

Impact of Physical Health and Daily Habits on Developer Productivity

SE 611: Software Metrics

Submitted by

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1. Introduction

We gathered data on productivity, daily habits, and physical health from Bangladeshi software professionals for this research. The effect of daily routines and physical health factors on developer productivity was analysed. The GQM framework was used to perform this research. We created a questionnaire and conducted a survey to collect data. Our procedure, questionnaire, metric implementation details, and outcome analysis are all included in the sections below.

2. GQM Paradigm

We selected and deduced the questions that must be answered to assess whether the goal has been accomplished, and we decided what must be measured in order to be able to effectively answer the questions based on the purpose, perspective, and environment. We began by identifying our purpose, perspective, and surroundings in order to determine our aim.

Purpose: To analyze developer productivity.

Perspective: Examine the effectiveness from the viewpoint of the developer.

Environment: Developers' daily life and habits are not well monitored or maintained.

Goal: Analyzing developer productivity based on their daily habits and physical health attributes.

Questions

Q1. Who is the target audience?

Q2. What does productivity mean?

Q3. What are the sources of daily habits and physical health factors of the target audience?

Metrics for Q1: Who is the target audience?

- Designation
- Age
- Gender

Metrics for Q2: What does productivity mean?

- Decision Contribution
- Average Daily Working Hour
- Spontaneous Participation
- Task Satisfaction
- Interaction Willingness
- External Interaction
- Deadline Crossing Frequency
- Overtime Frequency
- Frequency of Smartphone Usage
- Frequency of Absence/Leave
- Frequency of Being Late
- Appreciation/Motivation for Colleagues
- Cheerfulness

Metrics for Q3: What are the sources of daily habits and physical health factors of the target audience?

- Average Sleep Duration
- Height
- Weight
- Average Sleep Starting Time
- Average Breakfast Time
- Average Lunch Time
- Average Dinner Time
- Frequency of Physical Exercise
- Sitting Time

- Resting Time
- Frequency of Sickness
- Frequency of Smoking Habit
- Frequency of Vegetables in Diet
- Frequency of Sugar in Diet
- Frequency of Fast Food in Diet

3. Questionnaire Preparation and Data Collection

We created a survey questionnaire to collect data from Bangladeshi software experts after establishing the Goal, Questions, and Metrics. We collected data on the average daily working hour, contribution in managerial decisions, spontaneous participation in team works, satisfaction with task accomplishment, interaction willingness in project related work, interaction with other office team members, interaction with colleagues outside work needs, and personal information sharing, impact of informal information sharing on personal life, appreciation from teammates, frequency of crossing deadlines, overtime frequency, office time flexibility and cheerfulness, so that we can determine the derived productivity from all these factors.. We also gathered information on their job title, age, gender, and email address. Likert scale data was used to collect data on productivity, daily habits, and physical health.

A sample question is given here:

Question: How frequently do you contribute to any kind of managerial decision?

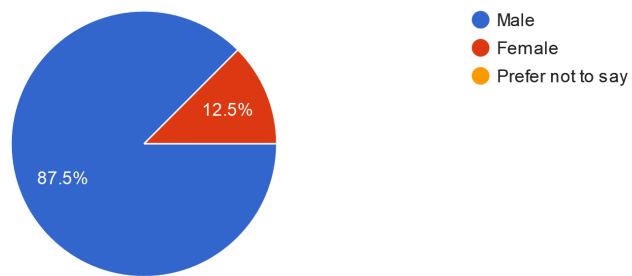
Options:

- Never
- Rarely
- Sometimes
- Often
- Always

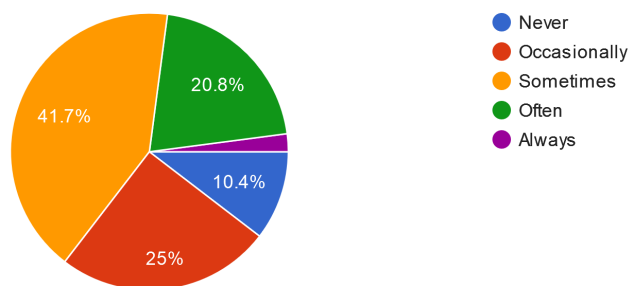
4. Data Visualization

In this section, the summary of the collected data is represented with pie charts.

Gender
48 responses

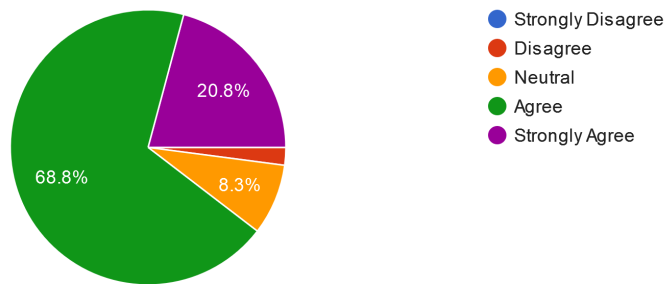


How frequently do you contribute to any kind of managerial decision?
48 responses



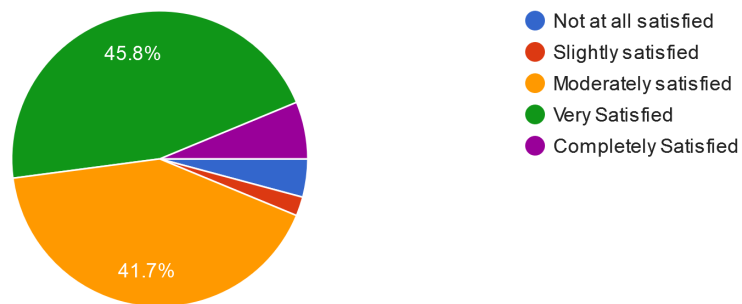
You spontaneously participate in team works.

48 responses



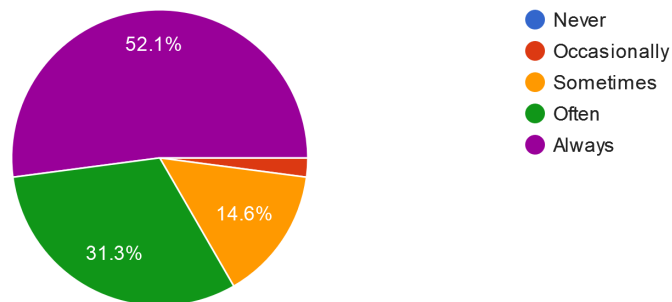
How much satisfied are you with your task accomplishments?

48 responses



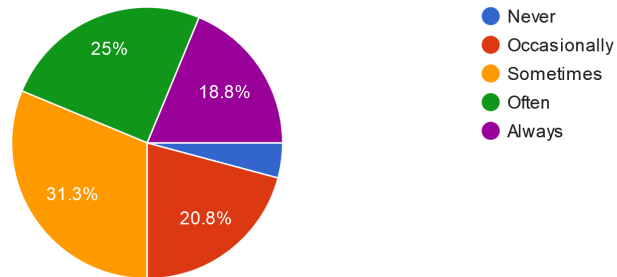
How often do you willingly interact with your colleagues for project related work?

48 responses



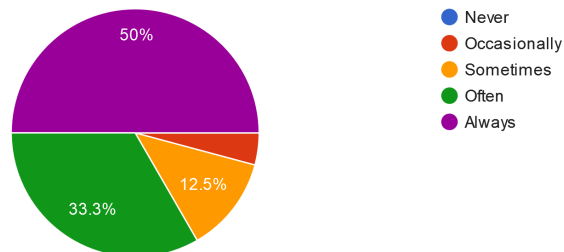
How often do you interact with other team members of the office? (other than your own teammates)

48 responses



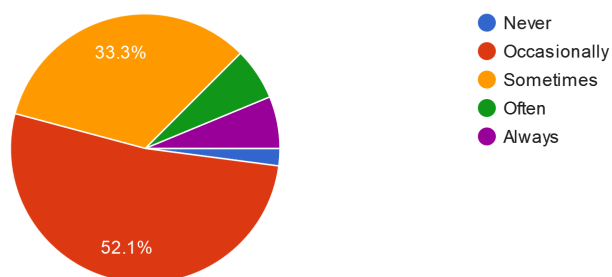
How often do you appreciate/motivate/help your colleagues?

48 responses



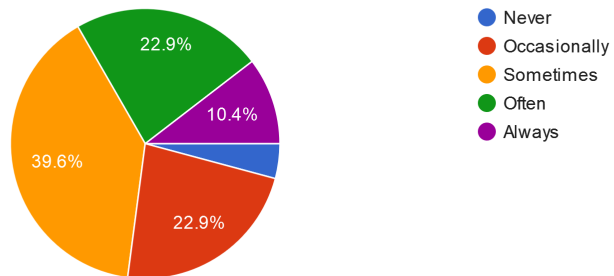
How often do you cross your deadline?

48 responses



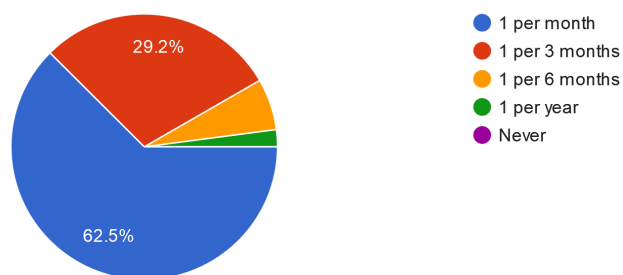
How often do you work overtime to reach your deadline?

