
# Inpatient Meal Survey Analysis


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ANLY482 Interim Report

# Introduction & Project Background

## "Food is your medicine – hence let your medicine be your food"

*Hippocrates, circa 400 BC*

All patients have a right to safe, nutritious food. They expect their nutritional needs to be fulfilled during hospitalization. The state and kind of food provided to patients in hospitals have a direct impact on their health. Providing unhealthy and poor quality food can severely affect the quality of life of a patient.

Recent studies have shown that there has been a drop in the nutritional content of the food provided by hospitals nowadays. According to one study, 29% of previously well-nourished patients faced a decline in their nutritional content after being admitted to the hospital[1]. Thus, food services should be given higher priority in hospitals and should be recognised as an important and integral part of a patient's health and treatment.

National University Hospital (NUH) is one of the leading medical institutions in Singapore with around 50,000 inpatients and 600,000 outpatients[2]. Sodexo is the esteemed provider of meals to the inpatients of NUH and is in charge of maintaining the standards of the meals for the patients. Lately, NUH has been placing great importance in the inpatients' perceptions and satisfaction towards the meals that are provided in the hospital.

Sodexo is in charge of conducting surveys with the inpatients to gather feedback on the meals that are provided to them in the hospital. The purpose of the survey is also to gain insights on what factors are most important for the patients and recommendations that can be helpful in improving the services provided to them.

The surveys are conducted by well-trained interviewers who have been involved in hospital surveys; especially those who are familiar with NUH conduct face-to-face interviews with respondents at the various NUH wards. This may include patients only as per agreed with Sodexo. The survey uses Likert scale (5 or 7 point scale) rating for the attribute to make it easier for the patients to answer and also to restrict the range of feedback that the company receives. The patients are required to rate each attribute on their importance and satisfaction level with reference to the food provided to them.

The survey conducted can only be helpful to Sodexo if they gain useful and actionable insights on how they can improve the quality of meals provided and which are the main attributes that they should focus on.

[1] http://health.gov.ie/wp-content/uploads/2014/03/undernutrition_hospital_guidelines.pdf
[2] https://en.wikipedia.org/wiki/National_University_Hospital

Since the survey captures qualitative data in the form of Likert scale ratings, the approach on analysing the feedback is different from the typical data analysis involving mean, median and mode.

Sodexo appointed Media Research Consultants, a Mediacorp Enterprise specializing in market research, for conducting and analysing the NUH In-Patient Meals Audit Survey from 2015-2017. This project is sponsored by MRC Mediacorp. In this project, we are expected to present the results of the analysis of the surveys in the form of a web based application to help MRC Mediacorp. It will help them to understand which attributes are most important for the patients as they should provide more attention and resources to improving those attributes. Moreover, it will also help them to know which the attributes that the patients are unsatisfied with are and has room for improvement. The application needs to be reusable for analysing future surveys.

## Literature Review

Market research, psychometric tests and customer feedback studies commonly use Likert scale or other semantic differential scale for rating purposes[3]. Survey data has a major impact in providing companies with directions on their strategies and performance. Thus, it is extremely important to interpret Likert scale properly. Measuring attitudes, feelings and personality traits can be difficult and ambiguous as it requires converting these qualities into quantitative numbers for data analysis. There have been many recent studies and experiment in measuring these qualities using Likert scale and how to analyze this data.

Likert scale, developed in 1932 by Rensis Likert[4], is a 5 or 7 point ordinal scale used to rate statements according to how users agree or disagree with them. The table (Figure 1) below shows a commonly used Likert scale rating.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

*Figure 1: Likert scale example*

A common mistake by most people while analysing Likert scale data is that they treat these ordinal ratings as continuous or discrete data by converting the rating into numbers and using the average of the numbers to do the analysis. That implies that there is some measure of distance between the rating values.

[3] https://www.amstat.org/sections/srms/Proceedings/y2011/Files/300784_64164.pdf
[4] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3886444/

In an ordinal scale, responses can be rated or ranked but there is no measurable distance between the values[5]. It doesn't make sense to say that feeling neutral is three time that of the feeling of strong disagreement. It is also incorrect to assume that the differences between the ratings are necessarily equal. Let's look at an example to illustrate the shortcomings of using average of the responses. In case of a controversial survey question, most people are likely to either choose strongly disagree or strongly agree. In that case, if we use the mean to do the analysis, it will indicate that on average everyone chose neutral which is actually wrong[6]. Thus, mean is a poor method of analysing Likert scale data.

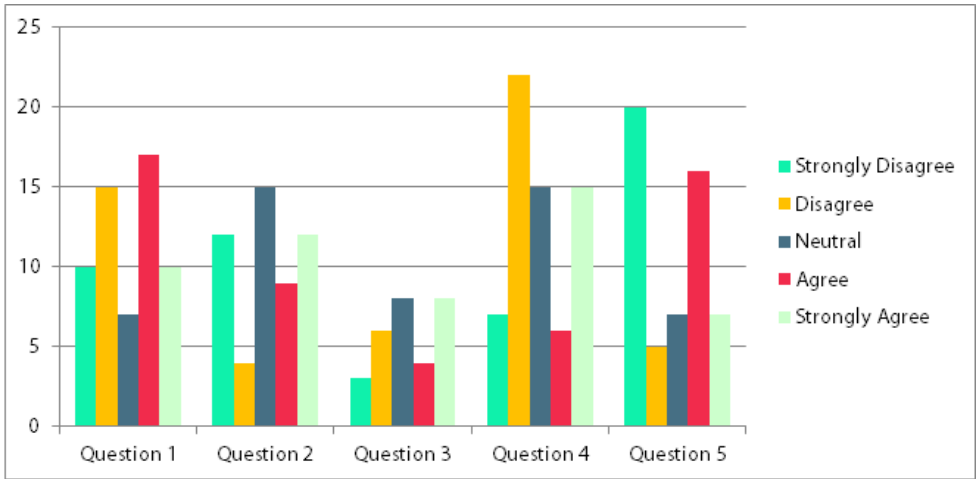
The most appropriate way of representing Likert scale data is in the form of a frequency table. This lets the users to see the distribution of the data on their own instead of influencing them with average numbers. The table (Figure 2) below shows a representation of frequency of the rating of participants for a market survey of a product.

| Not Important | Somewhat Important | Neutral | Important | Very Important |
|---|---|---|---|---|
| 3 (3%) | 60 (60%) | 5 (5%) | 2 (2%) | 30 (30%) |

*Figure 2: Frequency Table for Likert scale example*

The interpretation of the above results can be that most people think that the product is only somewhat important but there is large group that also thinks that the product is very important. Thus, the company should focus on allocating resources on the segment that thinks it's important and not waste it on the segment that does not find it useful.

