in unique various ways.
- Despite there is very powerful statistical tools are available like SAS, SPSS and AI but NHS did not use quantitative analysis in their forecasting.

Section B: Data Access, Cleaning and Preparation

First, I clean the raw data as per instructions in excel file. For all 14 regions there are 40 records left after cleaning and choosing cancer type is equal to all cancer type.

Time series plot showing the percentage treated in all mentioned health boards and mostly HB are percentage from 80 to 100 percentage it means that cancer referrals treated are in good position. Only special health board Golden jubilee national hospital is relatively low treated percentage.

A cancer patient from Scotland will have to fly to Manchester because the difficult treatment she needed has been postponed three times due to a lack of critical care beds in Dundee [1].

From the year 2019 to 2021 there was drop in treatment due to covid 19. Although the statistic was up 2.1 percent from the previous quarter, it was still 10% lower than the same period the previous year. Except for Highland, all health boards met their goal of treating 95 percent of patients within 64 days. Only two health boards, NHS Borders, and NHS Shetland, fulfilled another target: the 64-day requirement for waiting from urgent suspicion of cancer referral to first cancer treatment.

Management should take insights from this historical data and ensure that they have enough resources to tackle the requirements.
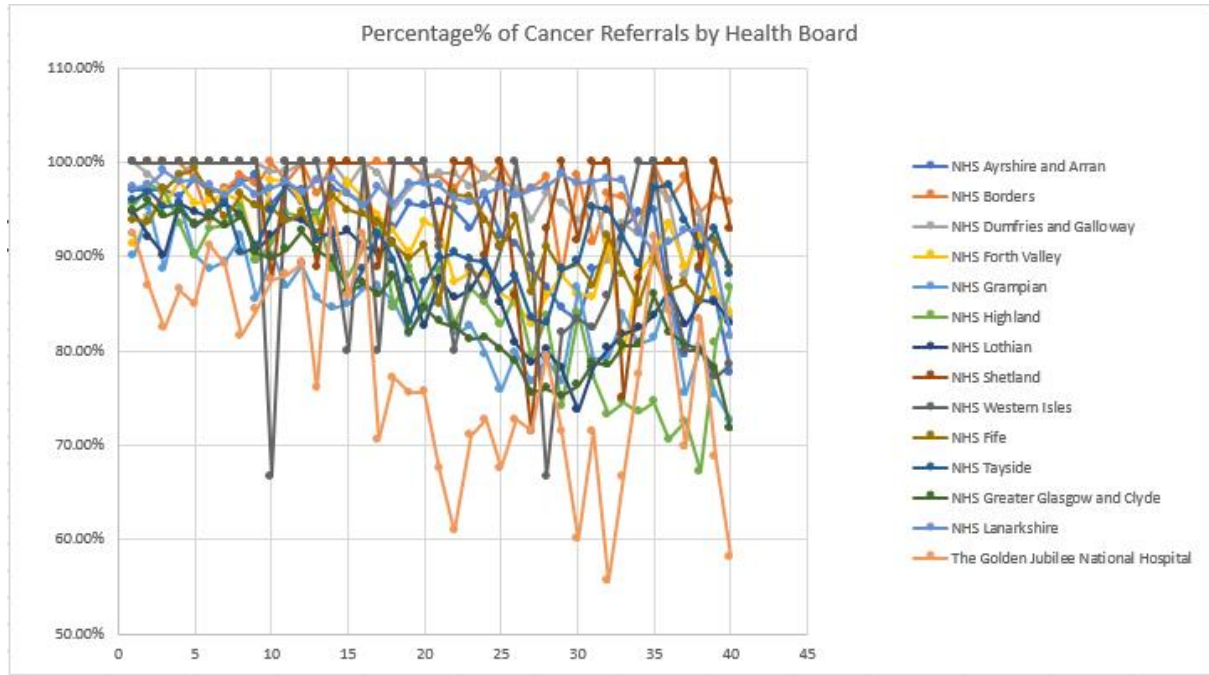
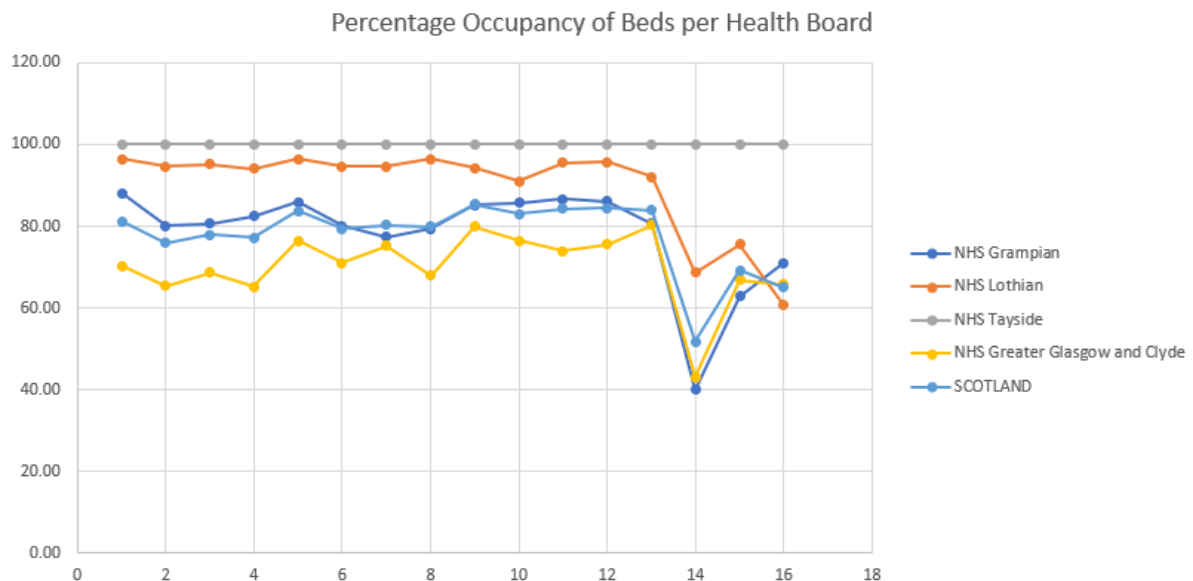*Figure 1: Time series plot of % of cancer referrals by HB*