48 responses



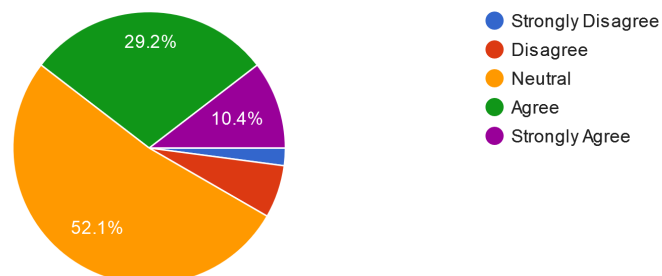
How often do you take leave?

48 responses



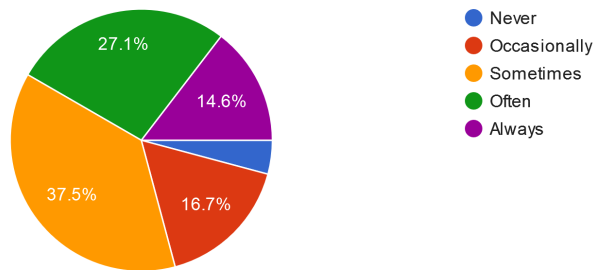
You feel cheerful while working.

48 responses



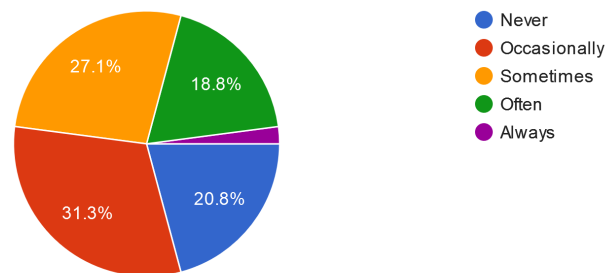
How often do you use smartphone while working?

48 responses



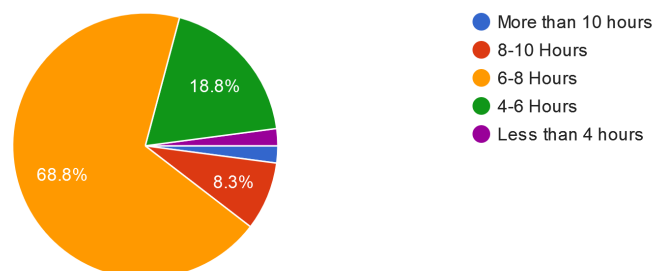
How often are you late to start your daily work?

48 responses



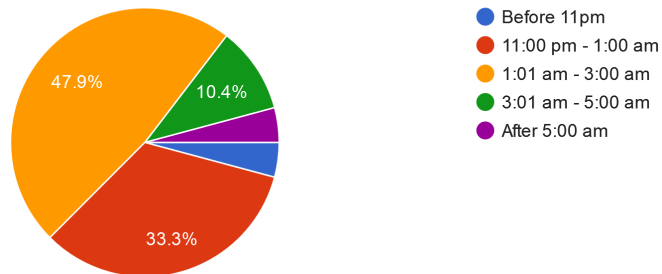
Average Sleep Duration

48 responses



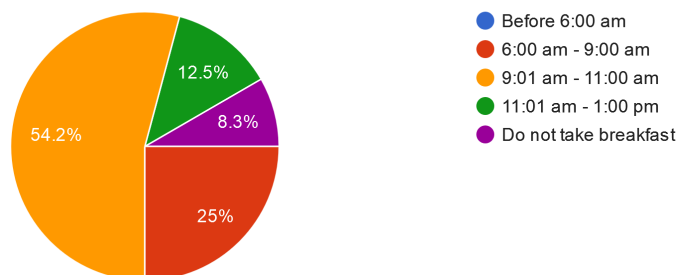
Average Sleep Starting Time

48 responses



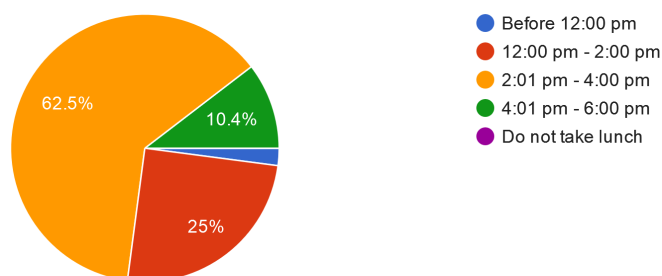
Average Breakfast Time

48 responses



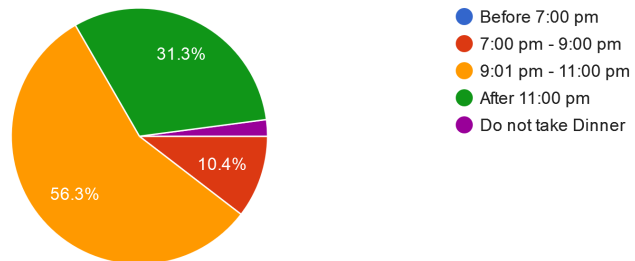
Average Lunch Time

48 responses



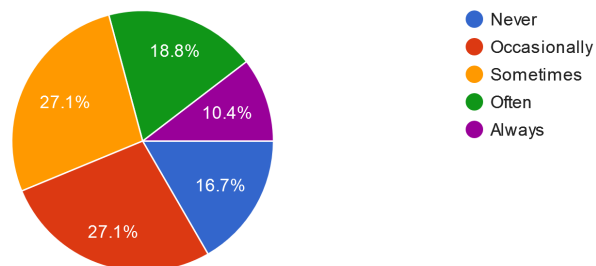
Average Dinner Time

48 responses



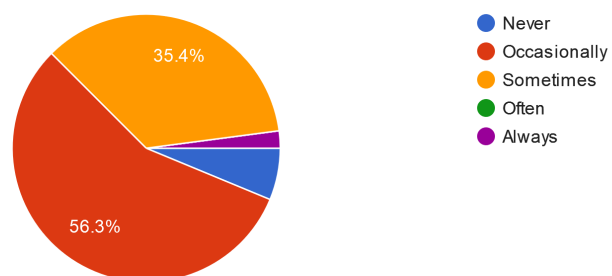
How frequently do you perform physical exercises?

48 responses



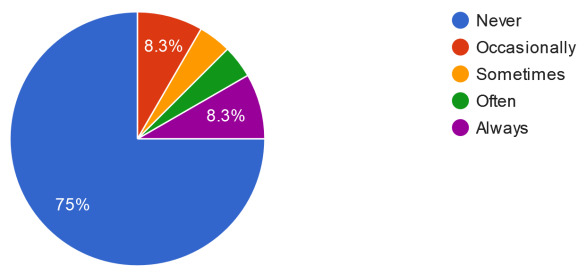
How often do you fall sick?

48 responses



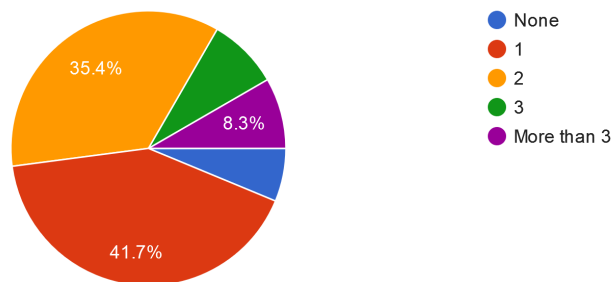
How often do you smoke?

48 responses



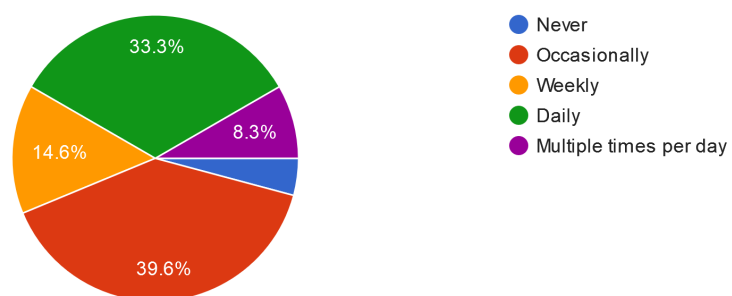
Number of serving of vegetables in your diet (per day)

48 responses



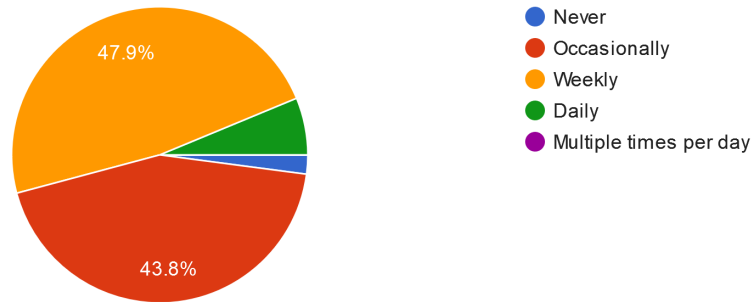
How often do you take sugar or sweet food? (e.g: coke, sweets etc.)