There have also been a lot of critiques on the ways of representing Likert scale data for visualization. Below are some examples of the representations and why they are recommended or not recommended for ordinal data representation.




[5] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3886444/
[6] https://zapier.com/learn/ultimate-guide-to-forms-and-surveys/design-analyze-survey/#oanalyze

*Figure 3: Bar graph for Likert scale data*

The above illustration (Figure 3) shows representation of Likert scale data using a bar graph. However, reading bar graphs can be confusing and difficult as that would involve one bar each for each rating for each question[7]. Also, it would be difficult to compare the ratings across different questions especially if there are many questions.

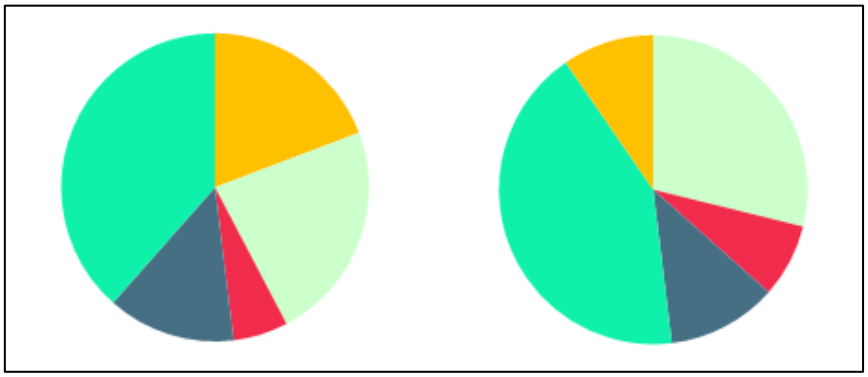


*Figure 4: Pie chart for Likert scale data*

Pie charts (Figure 4) for each factor do not communicate very well and are also difficult to interpret[8].

There are other representations as well like spider chart and waffle chart but they too are not easy to interpret and are not very efficient for comparison across different questions.

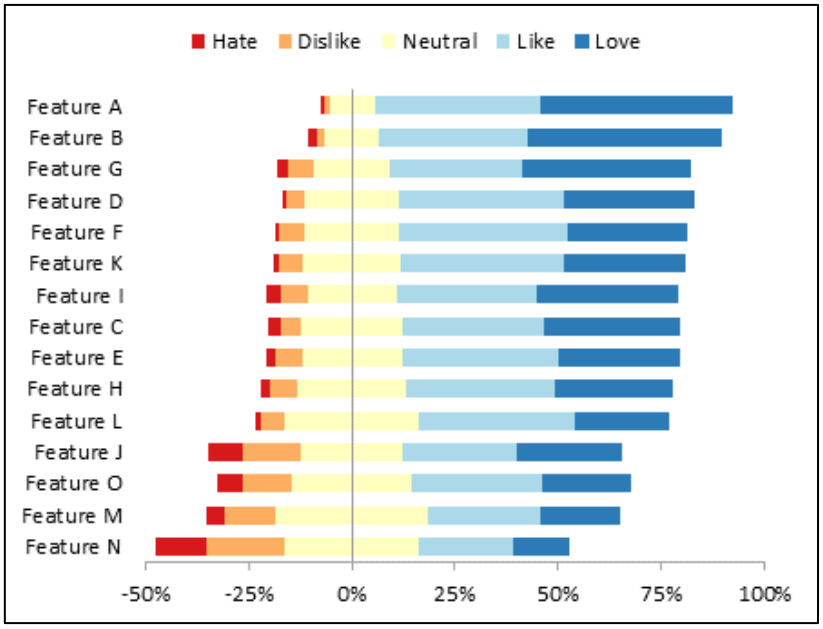



*Figure 5: Divergent Stacked Bar Graph for Likert scale data*

[7] https://www.amstat.org/sections/srms/Proceedings/y2011/Files/300784_64164.pdf
[8] https://www.amstat.org/sections/srms/Proceedings/y2011/Files/300784_64164.pdf

The most appropriate way of representation of Likert data is divergent stacked bar graph (Figure 5). The data is represented in percentages of the total participants. The positive responses are plotted to the right of the base line and the negative responses are plotted to the left. The percentages of the middle scale value is broken into have and plotted on the left and right of the base line. The common base line helps to compare the responses for different questions. This graph is easy to interpret and useful for analysis of Likert scale data[9].

## Project Scope

This project aims to provide an automated online dashboard to upload the data and provide the analysis needed on surveys conducted by Media Research Consultants for Sodexo. The project's scope is to provide a better solution, which relates to the latest research done in the field of survey analysis.

We aim to target and achieve the following from the online dashboard:

- An analysis of the factors by importance and satisfaction, to understand which factors of the food are important and satisfying to the patients
- A service gap analysis to read between the lines and find out factors that have a significant gap when it comes to importance and satisfaction
- An analysis of the factors done by ward, to focus on improving factors according to the wards
- An analysis of the factors done by diet preferences or type
- An analysis of the factors done by patient type (payment status - private or subsidized)

## Data

MRC conducts a survey for Sodexo every two months regarding the food that they supply to the patients at NUH. They then produce the analysis on this collected data and provide insights to Sodexo on the food.

***How is the data collection done?***

There are three interviewers who interview 50 patients every month. The patients are asked about the importance and satisfaction that they attach to 7-8 factors (depending on the class of the patient) of the food. This data is collected in a Qualtrics survey format and generated as an Excel every two months. The data is clean and formatted.

***The metadata***

- sno - The serial number of the interviewee
- survey month - The month the survey took place

[9] https://www.amstat.org/sections/srms/Proceedings/y2011/Files/300784_64164.pdf

- start date - The starting time of the survey
- end date - The ending time of the survey
- building - The NUH building the patient lives in (Kent Ridge or Main)
- payment - The payment status of the patient (private or subsidized)
- ward - The ward class of the patient
- ward no - The ward number for the patient
- citizenship - The citizenship of the patient
- respondent - The respondent for the survey is who? (The patients themselves or the interviewer)
- special diet - Is the patient consuming a special diet or a normal one?
- type of special diet - 25 columns to show the types of special diet (if previous question is a yes then one of these columns will contain a yes)
- meal type - The patient has 6 types of meals to choose from and that is reflected in the 6 columns for meal type.
- overall satisfaction - The patients rate their overall satisfaction with the food
- satisfaction reason - some of them provide a reason for the previous question
- comments - The patients are asked to write about one key area they think NUH meals could improve on
- sex - The gender of the patient
- race - The race of the patient
- age - The age of the patient
- age group - The age group of the patient
- education - The highest education level of the patient
- occupation - The occupation of the patient
- interviewer - The interviewer for the survey

There are 8 factors on which the patients rate the importance and satisfaction level according to them with relation to the NUH food.