Figure 2: Time series plot for % Bed occupancy

When we keep only the medical oncology department from the meta data, we left with 5 regions with 80 records. It can be clearly seen from time series plot that for all health board there is a drop in bed occupancy from period 13 to 16. This period represents the era from 2019 to 2021 Covid 19 time. In NHS Tayside their 100 percent occupancy of beds even in the covid 19 situation and patients are suffered in this region due to lack of beds availability as mentioned in the news article mentioned above. After first wave there is a again hype in bed occupancy and second wave came again drop can be seen from plot. According to the Public Health Scotland report, staffing and capacity difficulties have had an influence on performance in the most recent quarter, with issues such as self-isolation, social distance, and cleaning time between patients [2].

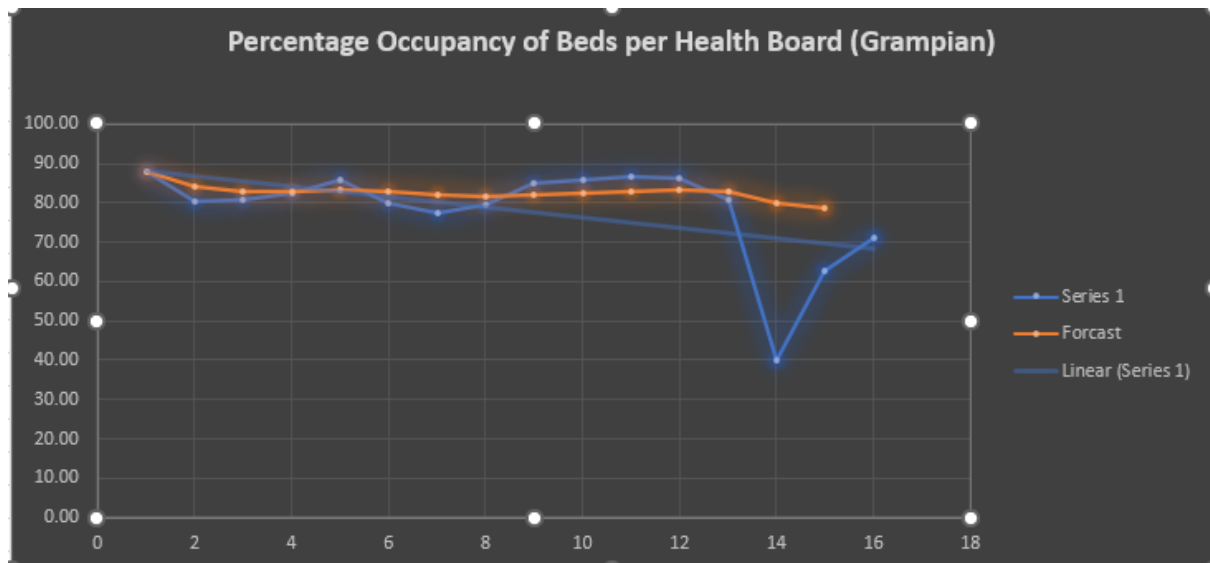**Section C: Time Series Forecasting**

For Grampian

Figure 3:percentage occupancy per health board (Grampian))

Above figure shows the Grampian region bed percentage in time series plot. It follows the horizontal trend while there is a dip after point 12 representing 2019 to 2020 covid time. Orange line shows our forecast using all historical data Mean square we got for this forecasting approach is 159.2.

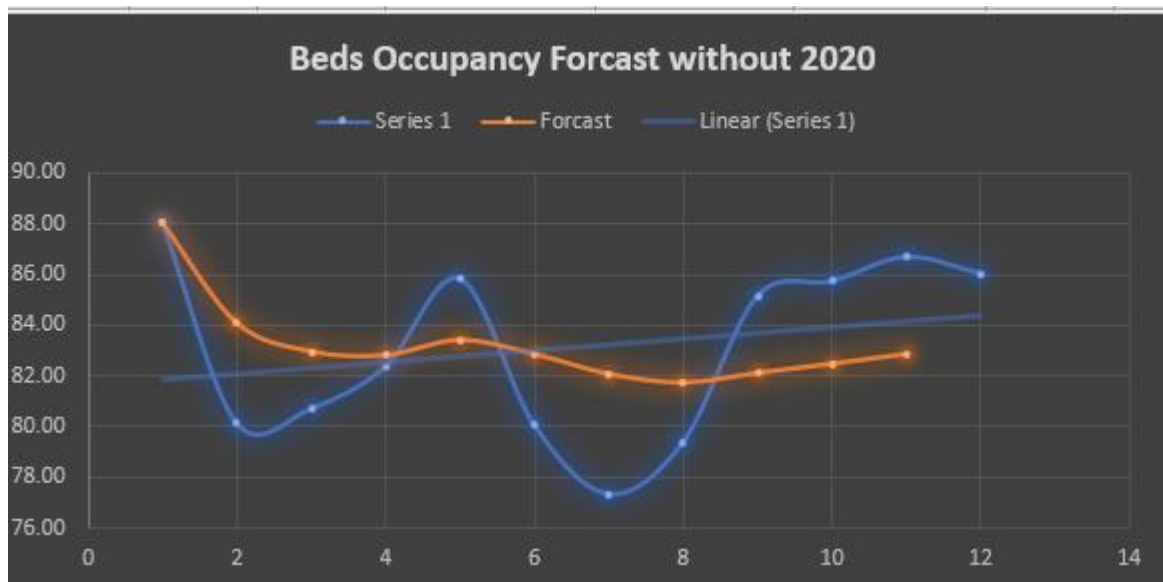Besides this I used regression forecasting approach, but I find All historical data is better then that.