48 responses



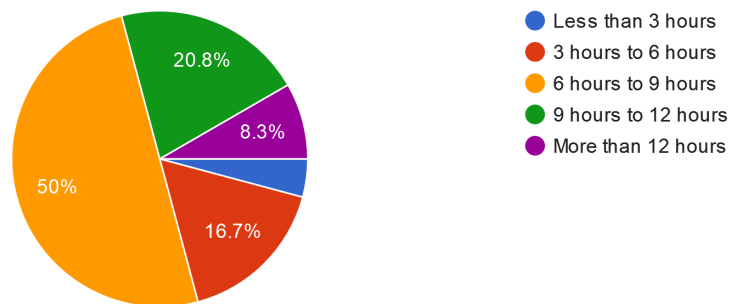
How often do you take fast food?

48 responses



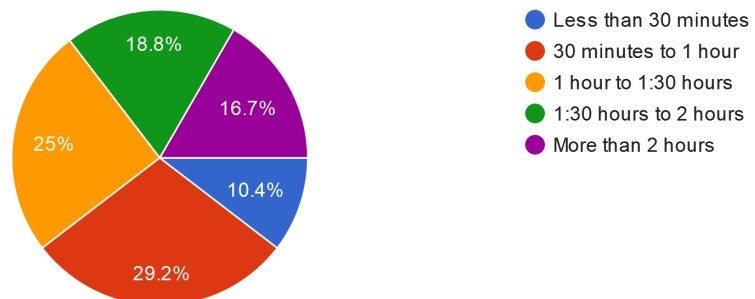
Average Sitting Time Per Day

48 responses



Average Resting Time Per Day (outside sleep)

48 responses



5. Metric Implementation

5.1 Data Preprocessing

We pre-processed and cleaned the data and changed the column names for handling easily. We collected data from 48 respondents. We discarded the timestamp and email from the data. The average working hour of the respondents was 7/8 hours. As there was no significant difference between their working hours, we discarded this data during our analysis. We have also derived BMI (Body Mass Index) from height and weight of the respondents.

5.2 Encoding

Most data were in the form of likert scale. We encoded the likert scale data in a scale of 1 to 5. A sample encoding is given here-

```
{'Never': 1, 'Occasionally': 2, 'Sometimes':3, 'Often':4, 'Always':5}
```

In case of data related to daily habits, we followed some research about optimum values for sleep duration, sleep time, breakfast time, lunch time and dinner time. We encoded the data in a way so that the most optimum value is assigned with the value 5 and the least optimum value is assigned the value 1.

Like for “Average Sleep Starting Time” we have encoded the data like this:

```
{'After 5:00 am': 1, '3:01 am - 5:00 am': 2, '1:01 am - 3:00 am':3, '11:00 pm - 1:00 am':4, 'Before 11pm':5}
```

5.3 Correlation Analysis

We examined the correlation between productivity and physical health and daily habits related factors. We used spearman correlation, because the spearman rank correlation test does not assume any assumptions about the distribution of the data and is the appropriate correlation analysis when the variables are measured on a scale that is at least ordinal. We prepared correlation heatmap for better interpretation and identified the productivity factor - daily habits, physical health factor pairs with a statistically significant correlation.

Daily Habits and Physical Health Related Factors	Productivity Related Factors
<ul style="list-style-type: none"> • Average Sleep Duration • BMI • Average Sleep Starting Time • Average Breakfast Time • Average Lunch Time • Average Dinner Time • Frequency of Physical Exercise • Sitting Time • Resting Time • Frequency of Sickness • Frequency of Smoking Habit • Frequency of Vegetables in Diet • Frequency of Sugar in Diet • Frequency of Fast Food in Diet 	<ul style="list-style-type: none"> • Cheerfulness • Decision Contribution • Spontaneous Participation • Task Satisfaction • Interaction Willingness • External Interaction • Deadline Crossing Frequency • Overtime Frequency • Frequency of Smartphone Usage • Frequency of Absence/Leave • Frequency of Being Late • Appreciation/Motivation for Colleagues

5.4 Bar Charts

For the productivity factor - physical health and daily habit's factors paired with a statistically significant correlation, we prepared bar charts showing the relationship between them. From the bar charts, we analyzed the nature of their relationship.

5.5 Used Tools and Libraries

We used pandas, numpy, matplotlib and seaborn for dataframe manipulation, data analysis and data visualization.

6. Result Analysis and Interpretation

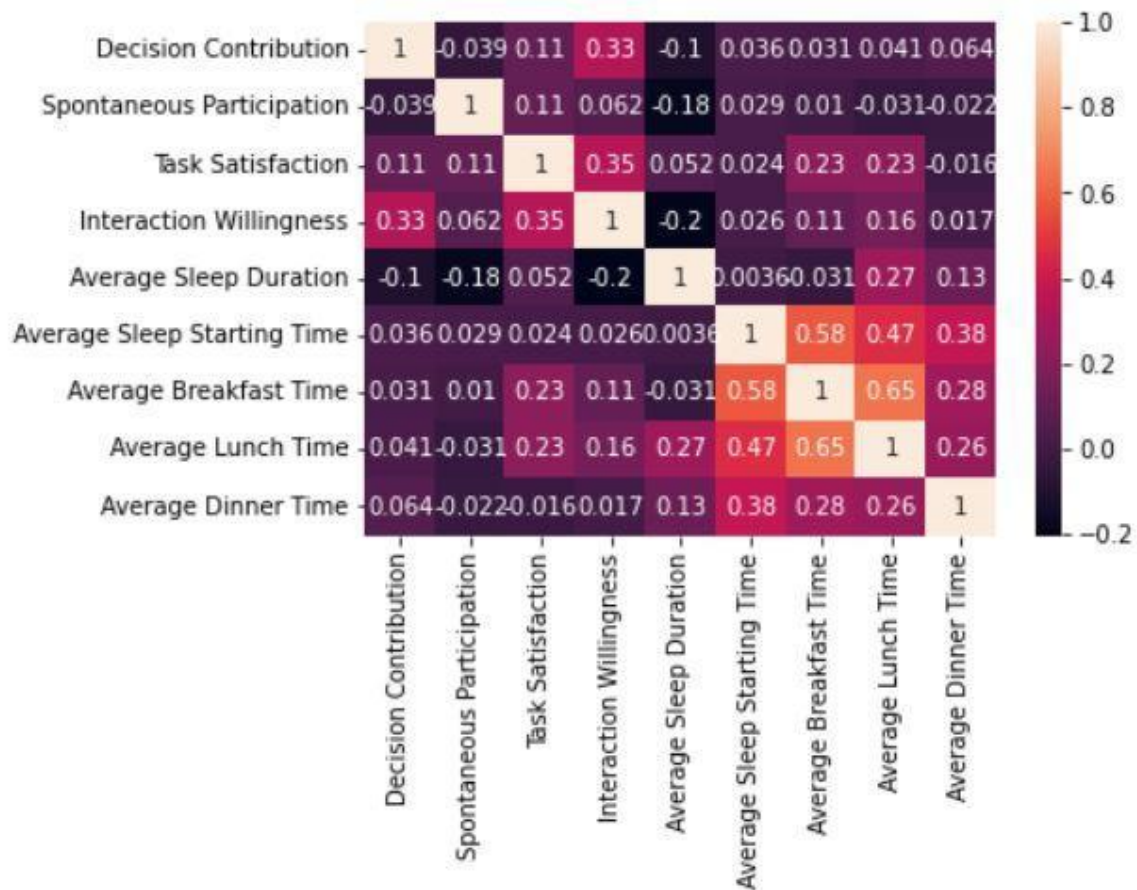
The result analysis from the correlation heatmap and bar charts are given in the following sections.

6.1 Correlation Heatmap

To determine if the correlation between a productivity factor - recreation factor pair is statistically significant, we referred to the Spearman rank correlation table of critical values, which shows the critical values associated with various sample sizes (n) and significance levels (α). In our example, our sample size was $n = 48$. Using a significance level of 0.1, we found that the critical value is **0.188**. If the absolute value of the correlation coefficient between two factors is greater than the critical value in the table, then we can say that the correlation is statistically significant.