- Temperature of Food
- Timeliness of Meals Served
- Accuracy of Meals Served
- Courtesy of the Food Service Staff
- Portion Size of the Meals Served
- Variety of the Food Provided in menu
- Presentation of the Meals Served (only for the private patients)

Rating Scale:

- Importance level - Not Important at all, Not Important, Somewhat Important, Important, Very Important
- Satisfaction level - Very Poor, Poor, Satisfactory, Good, Excellent
- Reasons - The patients are given an option to write their reasons for the above ratings that they provide

***Demographics of the interviewees***

The figure below (Figure 6) represents the demographics of the interviewees for the October 2015 and November 2015 survey.

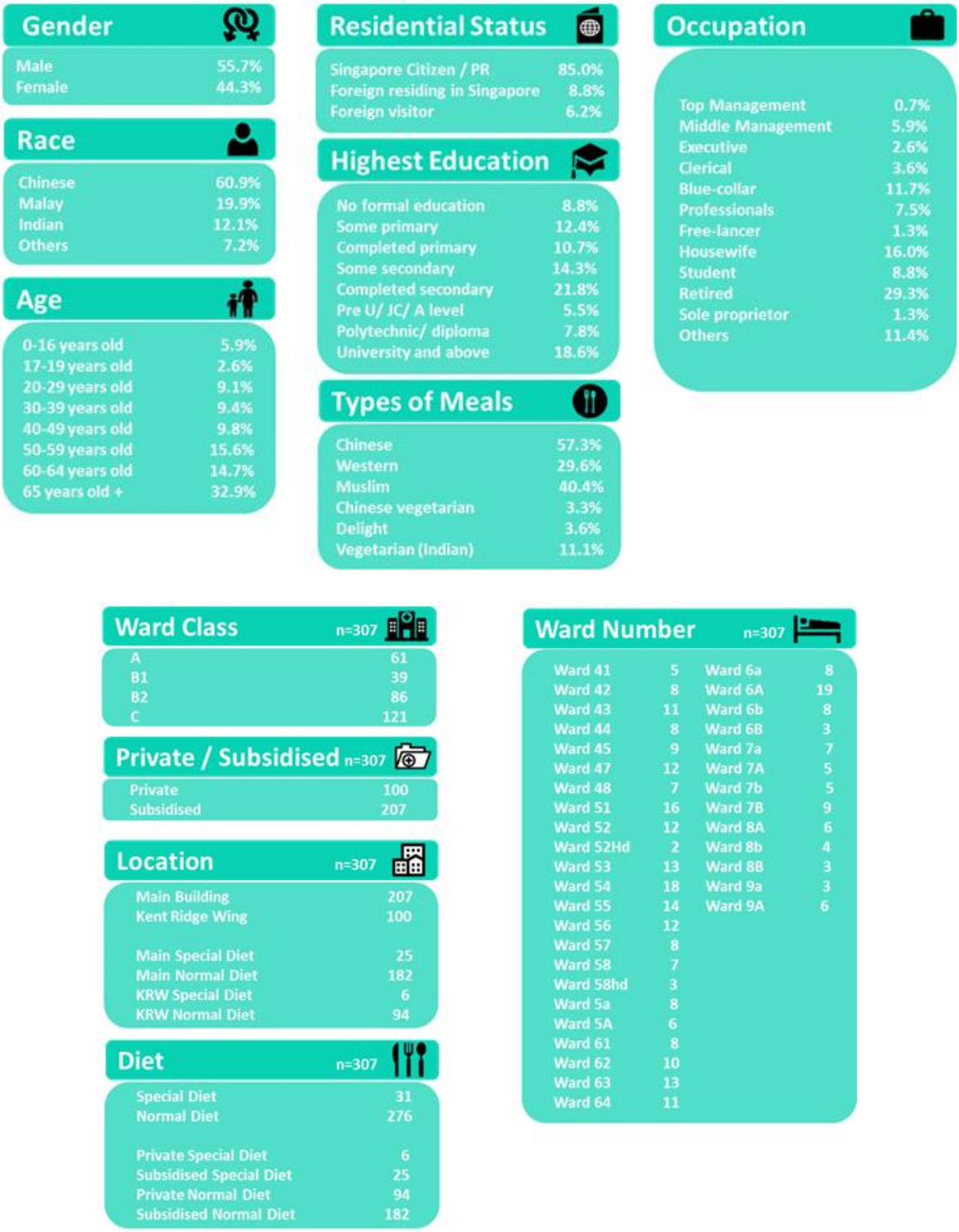



*Figure 6: Demographics of the interviewees*[10]

[10] Image source: MRC Mediacorp Oct 2015-Nov 2015 Survey analysis

# Methodology

***Current Method***

MRC currently conducts these surveys using Qualtrics and then uses SPSS software to analyze the data. The main statistical measure used to analyze the data is the mean of the ratings given for each attribute. They drill down to analyze the average rating by wards, dietary preferences, types of patients and other dimensions. However, as discussed before in the report, this method is flawed and does not provide the best results. This is primarily because the distance between the ratings are not measurable and cannot be interpreted.

The mean can fall in a decimal and a mean of say 3.4 or 3.6 is not telling much of the story that the client will want to read. What can one make of the data when the mean comes to a decimal point between 3 and 4? Say for example the mean is 3.4, the report would say that the patients are satisfied on an average, but then again this is a mean what if this mean arrived due to a lot of people rating 5 and just a lesser number than that rating 1. Is the analysis correct then? No, because there are a lot of people who are not at all satisfied and their needs are overlooked.

Different graphs are generated and then insights are collaborated. Below are some screenshots (Figure 7-10) of the analysis done by MRC on the survey data for Oct-Nov 2015.