Figure 4: without 2020

After filtering 2020 we got this horizontal trend showing average occupancy still greater than 77 percent. Orange line showing forecasting All historical data. Our forecast is illustrating that occupancy will remain more than 80 percent in future.
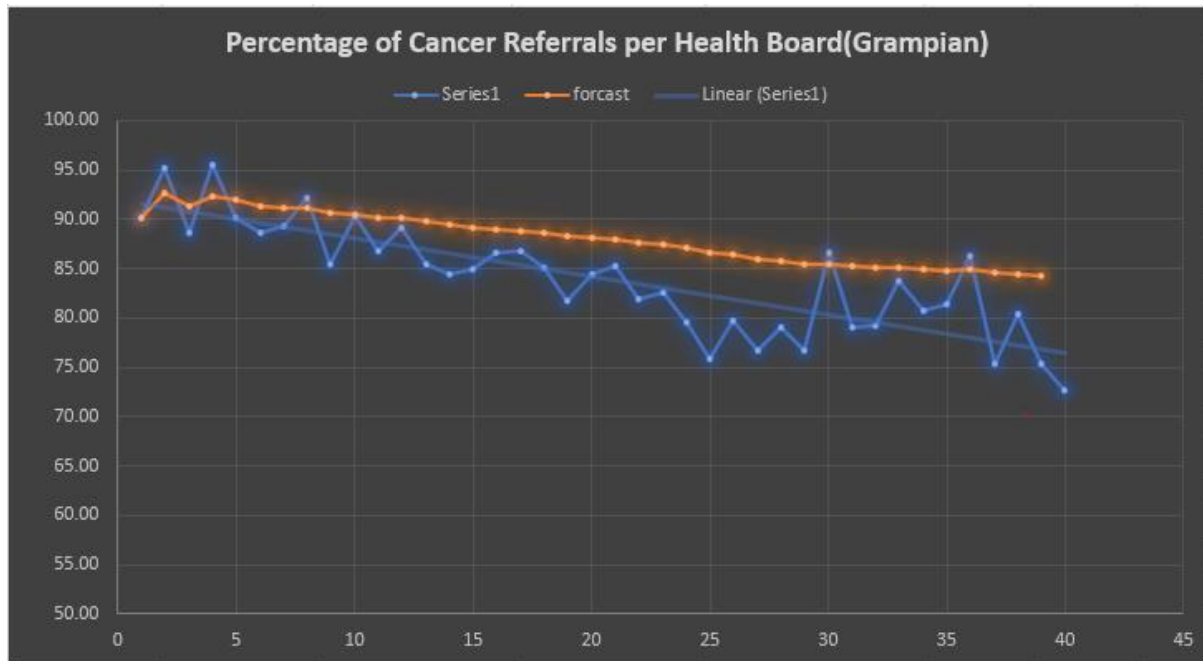
Figure 5: percentage of cancer referrals (Grampian)

This time series plot is referred to Grampian for percentage of health referrals it has decreasing horizontal trend. Orange line shows the forecast line by using All historical data its mean square value is 32.18.
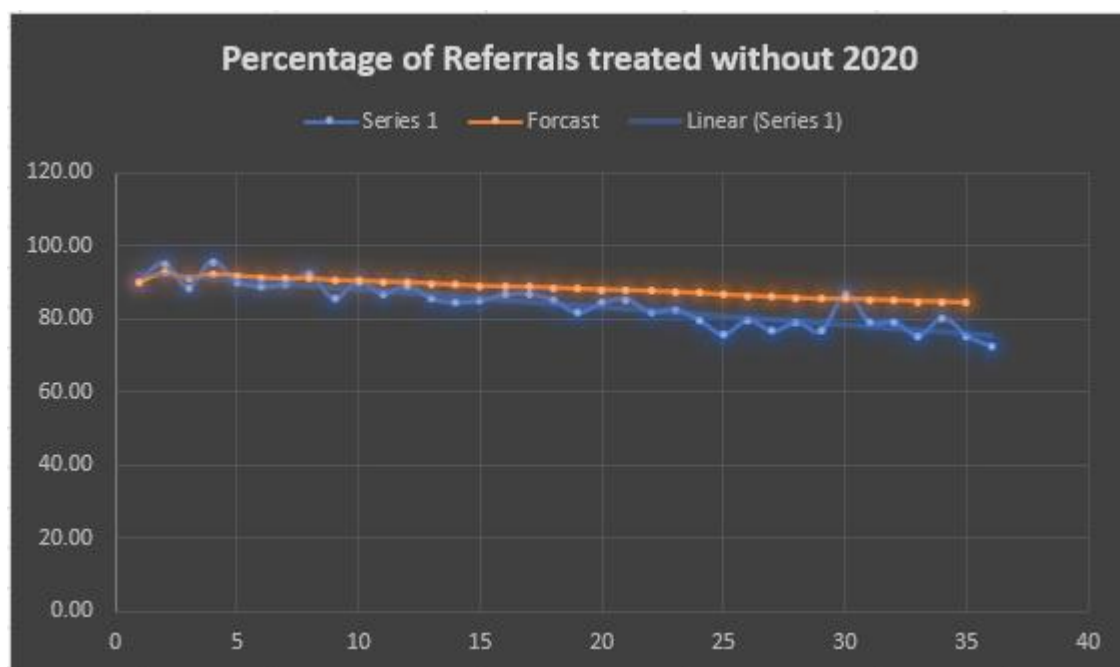