Code for the heatmap generation can be found here:

<https://github.com/bsse1006/ImpactOfPhysicalFitnessOnDeveloperProductivity/blob/main/heatmap.ipynb>

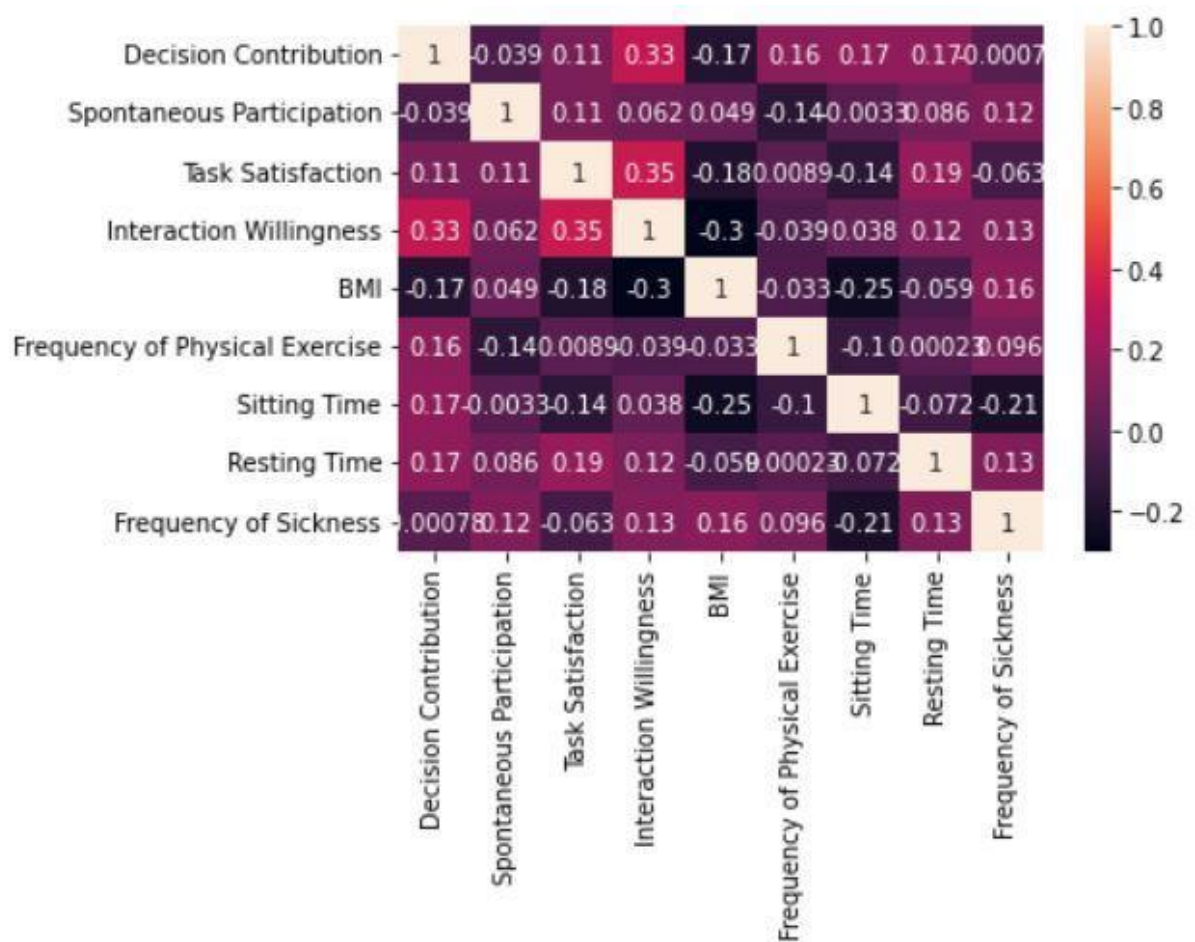


Here, we can see that,

- I. Decision contribution and Average Sleep Duration has no statistically significant correlation (coefficient = $|-0.1| < \text{critical value } 0.188$)
- II. Decision contribution and Average Sleep Starting time has no statistically significant correlation (coefficient = $|0.036| < \text{critical value } 0.188$)
- III. Decision contribution and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.031| < \text{critical value } 0.188$)
- IV. Decision contribution and Average Lunch time has no statistically significant correlation (coefficient = $|0.041| < \text{critical value } 0.188$)
- V. Decision contribution and Average Dinner Time has no statistically significant correlation (coefficient = $|0.064| < \text{critical value } 0.188$)

- VI. Spontaneous Participation and Average Sleep Duration has no statistically significant correlation (coefficient = $|-0.18| < \text{critical value } 0.188$)
- VII. Spontaneous Participation and Average Sleep Starting Time has no statistically significant correlation (coefficient = $|0.029| < \text{critical value } 0.188$)
- VIII. Spontaneous Participation and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.01| < \text{critical value } 0.188$)
- IX. Spontaneous Participation and Average Lunch Time has no statistically significant correlation (coefficient = $|-0.031| < \text{critical value } 0.188$)
- X. Spontaneous Participation and Average Dinner Time has no statistically significant correlation (coefficient = $|-0.022| < \text{critical value } 0.188$)
- XI. Task Satisfaction and Average Sleep Duration has no statistically significant correlation (coefficient = $|0.052| < \text{critical value } 0.188$)
- XII. Task Satisfaction and Average Sleep Starting Time has no statistically significant correlation (coefficient = $|0.024| < \text{critical value } 0.188$)
- XIII. **Task Satisfaction and Average Breakfast Time has statistically positive correlation (coefficient = $|0.23| > \text{critical value } 0.188$)**
- XIV. **Task Satisfaction and Average Lunch Time has statistically positive correlation (coefficient = $|0.23| > \text{critical value } 0.188$)**
- XV. Task Satisfaction and Average Dinner Time has no statistically significant correlation (coefficient = $|-0.016| < \text{critical value } 0.188$)
- XVI. **Interaction Willingness and Average Sleep Duration has statistically negative correlation (coefficient = $|-0.2| > \text{critical value } 0.188$)**
- XVII. Interaction Willingness and Average Sleep Starting Time has no statistically significant correlation (coefficient = $|0.026| < \text{critical value } 0.188$)

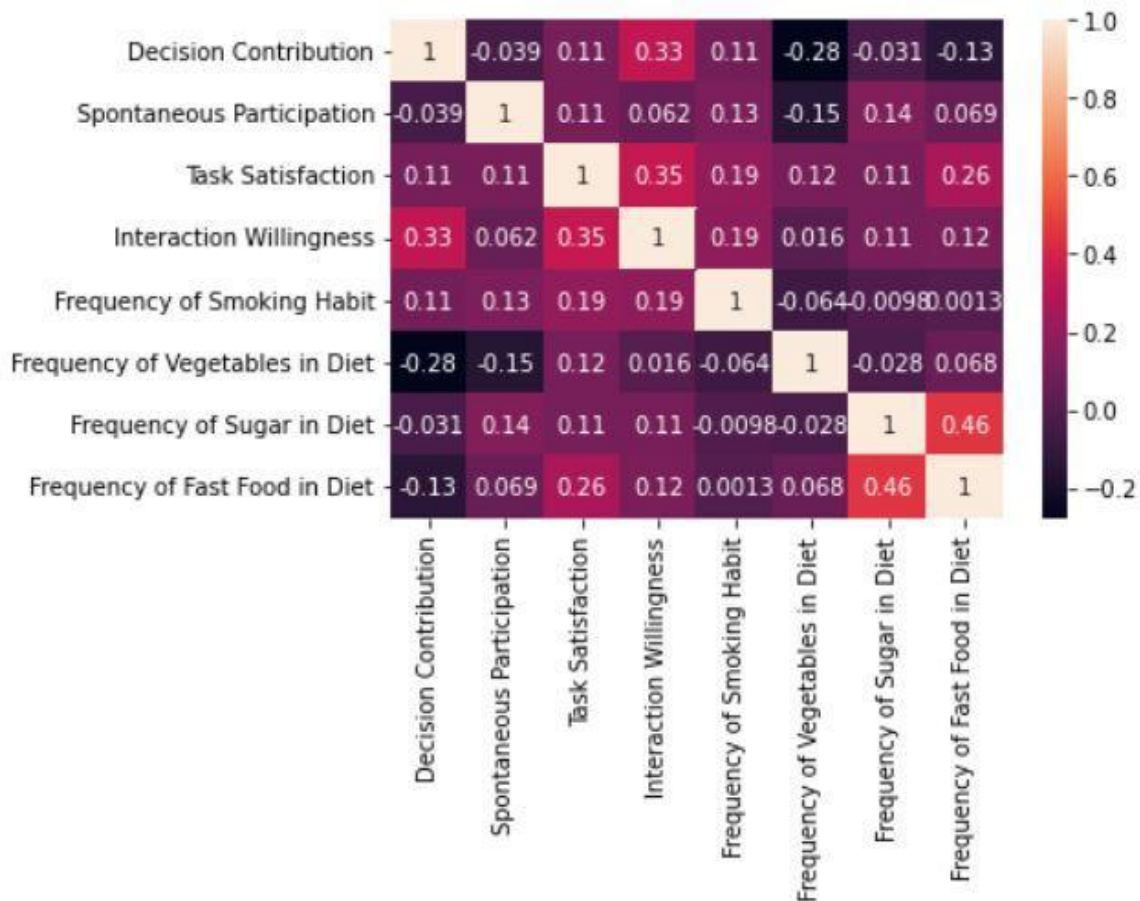
- XVIII. Interaction Willingness and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.11| < \text{critical value } 0.188$)
- XIX. Interaction Willingness and Average Lunch Time has no statistically significant correlation (coefficient = $|0.16| < \text{critical value } 0.188$)
- XX. Interaction Willingness and Average Dinner Time has no statistically significant correlation (coefficient = $|0.017| < \text{critical value } 0.188$)