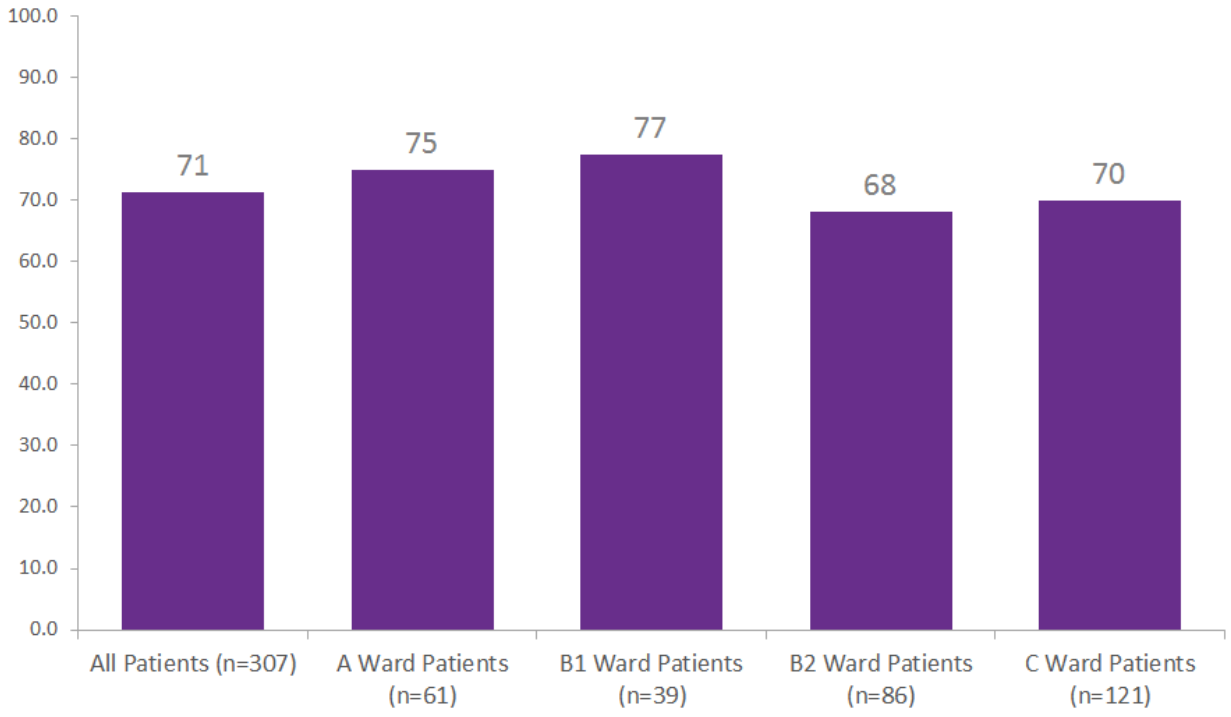



*Figure 7: Average Satisfaction by Ward Class*[11]

[11] Image source: MRC Mediacorp Oct 2015-Nov 2015 Survey analysis

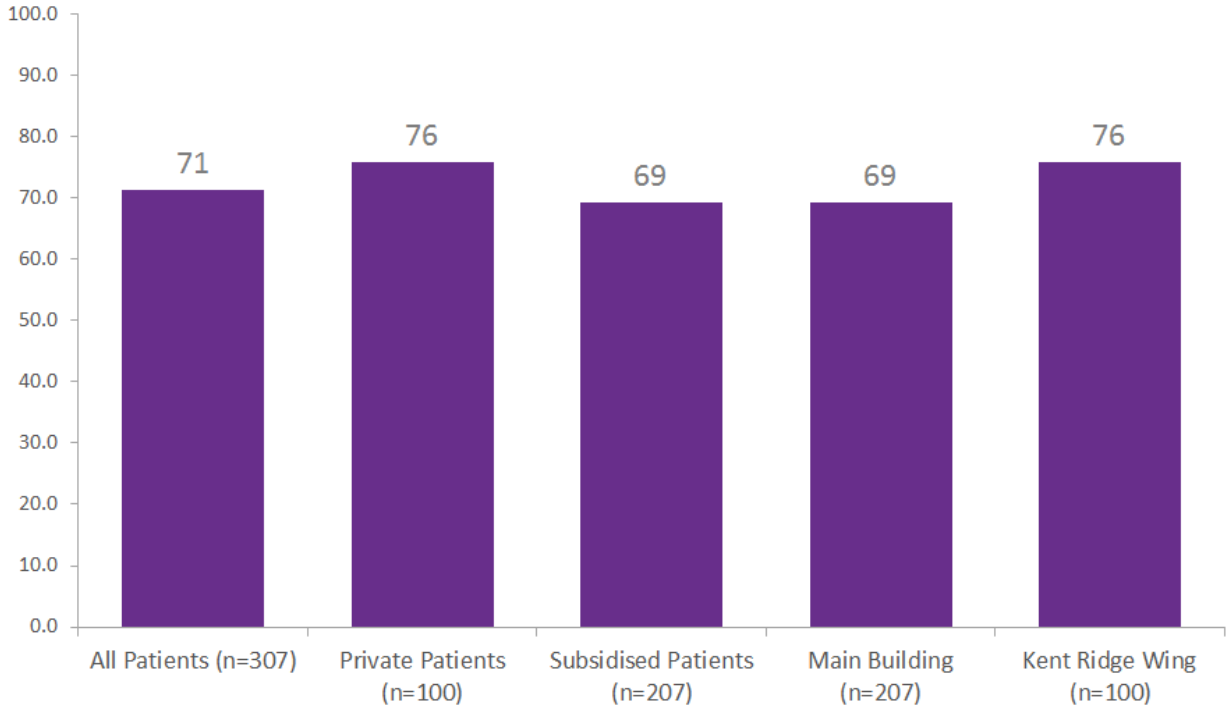



*Figure 8: Average Satisfaction by Patient Type*[12]

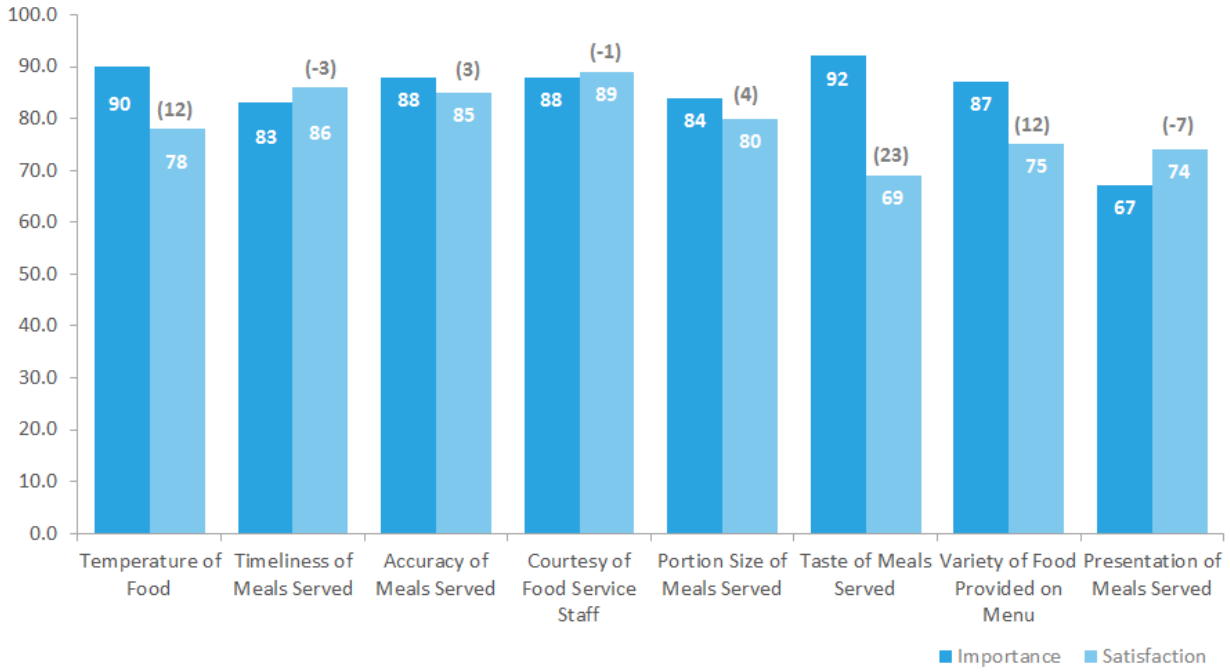



*Figure 9: Service Gap Analysis for all patients*[13]