Figure 6:without 2020

Percentage referrals without 2020 it is showing horizontal trend as well and forecasting values are also above calculating values this mean there is better chance for treated patients in near future.

I have done same for other three regions (see excel files) plotting time series then forecasting by using All historical data. Finding mean square error. Most of the time series plot follow horizontal pattern. Only NHS Tayside follow linear trend because 100 percent bed occupancy is there. By using these forecast NHS Scotland tackle the areas which has shortage of bed etc.

Section D: Linear Programming/Linear Optimisation

a) The focus of hospital management teams is on how to improve the efficiency of bed resource usage using scientific management measurements and procedures, with the goal of optimising total health resources. At the clinic and regional levels, there are no fixed norms for the needed number of beds, although some of the described models and approaches may be used to estimate this number in different scenarios. Furthermore, new techniques to designing hospital capacity, such as care pathways, should be considered to overcome the limits of "bed numbers [3]."

By using Linear Optimization, we are identifying our variables. Result variable (percentage bed occupancy, percentage cancer referral treated) Decision variable (year, quarter and health boards), uncontrollable variables (All staff beds, occupied beds).

b) Problem Case: Staff Allocation

This section requires you to create a linear programming model based on the data from the case study. The linear programming approach below is adequate for handling the case study's staffing challenge.

Index I = Shifts

Decision variable x_i = Number of worker starting shifts on this time

Constraints

$X_1 + X_2 + X_3 >= 32$

$X_2 + X_3 + X_4 >= 24$

$X_3 + X_4 + X_5 >= 20$

$X_4 + X_5 + X_6 >= 28$

$X_5 + X_6 + X_7 >= 16$

$X_6 + X_7 + X_8 >= 4$

$X_7 + X_8 + X_1 >= 5$
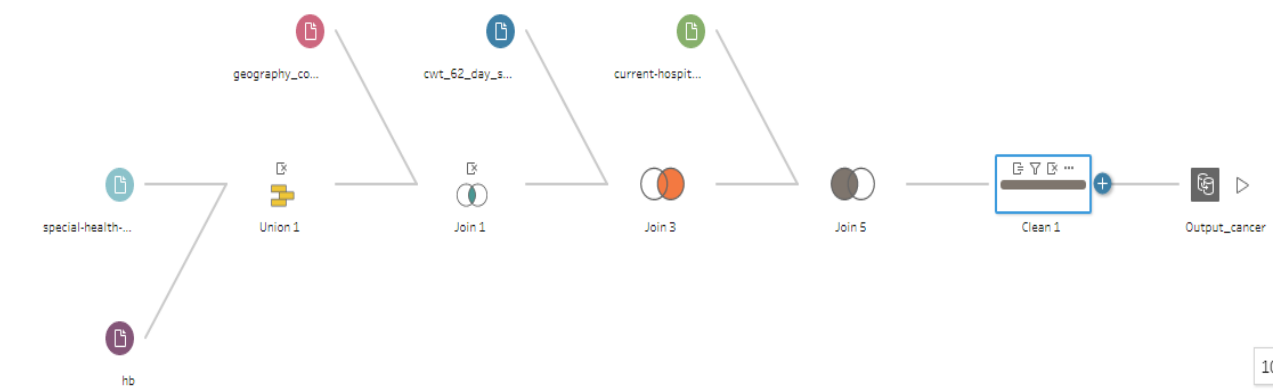
$X_8 + X_1 + X_2 >= 12$

Result variables z = $X_1 + X_2 + X_3 + \ldots + X_8$

There is only one problem in this person starting shift at shift time period x8 he has to work on next day because 24 hour completed.