Here, we can see that,

- I. Decision contribution and BMI has no statistically significant correlation (coefficient = $|-0.17| < \text{critical value } 0.188$)
- II. Decision contribution and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|0.16| < \text{critical value } 0.188$)
- III. Decision contribution and Sitting Time has no statistically significant correlation (coefficient = $|0.17| < \text{critical value } 0.188$)
- IV. Decision contribution and Resting time has no statistically significant correlation (coefficient = $|0.17| < \text{critical value } 0.188$)
- V. Decision contribution and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.0007| < \text{critical value } 0.188$)
- VI. Spontaneous Participation and BMI has no statistically significant correlation (coefficient = $|0.049| < \text{critical value } 0.188$)
- VII. Spontaneous Participation and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|-0.14| < \text{critical value } 0.188$)
- VIII. Spontaneous Participation and Sitting Time has no statistically significant correlation (coefficient = $|0.003| < \text{critical value } 0.188$)
- IX. Spontaneous Participation and Resting time has no statistically significant correlation (coefficient = $|0.086| < \text{critical value } 0.188$)
- X. Spontaneous Participation and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.12| < \text{critical value } 0.188$)
- XI. Task Satisfaction and BMI has no statistically significant correlation (coefficient = $|-0.18| < \text{critical value } 0.188$)

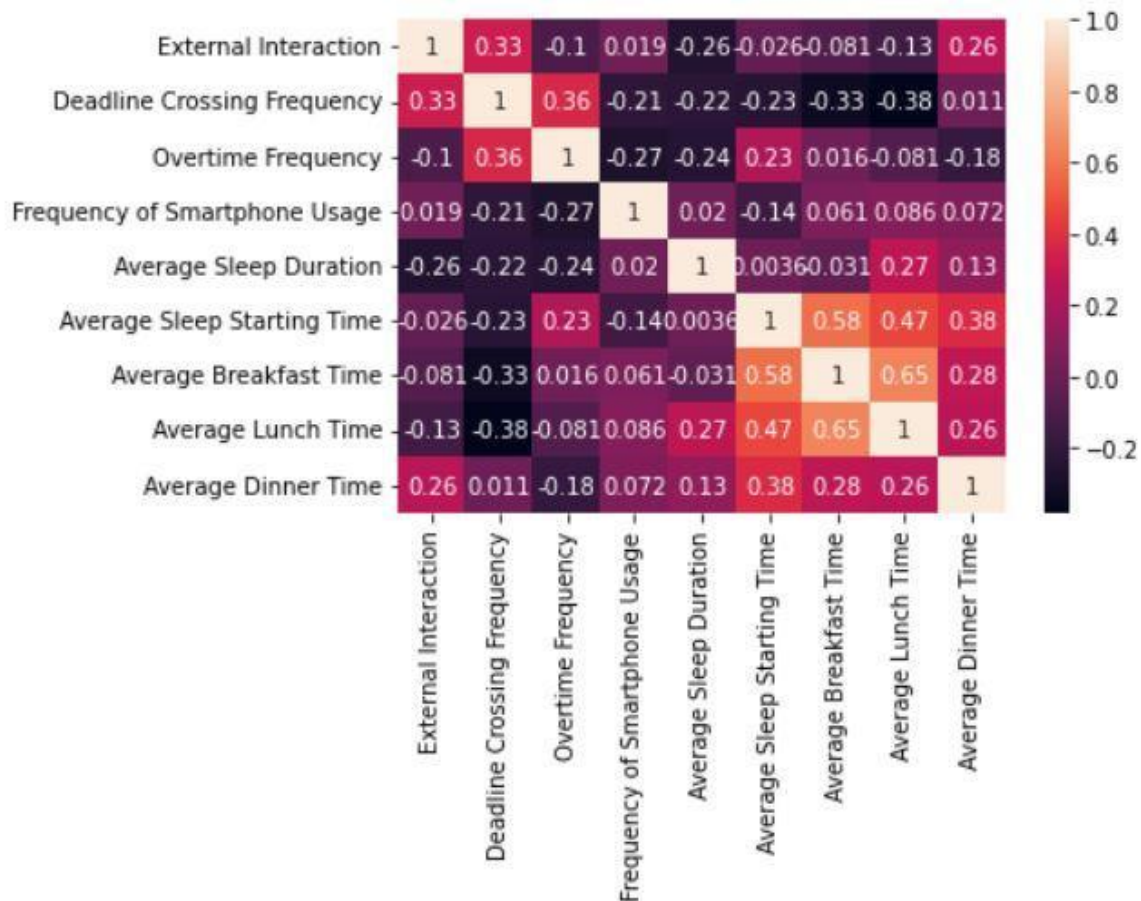
- XII. Task Satisfaction and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|0.008| < \text{critical value } 0.188$)
- XIII. Task Satisfaction and Sitting Time has no statistically significant correlation (coefficient = $|-0.14| < \text{critical value } 0.188$)
- XIV. Task Satisfaction and Resting time has statistically positive correlation (coefficient = $|0.19| > \text{critical value } 0.188$)**
- XV. Task Satisfaction and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.063| < \text{critical value } 0.188$)
- XVI. Interaction Willingness and BMI has statistically negative correlation (coefficient = $|-0.3| < \text{critical value } 0.188$)**
- XVII. Interaction Willingness and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|0.039| < \text{critical value } 0.188$)
- XVIII. Interaction Willingness and Sitting Time has no statistically significant correlation (coefficient = $|0.038| < \text{critical value } 0.188$)
- XIX. Interaction Willingness and Resting time has no statistically significant correlation (coefficient = $|0.12| < \text{critical value } 0.188$)
- XX. Interaction Willingness and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.13| < \text{critical value } 0.188$)



Here, we can see that,

- I. Decision contribution and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|-0.11| < \text{critical value } 0.188$)
- II. **Decision contribution and Frequency of Vegetables in Diet has statistically negative correlation (coefficient = $|-0.28| > \text{critical value } 0.188$)**
- III. Decision contribution and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|-0.031| < \text{critical value } 0.188$)
- IV. Decision contribution and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|-0.13| < \text{critical value } 0.188$)

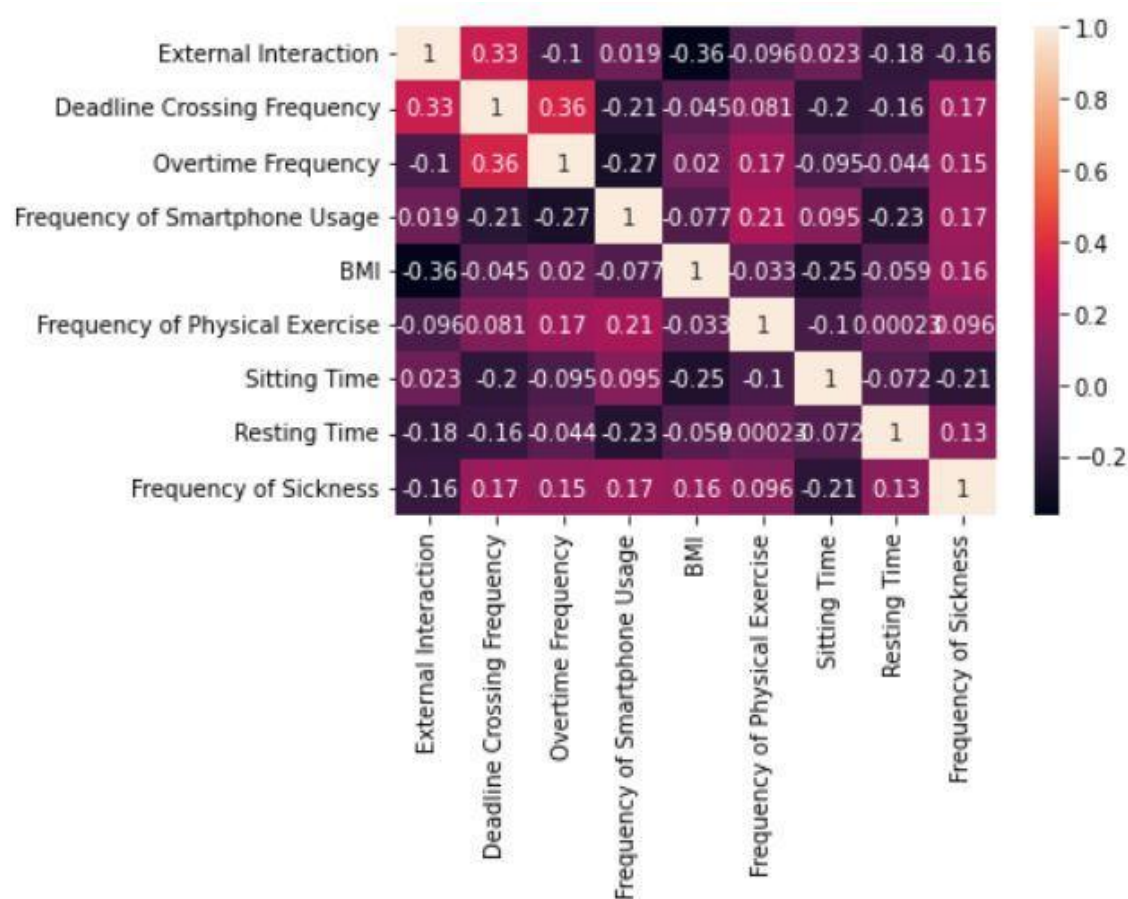
- V. Spontaneous Participation and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.13| < \text{critical value } 0.188$)
- VI. Spontaneous Participation and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|-0.15| < \text{critical value } 0.188$)
- VII. Spontaneous Participation and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|0.14| < \text{critical value } 0.188$)
- VIII. Spontaneous Participation and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.069| < \text{critical value } 0.188$)
- IX. Task Satisfaction and Frequency of Smoking Habit has statistically positive correlation (coefficient = $|0.19| > \text{critical value } 0.188$)**
- X. Task Satisfaction and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.12| < \text{critical value } 0.188$)
- XI. Task Satisfaction and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|0.11| < \text{critical value } 0.188$)
- XII. Task Satisfaction and Frequency of Fast Food in Diet has statistically positive correlation (coefficient = $|0.26| > \text{critical value } 0.188$)**
- XIII. Interaction Willingness and Frequency of Smoking Habit has statistically positive correlation (coefficient = $|0.19| > \text{critical value } 0.188$)**
- XIV. Interaction Willingness and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.016| < \text{critical value } 0.188$)
- XV. Interaction Willingness and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|0.11| < \text{critical value } 0.188$)
- XVI. Interaction Willingness and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.12| < \text{critical value } 0.188$)