[12] Image source: MRC Mediacorp Oct 2015-Nov 2015 Survey analysis
[13] Image source: MRC Mediacorp Oct 2015-Nov 2015 Survey analysis

| Main Attributes by Wards (highlighted if below average) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WARD | size = n | Temperature | Timeliness | Accuracy | Courtesy of staff | Portion Size | Taste | Variety | Presentation |
| Total | 307 | 78 | 86 | 85 | 89 | 80 | 69 | 75 | 74 |
| 41 | 5 | 80 | 88 | 88 | 80 | 80 | 60 | 72 | - |
| 42 | 8 | 68 | 83 | 80 | 78 | 73 | 63 | 70 | - |
| 43 | 11 | 64 | 73 | 69 | 78 | 76 | 64 | 69 | - |
| 44 | 8 | 68 | 75 | 73 | 88 | 80 | 63 | 65 | - |
| 45 | 9 | 80 | 82 | 82 | 87 | 69 | 64 | 71 | - |
| 47 | 12 | 65 | 73 | 73 | 78 | 73 | 62 | 65 | - |
| 48 | 7 | 69 | 77 | 71 | 83 | 80 | 60 | 66 | - |
| 51 | 16 | 91 | 95 | 95 | 91 | 81 | 75 | 79 | - |
| 52 | 12 | 88 | 98 | 97 | 95 | 82 | 77 | 78 | - |
| 52Hd | 2 | 80 | 80 | 80 | 80 | 80 | 60 | 70 | - |
| 53 | 13 | 92 | 94 | 95 | 92 | 94 | 82 | 80 | - |
| 54 | 18 | 88 | 94 | 94 | 97 | 86 | 78 | 79 | - |
| 55 | 14 | 87 | 91 | 93 | 96 | 89 | 66 | 71 | - |
| 56 | 12 | 82 | 90 | 88 | 90 | 85 | 65 | 75 | - |
| 57 | 8 | 80 | 88 | 88 | 88 | 85 | 70 | 83 | - |
| 58 | 7 | 80 | 86 | 86 | 91 | 77 | 60 | 74 | - |
| 58hd | 3 | 67 | 73 | 80 | 80 | 73 | 53 | 73 | - |
| 5a | 8 | 65 | 73 | 75 | 88 | 70 | 60 | 60 | 68 |
| 5A | 6 | 83 | 97 | 97 | 97 | 83 | 73 | 83 | 77 |
| 61 | 8 | 73 | 78 | 75 | 88 | 73 | 73 | 75 | - |
| 62 | 10 | 74 | 80 | 70 | 80 | 72 | 68 | 74 | - |
| 63 | 13 | 69 | 72 | 69 | 83 | 72 | 58 | 71 | - |
| 64 | 11 | 71 | 80 | 76 | 85 | 71 | 60 | 69 | - |

*Figure 10: Analysis by Wards (%)*[14]

***Our Method***

The main objective is to provide the users with a dashboard which provides visualizations that appropriately represents the data and can be interpreted easily. The dashboard is built using HTML, CSS and Java and the visualizations are made using JavaScript and D3.js.

The dashboard provides upload functionality where the user can upload the survey data that he/she wants to analyze. This ensures that the dashboard is dynamic and can be used for analysing future surveys. The application is linked to a MySQL database which keeps record of the data that is uploaded. This helps the user to store earlier surveys and to analyze the attributes across months and record the change in pattern.

The statistical measure used to represent the data is frequency of each rating for each factor as a percentage of the total population of interviewees. The basic graph shows the frequency of the ratings across each attribute for all patients using a divergent bar graph for both importance and satisfaction. As discussed earlier, this graph is easy to understand and interpret and provides an overall view of the ratings across each attribute.

The user has the option to select and view the overall divergent graph for any of the months for which the survey has been uploaded. Apart from the overall view, we are also drilling down across different dimensions of the data. These dimensions include:

[14] Image source: MRC Mediacorp Oct 2015-Nov 2015 Survey analysis

- Wards
- Types of patients (Private or Subsidized)
- Types of patient diets (Normal diet or Special diet)

Moreover, time series analysis is used to view and analyze the survey data across different months. The user can drill down to a specific attribute and see the trend of its ratings across several months.

Apart from analysing importance and satisfaction separately, it is also imperative to analyze the service gap for each attribute. Service gap represents the difference in the satisfaction and importance rating for each attribute. Bigger the difference in the importance and satisfaction, more attention needs to be paid to that attribute.

All the above analysis is represented using Divergent bar graph which can be easily implemented by using D3.js.

Apart from that, the dashboard also provides the relationship between the different attributes based on the ratings provided by the patients. This is visually represented using parallel sets. The picture below shows an example of a parallel set. D3.js helps build an interactive parallel set to see the relationship between the ratings across different attributes.

The dashboard is a simple, easy-to-use application which provides interactive graphs with appropriate filters for in-depth analysis. The graphs are easy to read and interpret and provide accurate representation of Likert scale data.

## Analysis

***Overall Analysis***

For the analysis, we first see the survey feedback for the month of November as it is the more recent survey conducted and will provide the most accurate results for the analysis. At first, we see the overall view of the importance and satisfaction values for all attributes.