Part 2: Tableau

Dashboard 1 for Cancer wait Referral treatment

**Flow diagram of cancer referral**

Figure 7:Flow diagram of cancer referral

First of all, In tableau prep I clean and prepare data as you can see from above figure.

- Union the health board and special health board file.
- Then join the geographical codes to the files for the post codes mapping.
- Then right join the main meta data file based on HB
- Left join the hospital labels and name after this clean the data
- In cleaning step, I have done 19 changes in cleaning step. Delete the unnecessary columns change data type and split column and keep only All cancer type   then make output file.

Dashboard 1: Cancer Waiting Times with a 62-day waiting standard
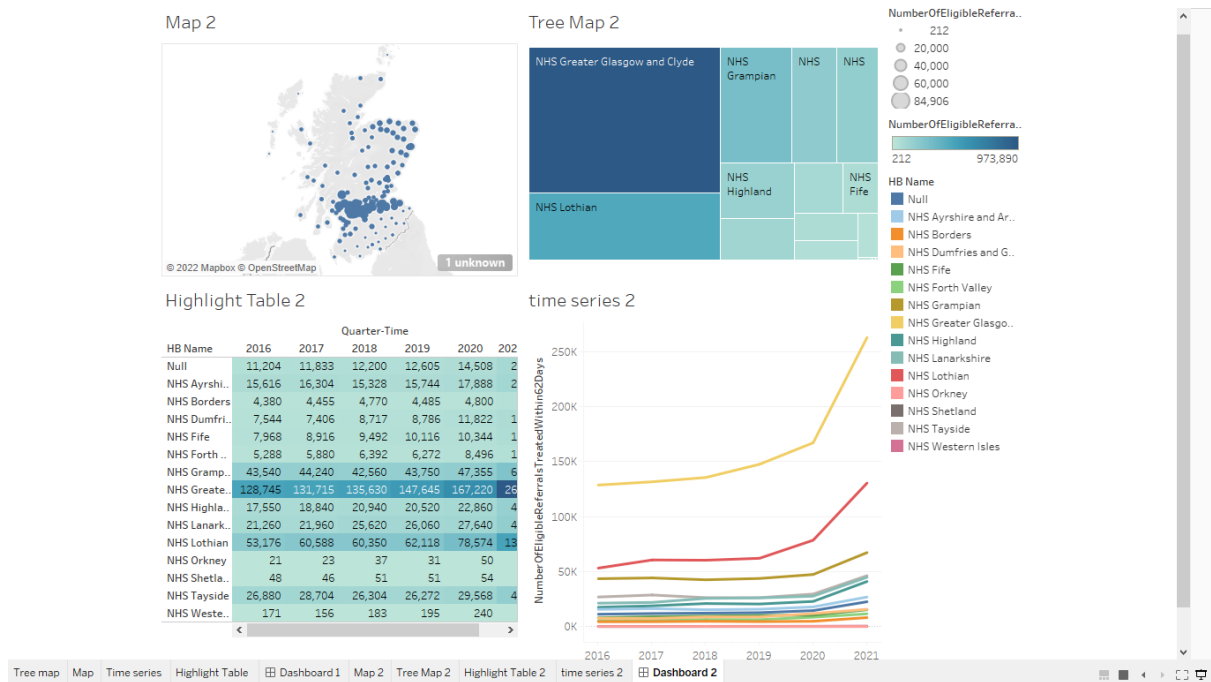
From the Tree map in Dashboard, it can be seen that For All Cancer type Health board NHS Greater Glasgow and Clyde, NHS Lothian, NHS Grampian and NHS are relatively good. And the health board region NHS Tayside, NHS Lanarkshire, NHS highland and NHS Arran are relatively low these regions need improvements with regard to treatment of cancer referrals. And the region named NHS west island, Shetland, fife, forth valley etc have very low number of referrals treatment patients and management should focus on these areas so that the number of treated persons increases.