Here, we can see that,

- I. **External Interaction and Average Sleep Duration has statistically negative correlation (coefficient = $|-0.26| > \text{critical value } 0.188$)**
- II. External Interaction and Average Sleep Starting time has no statistically significant correlation (coefficient = $|-0.026| < \text{critical value } 0.188$)
- III. External Interaction and Average Breakfast Time has no statistically significant correlation (coefficient = $|-0.081| < \text{critical value } 0.188$)
- IV. External Interaction and Average Lunch time has no statistically significant correlation (coefficient = $|-0.13| < \text{critical value } 0.188$)
- V. **External Interaction and Average Dinner Time has statistically positive correlation (coefficient = $|0.26| > \text{critical value } 0.188$)**
- VI. **Deadline Crossing Frequency and Average Sleep Duration has statistically negative correlation (coefficient = $|-0.22| > \text{critical value } 0.188$)**
- VII. **Deadline Crossing Frequency and Average Sleep Starting time has statistically negative significant correlation (coefficient = $|-0.23| > \text{critical value } 0.188$)**

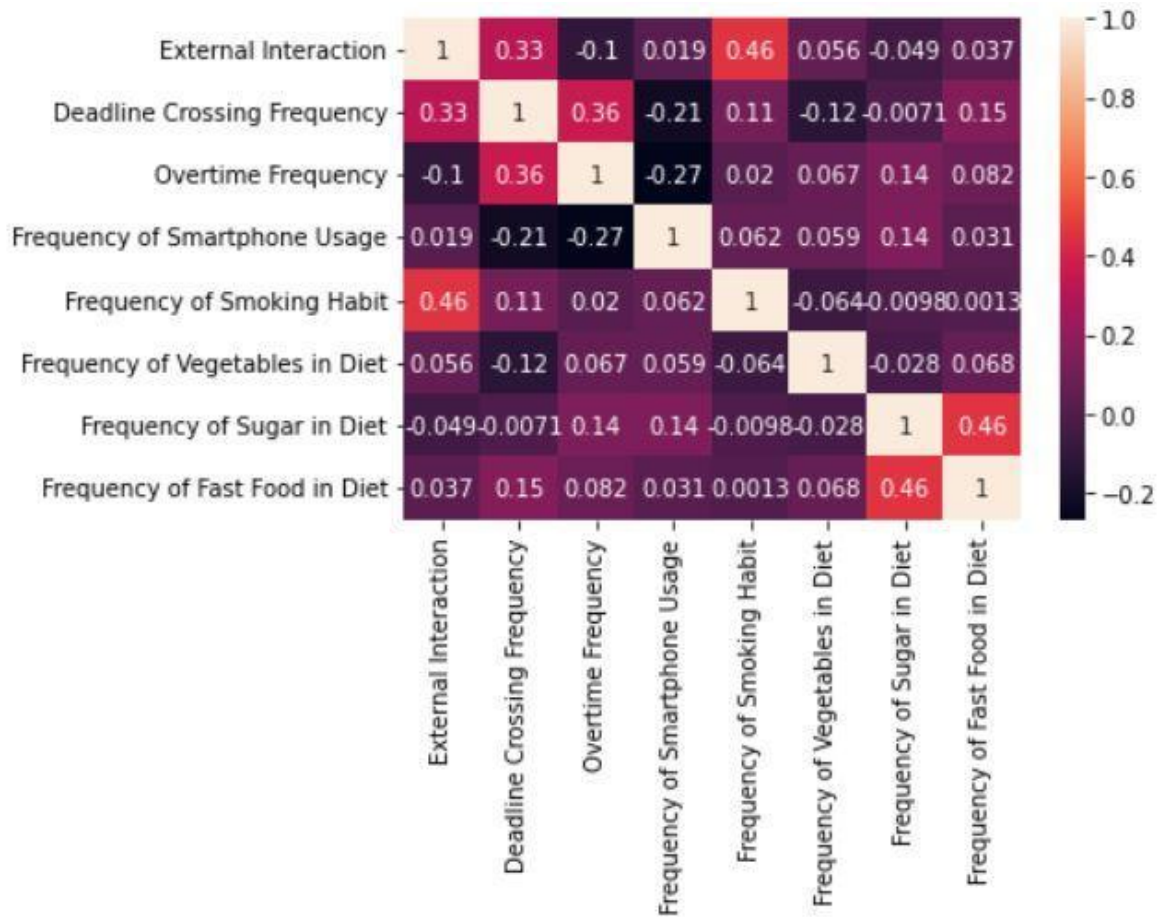
- VIII. **Deadline Crossing Frequency and Average Breakfast Time has statistically negative significant correlation (coefficient = $|-0.33| > \text{critical value } 0.188$)**
- IX. **Deadline Crossing Frequency and Average Lunch time has statistically negative significant correlation (coefficient = $|-0.38| > \text{critical value } 0.188$)**
- X. Deadline Crossing Frequency and Average Dinner Time has no statistically significant correlation (coefficient = $|0.011| < \text{critical value } 0.188$)
- XI. **Overtime Frequency and Average Sleep Duration has statistically significant negative correlation (coefficient = $|-0.24| > \text{critical value } 0.188$)**
- XII. **Overtime Frequency and Average Sleep Starting time has statistically significant positive correlation (coefficient = $|0.23| > \text{critical value } 0.188$)**
- XIII. Overtime Frequency and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.016| < \text{critical value } 0.188$)
- XIV. Overtime Frequency and Average Lunch time has no statistically significant correlation (coefficient = $|-0.081| < \text{critical value } 0.188$)
- XV. Overtime Frequency and Average Dinner Time has no statistically significant correlation (coefficient = $|-0.18| < \text{critical value } 0.188$)
- XVI. Frequency of Smartphone Usage (During work) and Average Sleep Duration has no statistically significant correlation (coefficient = $|0.02| < \text{critical value } 0.188$)
- XVII. Frequency of Smartphone Usage(During work) and Average Sleep Starting time has no statistically significant correlation (coefficient = $|-0.14| < \text{critical value } 0.188$)
- XVIII. Frequency of Smartphone Usage(During work) and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.061| < \text{critical value } 0.188$)
- XIX. Frequency of Smartphone Usage(During work) and Average Lunch time has no statistically significant correlation (coefficient = $|0.086| < \text{critical value } 0.188$)
- XX. Frequency of Smartphone Usage(During work) and Average Dinner Time has no statistically significant correlation (coefficient = $|0.072| < \text{critical value } 0.188$)



Here, we can see that,

- I. **External Interaction and BMI has statistically negative correlation (coefficient = $|-0.36| > \text{critical value } 0.188$)**
- II. External Interaction and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|-0.096| < \text{critical value } 0.188$)
- III. External Interaction and Sitting Time has no statistically significant correlation (coefficient = $|0.023| < \text{critical value } 0.188$)
- IV. External Interaction and Resting Time has no statistically significant correlation (coefficient = $|-0.18| < \text{critical value } 0.188$)
- V. External Interaction and Frequency of Sickness has no statistically significant correlation (coefficient = $|-0.16| < \text{critical value } 0.188$)
- VI. Deadline Crossing Frequency and BMI has no statistically significant correlation (coefficient = $|-0.045| < \text{critical value } 0.188$)
- VII. Deadline Crossing Frequency and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|0.081| < \text{critical value } 0.188$)