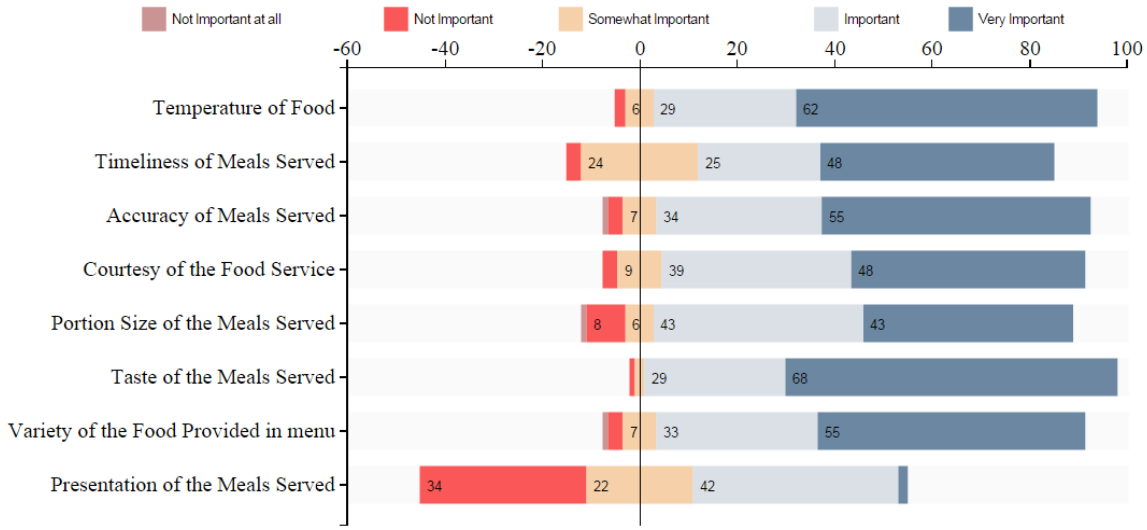



*Figure 11: Frequency (in %) of Importance ratings for all attributes*

As seen from the above graph (Figure 11), the most important attribute for the patients are “Taste of the Meal Served”, “Temperature of Food” and “Variety of Food Provided in menu.” Thus, it is important for us to look deeper into these attributes and see the satisfaction of the patients and how it can be improved. The less important attribute for the patients is “Presentation of the Meals Served.” Thus, lesser focus should be put into maintaining or improving this attribute for the meals.

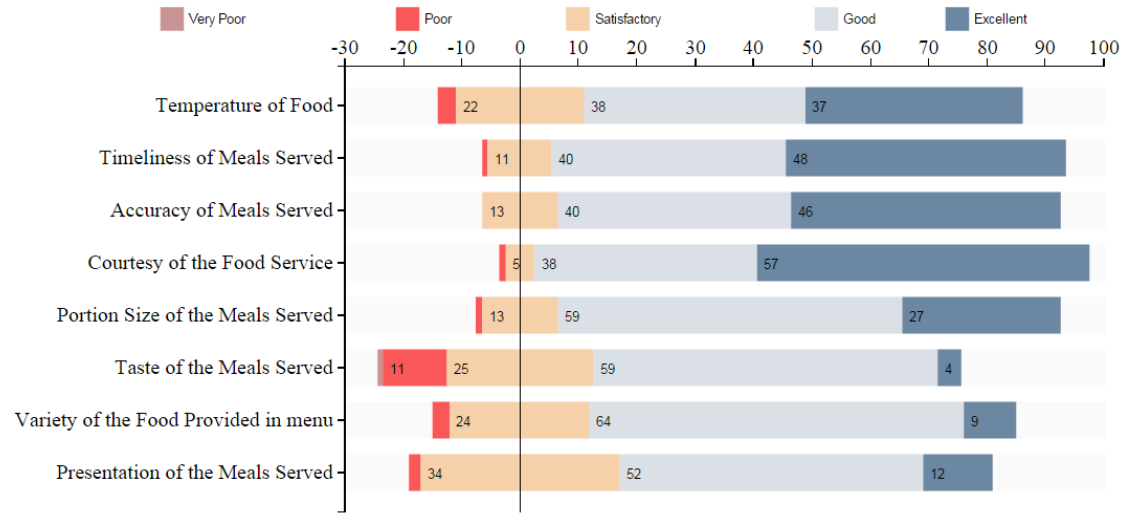



*Figure 11: Frequency (in %) of Satisfaction ratings for all attributes*

Figure 11 clearly shows that, patients are least satisfied with the taste and variety of the meals. Since, these two attributes are extremely important for the patients, the hospital should focus more on improving these attributes.

Moreover, it can be seen that the patients are extremely satisfied with the presentation of the meals. The satisfaction level of this attribute is higher than the importance level. Thus, NUH is wasting more resources in this attribute than is required. They can try and save up resources from presentation of meals and put in improving the taste and variety of meals served.

***Drill down to attribute "Taste of the meals served"***

After the overall view, we analyze each attribute by wards, type of patients and type of diets. This will give a more accurate view of where the improvements can be made.