When we see at time series in dashboard it can seen that in the health board region NHS Greater Glasgow and Clyde and NHS Lothian treatments are increases from 2019 to 2021 and in other HB average percentage is almost same from 2016 to 2021.

Map defines the Number of cancers treated person in Each Hospital with post code location. It is easier way to know the performance of each hospital.

Dashboard 2 for Percentage occupancy of beds

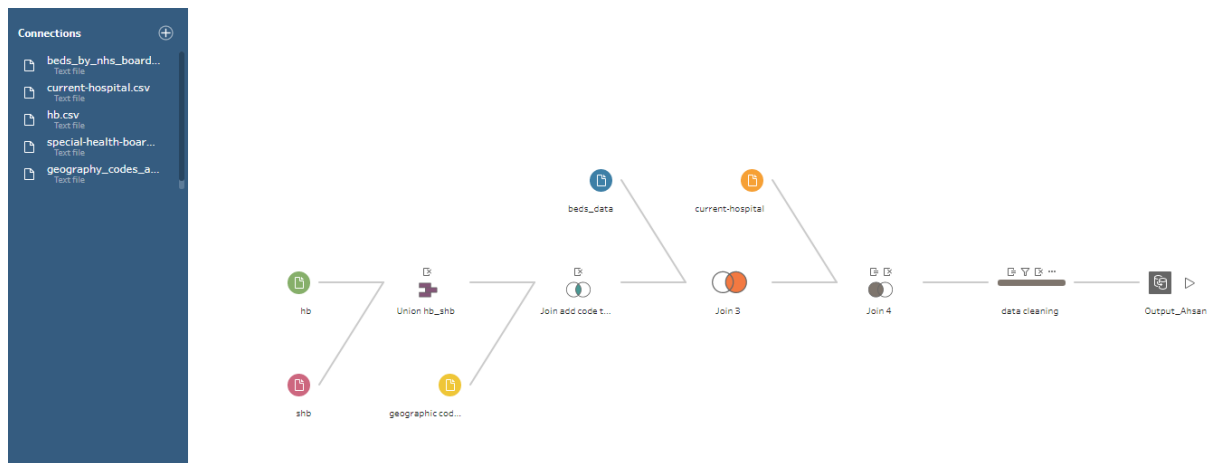**Flow diagram of Percentage occupancy of beds**

Figure 8: Flow diagram of percentage occupancy

We did the same first three steps in this flow as well union HB and SHB then join by geographical codes, main meta data file and hospital names and then clean the data. In cleaning process

- Remove unnecessary column e.g. quarter QF, HBQF etc.
- Split the post code and only take first part of post code.
- Change the data type of quarter year and set Scotland as a state or province. After this I got output shown below.

Figure 9: Output of beds occupancy in tableau

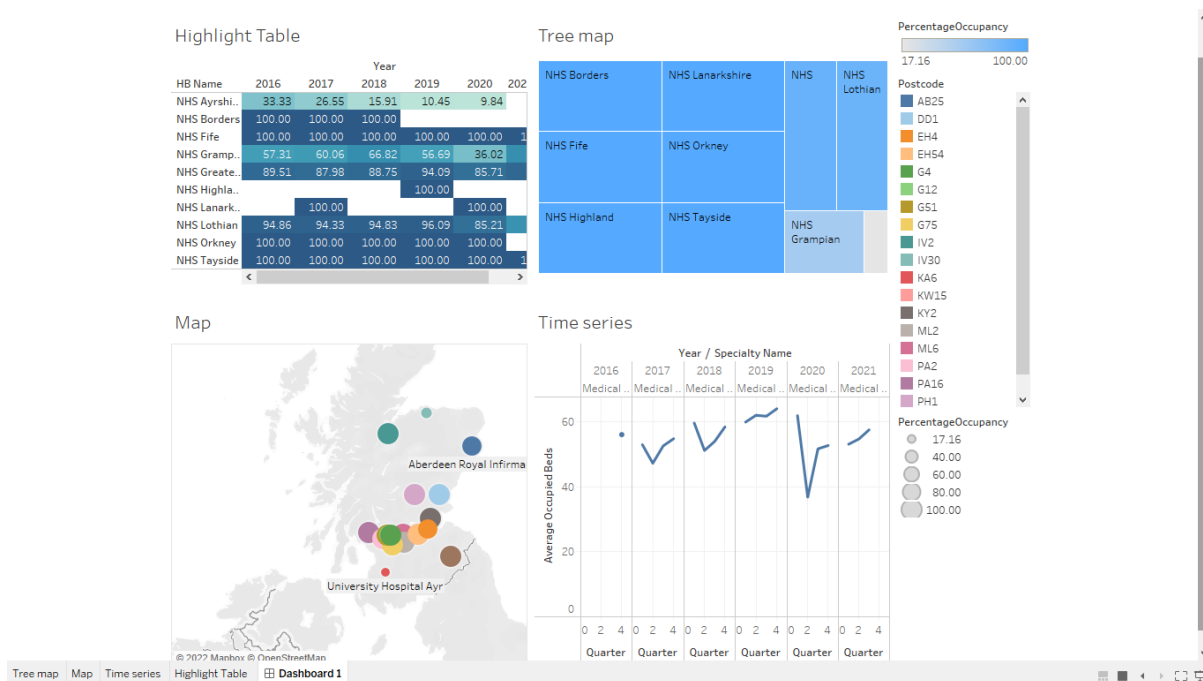**Dashboard 2: Percentage occupancy of Beds**