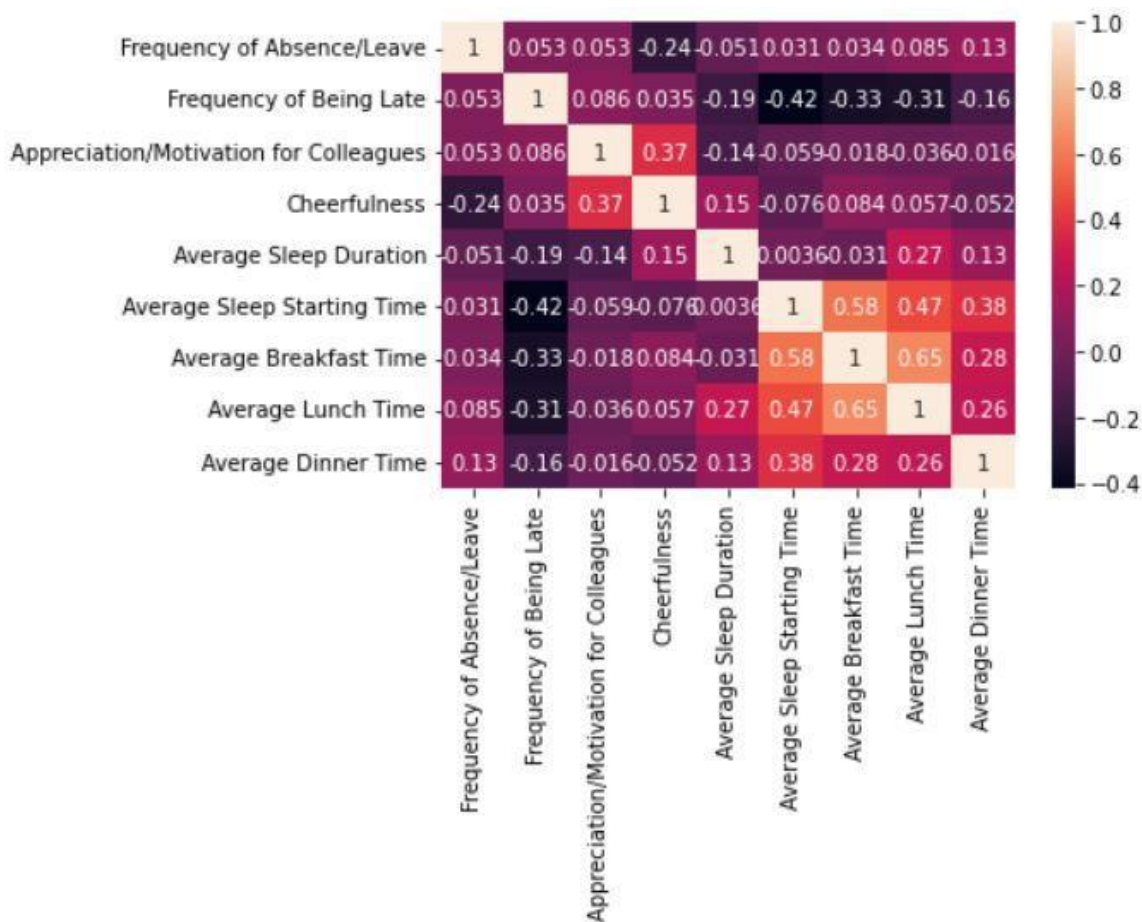
- VIII. Deadline Crossing Frequency and Sitting Time has statistically negative correlation (coefficient = $|-0.2| > \text{critical value } 0.188$)**
- IX. Deadline Crossing Frequency and Resting Time has no statistically significant correlation (coefficient = $|-0.16| < \text{critical value } 0.188$)
- X. Deadline Crossing Frequency and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.17| < \text{critical value } 0.188$)
- XI. Overtime Frequency and BMI has no statistically significant correlation (coefficient = $|0.02| < \text{critical value } 0.188$)
- XII. Overtime Frequency and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|0.17| < \text{critical value } 0.188$)
- XIII. Overtime Frequency and Sitting Time has no statistically significant correlation (coefficient = $|-0.095| < \text{critical value } 0.188$)
- XIV. Overtime Frequency and Resting Time has no statistically significant correlation (coefficient = $|-0.044| < \text{critical value } 0.188$)
- XV. Overtime Frequency and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.15| < \text{critical value } 0.188$)
- XVI. Frequency of Smartphone Usage and BMI has no statistically significant correlation (coefficient = $|-0.077| < \text{critical value } 0.188$)
- XVII. Frequency of Smartphone Usage and Frequency of Physical Exercise has statistically positive correlation (coefficient = $|0.21| > \text{critical value } 0.188$)**
- XVIII. Frequency of Smartphone Usage and Sitting Time has no statistically significant correlation (coefficient = $|0.095| < \text{critical value } 0.188$)
- XIX. Frequency of Smartphone Usage(During work) and Resting Time has statistically negative correlation (coefficient = $|-0.23| > \text{critical value } 0.188$)**
- XX. Frequency of Smartphone Usage(During work) and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.17| < \text{critical value } 0.188$)



Here, we can see that,

- I. **External Interaction and Frequency of Smoking Habit has statistically positive correlation (coefficient = $|0.46| > \text{critical value } 0.188$)**
- II. External Interaction and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.056| < \text{critical value } 0.188$)
- III. External Interaction and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|-0.049| < \text{critical value } 0.188$)
- IV. External Interaction and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.037| < \text{critical value } 0.188$)

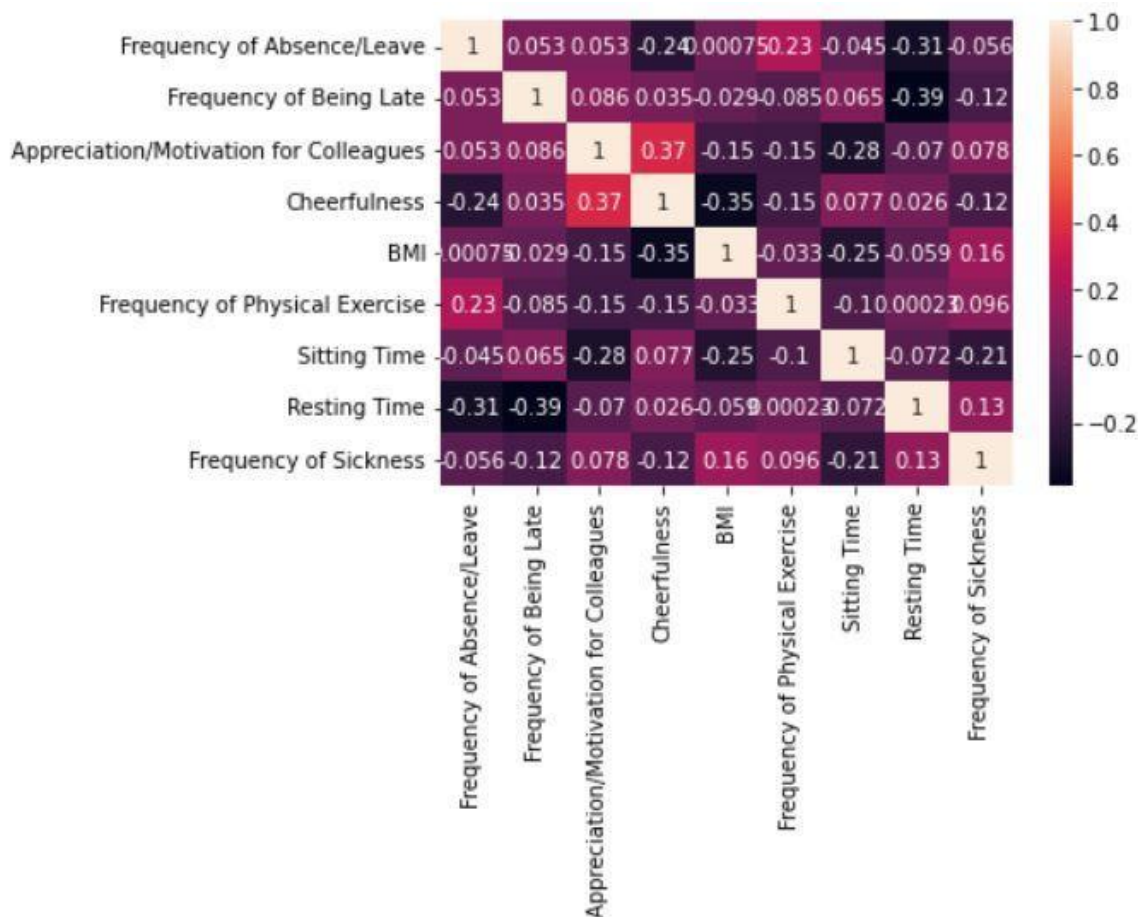
- V. Deadline Crossing Frequency and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.11| < \text{critical value } 0.188$)
- VI. Deadline Crossing Frequency and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|-0.12| < \text{critical value } 0.188$)
- VII. Deadline Crossing Frequency and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|-0.0071| < \text{critical value } 0.188$)
- VIII. Deadline Crossing Frequency and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.15| < \text{critical value } 0.188$)
- IX. Overtime Frequency and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.02| < \text{critical value } 0.188$)
- X. Overtime Frequency and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.067| < \text{critical value } 0.188$)
- XI. Overtime Frequency and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|0.14| < \text{critical value } 0.188$)
- XII. Overtime Frequency and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.082| < \text{critical value } 0.188$)
- XIII. Frequency of Smartphone Usage and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.062| < \text{critical value } 0.188$)
- XIV. Frequency of Smartphone Usage and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.059| < \text{critical value } 0.188$)
- XV. Frequency of Smartphone Usage and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|0.14| < \text{critical value } 0.188$)
- XVI. Frequency of Smartphone Usage and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.031| < \text{critical value } 0.188$)



Here, we can see that,

- I. Frequency of Absence/Leave and Average Sleep Duration has no statistically significant correlation (coefficient = $|-0.051| < \text{critical value } 0.188$)
- II. Frequency of Absence/Leave and Average Sleep Starting time has no statistically significant correlation (coefficient = $|0.031| < \text{critical value } 0.188$)
- III. Frequency of Absence/Leave and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.034| < \text{critical value } 0.188$)
- IV. Frequency of Absence/Leave and Average Lunch time has no statistically significant correlation (coefficient = $|0.085| < \text{critical value } 0.188$)
- V. Frequency of Absence/Leave and Average Dinner Time has no statistically significant correlation (coefficient = $|0.13| < \text{critical value } 0.188$)