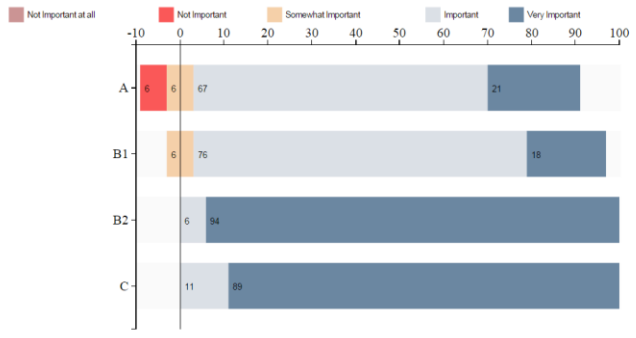



*Figure 12: Frequency (in %) of Importance for each ward*

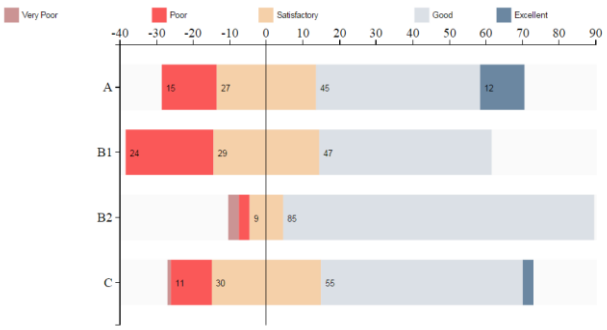



*Figure 13: Frequency (in %) of Satisfaction for each ward*

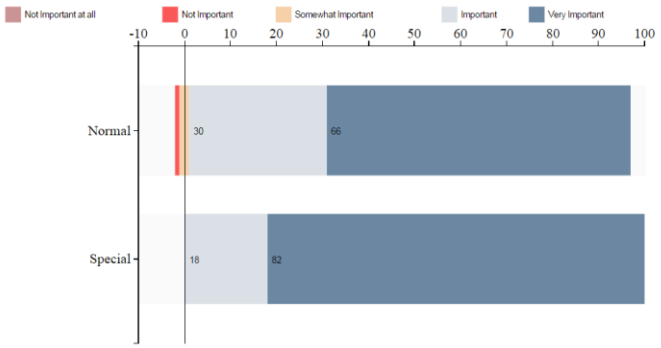



*Figure 14: Frequency (in %) of Importance for diet types*

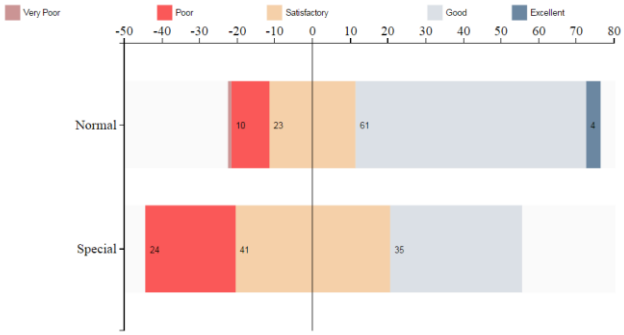



*Figure 15: Frequency (in %) of Satisfaction for diet types*

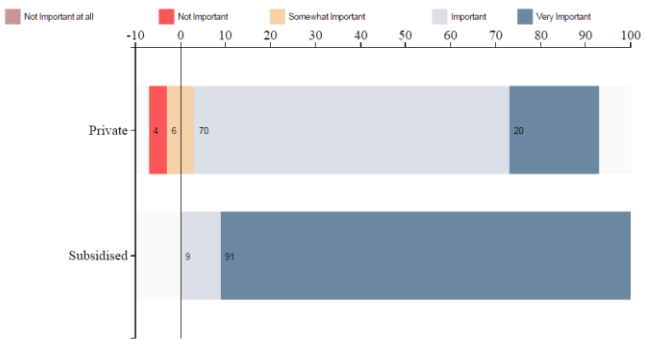



*Figure 16: Frequency (in %) of Importance for patient type*

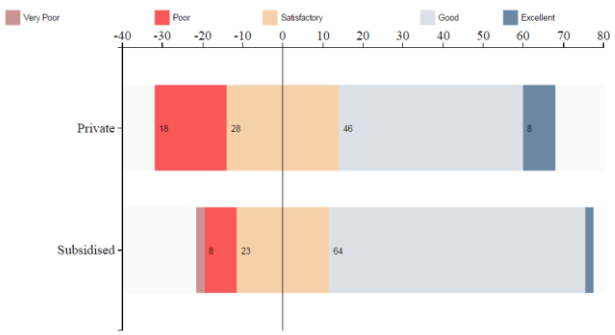



*Figure 17: Frequency (in %) of Satisfaction for patient type*

As seen from Figure 12, 14 and 16, taste of meal is an extremely important attribute for all wards, patient types and diet types. The service gap between the satisfaction and importance is a lot for the patients in Ward B1 and C. This means, NUH should look at improving the taste of the meals for the patients in these 2 wards the most as they are most dissatisfied.

As for the diet types, patients with special diet types are more dissatisfied with the taste of the meal. This may be due to the dietary restrictions of the patients. Thus, NUH needs to try and improve the taste of special diets keeping in mind the dietary requirements. They need to be more innovative with the restrictions of the diets.

On analysing the reasons, it is seen that the reason for dissatisfaction for taste is mostly because either the food is bland and tasteless or it is too oily. Thus, NUH should look into improving the taste by using these suggestions.