Figure 10: Dashboard of Beds occupancy

From the tree map it can be seen that NHS Borders, NHS fife, NHS highland, NHS Tayside, NHS Orkney and NHS Lanarkshire beds are 100 percent occupied so it is clear insights for the managers that they should arrange new beds for the patients so that new arrangements can be made for the patients to avoid any inconvenience situation.

Time series plot in the dashboard shows the quarterly occupancy of beds from year 2016 to 2021 for medical oncology department.

Part 3: Ethical Issues in Business Intelligence

A summary of the legal, ethical, and privacy concerns that may arise in relation to NHS Scotland and the proposed business intelligence platforms**.**

To be able to tackle any ethical dilemma, you must first recognise that there is one. Try to be upfront and honest about the situation while also avoiding talks that would exacerbate the problem.

Theft of personal details such as social security numbers, birth dates, and credit card numbers has allowed technology-savvy criminals throughout the country to potentially walk away with billions of pounds in money belonging to innocent victims. Other ethical issues are privacy, accuracy, property, and accessibility.

NHS Scotland should commit to ethical behaviour in all they do, and its employees try to uphold the highest levels of professionalism and honesty. Actions that promote equality and diversity benefit both our employees and the communities we serve [4].

NHS Scotland should hire IT professional which certainly have a responsibility to play in ensuring the security and integrity of BI systems. IT workers are the most knowledgeable about the system in the firm, and they have a responsibility to assist keep the data safe.

Reference:

1. Anderson, K. (2021). *Surgery cancelled three times due to lack of ICU beds*. [online] Daily Record. Available at: https://www.dailyrecord.co.uk/news/local-news/cancer-operation-put-three-times-25634355?utm_source=ground.news&utm_medium=referral [Accessed 2 Jun. 2022].

2. Covid in Scotland: Thousands fewer had cancer treatment. (2021). *BBC News*. [online] 29 Jun. Available at: https://www.bbc.co.uk/news/uk-scotland-57650825.

3. Ravaghi, H., Alidoost, S., Mannion, R. and Bélorgeot, V.D. (2020). Models and methods for determining the optimal number of beds in hospitals and regions: a systematic scoping review. *BMC Health Services Research*, 20(1). doi:10.1186/s12913-020-5023-z.

4. NHS Sustainability Action. (n.d.). *Ethical Issues*. [online] Available at: https://nhssustainabilityaction.co.uk/areas-of-focus/ethical-issues/ [Accessed 3 Jun. 2022].

5. Erickson, A.M. (2014). *Adam M. Erickson*. [online] Adam M. Erickson. Available at: https://a-erickson.com/ethics-in-business-intelligence/.

6. www.mckinsey.com. (n.d.). *Bringing the real world into your forecasting process | McKinsey*. [online] Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/bringing-a-real-world-edge-to-forecasting.