***Drill down to attribute "Variety of Meals in menu"***

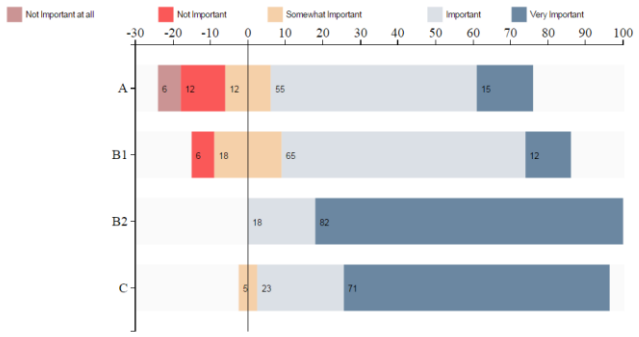



*Figure 18: Frequency (in %) of Importance for each ward*

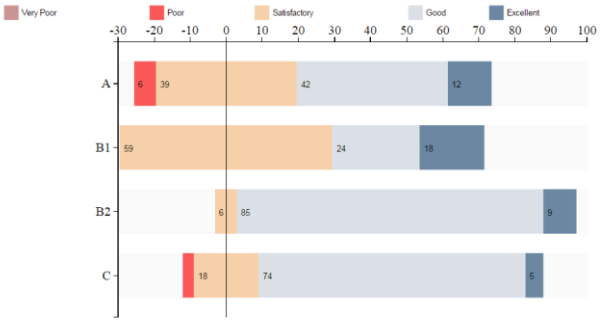



*Figure 19: Frequency (in %) of Satisfaction for each ward*

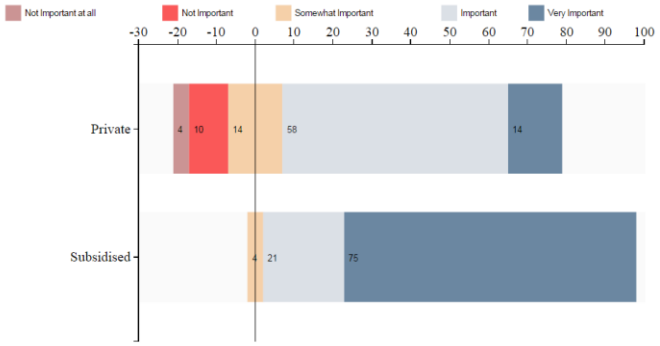



*Figure 20: Frequency (in %) of Importance for patient types*

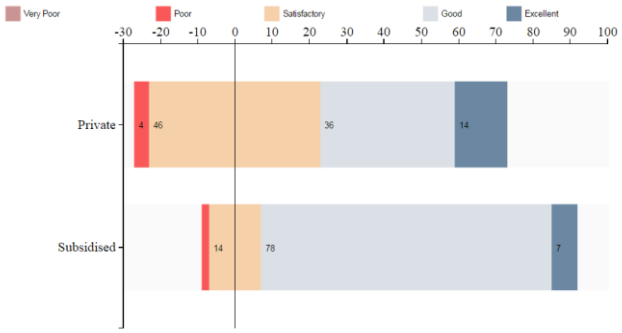



*Figure 21: Frequency (in %) of Satisfaction for patient types*

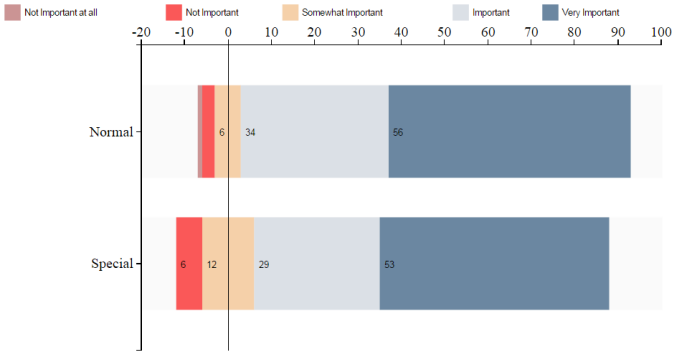



*Figure 22: Frequency (in %) of Importance for diet type*

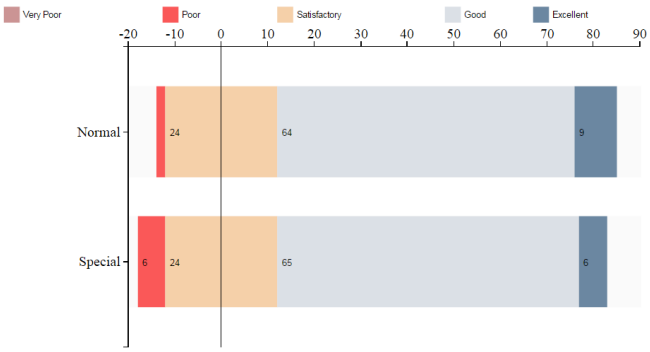


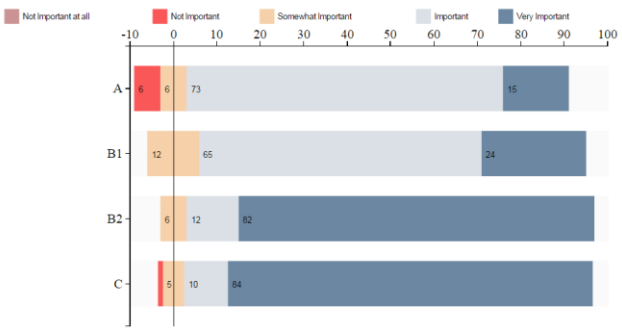

*Figure 23: Frequency (in %) of Satisfaction for diet type*

The service gap for variety is big for Subsidised patient. They seem to be dissatisfied with the variety. NUH should thus, look into increasing the variety and extending the menu for subsidised patients. Also, B1 ward class *seem* to be extremely dissatisfied with the variety too. Thus, we would suggest NUH to increase the variety of meals in the menu for subsidised patients in ward class B1. Patients with special diets also seem to be dissatisfied with the variety, but given the restrictions of their dietary requirements, it might be difficult to increase the variety of meals.

From the feedback, it is seen that patients with Indian and Muslim food preferences have most complaints on the variety. Thus, NUH should look into increasing the variety of food on the menu for these cuisines.

***Drill down to attribute "Temperature of the Food"***

After the overall view, we analyse each attribute by wards, type of patients and type of diets. This will give a more accurate view of where the improvements can be made.



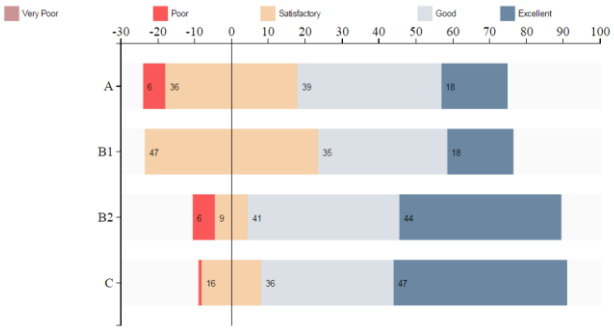



*Figure 24: Frequency (in %) of Importance for each ward*

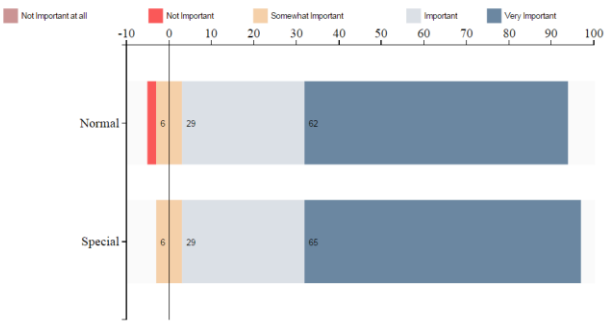



*Figure 25: Frequency (in %) of Satisfaction for each ward*

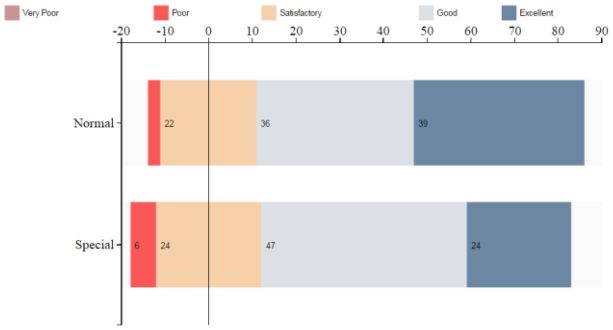



*Figure 26: Frequency (in %) of Importance by Diet types*

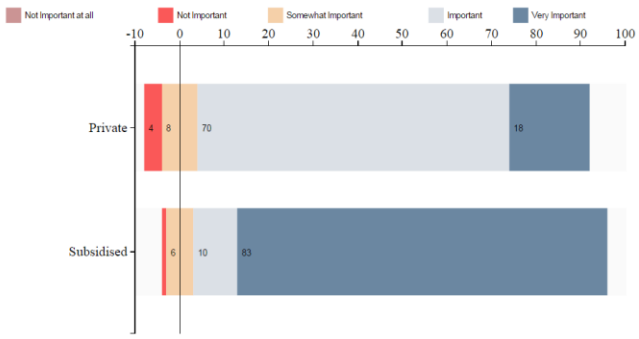



*Figure 27: Frequency (in %) of Satisfaction by Diet types*

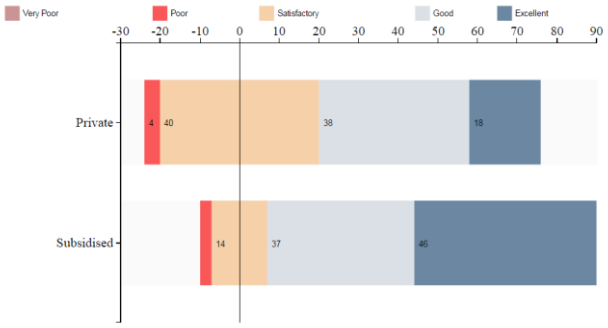



*Figure 28: Frequency (in %) of Importance by Patient types*

*Figure 29: Frequency (in %) of Satisfaction by Patient types*

As can be seen here, Temperature is a very important factor for a lot of patients. This is therefore a factor that should be definitely focused on. We found that the private patients are not satisfied with the temperature of food they receive and there is a big service gap there. Also, the patients who are served special diets are not overall satisfied with this factor, and there is definitely room for improvement. Another thing to note is that the patients in Wards A, B1 and a few even in B2 are not satisfied with the temperature. This is a good note to take as these wards need to therefore be looked after closely and ensure that the food is hot while serving. As from the feedback it is seen that most people find that the food is cold and thus, NUH should try and serve hotter meals right after they are cooked.

## References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