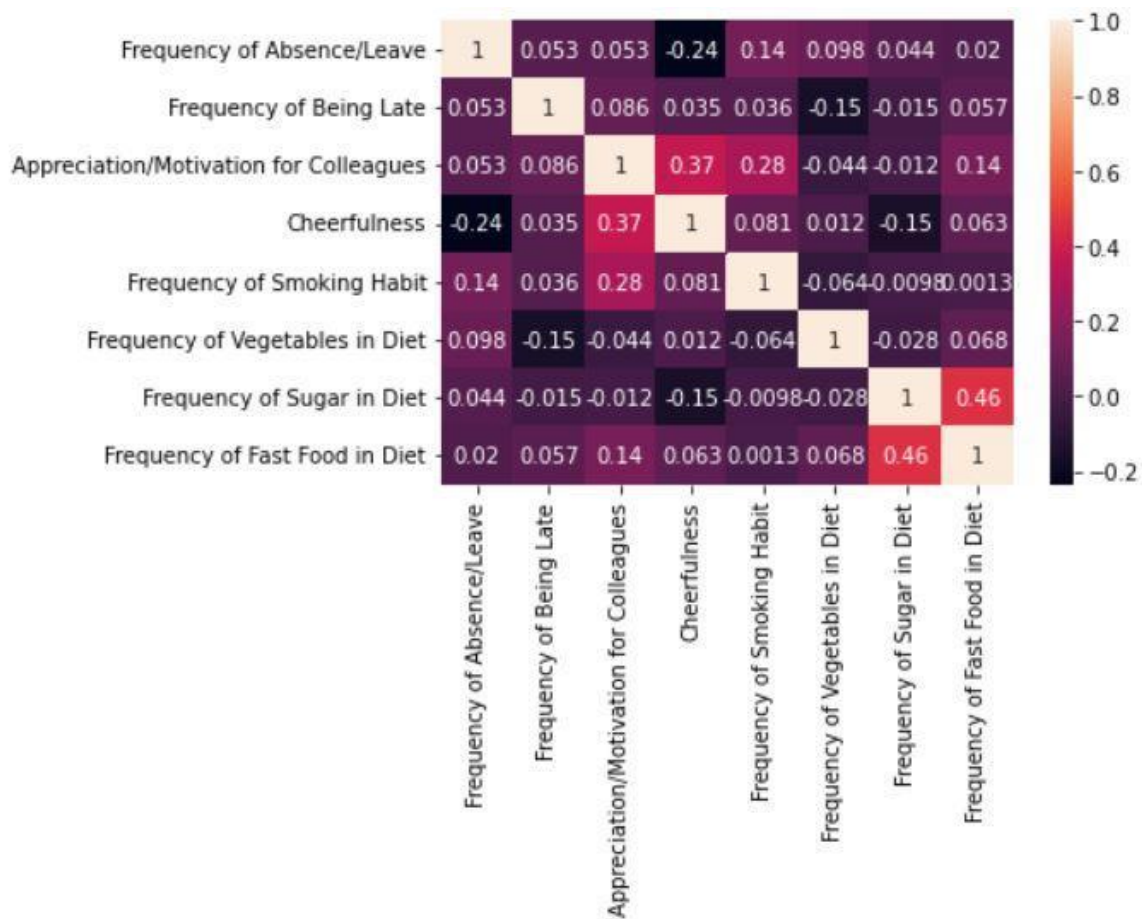
- VI. **Frequency of Being Late and Average Sleep Duration has statistically negative correlation (coefficient = $|-0.19| > \text{critical value } 0.188$)**
- VII. **Frequency of Being Late and Average Sleep Starting Time has statistically negative correlation (coefficient = $|-0.42| > \text{critical value } 0.188$)**
- VIII. **Frequency of Being Late and Average Breakfast Time has statistically negative correlation (coefficient = $|-0.33| > \text{critical value } 0.188$)**
- IX. **Frequency of Being Late and Average Lunch Time has statistically negative correlation (coefficient = $|-0.31| > \text{critical value } 0.188$)**
- X. Frequency of Being Late and Average Dinner Time has no statistically significant correlation (coefficient = $|-0.16| < \text{critical value } 0.188$)
- XI. Appreciation/Motivation for Colleagues and Average Sleep Duration has no statistically significant correlation (coefficient = $|-0.14| < \text{critical value } 0.188$)
- XII. Appreciation/Motivation for Colleagues and Average Sleep Starting Time has no statistically significant correlation (coefficient = $|-0.059| < \text{critical value } 0.188$)
- XIII. Appreciation/Motivation for Colleagues and Average Breakfast Time has statistically positive correlation (coefficient = $|-0.018| < \text{critical value } 0.188$)
- XIV. Appreciation/Motivation for Colleagues and Average Lunch Time has statistically positive correlation (coefficient = $|-0.036| < \text{critical value } 0.188$)
- XV. Appreciation/Motivation for Colleagues and Average Dinner Time has no statistically significant correlation (coefficient = $|0.016| < \text{critical value } 0.188$)
- XVI. Cheerfulness and Average Sleep Duration has statistically negative correlation (coefficient = $|0.15| < \text{critical value } 0.188$)
- XVII. Cheerfulness and Average Sleep Starting Time has no statistically significant correlation (coefficient = $|-0.076| < \text{critical value } 0.188$)
- XVIII. Cheerfulness and Average Breakfast Time has no statistically significant correlation (coefficient = $|0.084| < \text{critical value } 0.188$)
- XIX. Cheerfulness and Average Lunch Time has no statistically significant correlation (coefficient = $|0.057| < \text{critical value } 0.188$)
- XX. Cheerfulness and Average Dinner Time has no statistically significant correlation (coefficient = $|-0.052| < \text{critical value } 0.188$)



Here, we can see that,

- I. Frequency of Absence/Leave and BMI has no statistically significant correlation (coefficient = $|0.00075| < \text{critical value } 0.188$)
- II. **Frequency of Absence/Leave and Frequency of Physical Exercise has statistically positive correlation (coefficient = $|0.23| > \text{critical value } 0.188$)**
- III. Frequency of Absence/Leave and Sitting Time has no statistically significant correlation (coefficient = $|-0.045| < \text{critical value } 0.188$)
- IV. **Frequency of Absence/Leave and Resting time has statistically negative correlation (coefficient = $|-0.31| > \text{critical value } 0.188$)**
- V. Frequency of Absence/Leave and Frequency of Sickness has no statistically significant correlation (coefficient = $|-0.056| < \text{critical value } 0.188$)
- VI. Frequency of Being Late and BMI has no statistically significant correlation (coefficient = $|-0.029| < \text{critical value } 0.188$)
- VII. Frequency of Being Late and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|-0.085| < \text{critical value } 0.188$)
- VIII. Frequency of Being Late and Sitting Time has no statistically significant correlation (coefficient = $|0.065| < \text{critical value } 0.188$)

- IX. Frequency of Being Late and Resting time has statistically negative correlation (coefficient = $|-0.39| > \text{critical value } 0.188$)**
- X. Frequency of Being Late and Frequency of Sickness has no statistically significant correlation (coefficient = $|-0.12| < \text{critical value } 0.188$)
- XI. Appreciation/Motivation for Colleagues and BMI has no statistically significant correlation (coefficient = $|-0.15| < \text{critical value } 0.188$)
- XII. Appreciation/Motivation for Colleagues and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|-0.15| < \text{critical value } 0.188$)
- XIII. Appreciation/Motivation for Colleagues and Sitting Time has statistically negative correlation (coefficient = $|-0.28| > \text{critical value } 0.188$)**
- XIV. Appreciation/Motivation for Colleagues and Resting time has statistically positive correlation (coefficient = $|-0.07| < \text{critical value } 0.188$)
- XV. Appreciation/Motivation for Colleagues and Frequency of Sickness has no statistically significant correlation (coefficient = $|0.078| < \text{critical value } 0.188$)
- XVI. Cheerfulness and BMI has statistically negative correlation (coefficient = $|-0.35| > \text{critical value } 0.188$)**
- XVII. Cheerfulness and Frequency of Physical Exercise has no statistically significant correlation (coefficient = $|-0.15| < \text{critical value } 0.188$)
- XVIII. Cheerfulness and Sitting Time has no statistically significant correlation (coefficient = $|0.077| < \text{critical value } 0.188$)
- XIX. Cheerfulness and Resting time has no statistically significant correlation (coefficient = $|0.026| < \text{critical value } 0.188$)
- XX. Cheerfulness and Frequency of Sickness has no statistically significant correlation (coefficient = $|-0.12| < \text{critical value } 0.188$)



Here, we can see that,

- I. Frequency of Absence/Leave and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.14| < \text{critical value } 0.188$)
- II. Frequency of Absence/Leave and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.098| < \text{critical value } 0.188$)
- III. Frequency of Absence/Leave and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|0.044| < \text{critical value } 0.188$)
- IV. Frequency of Absence/Leave and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.02| < \text{critical value } 0.188$)
- V. Frequency of Being Late and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.036| < \text{critical value } 0.188$)
- VI. Frequency of Being Late and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|-0.15| < \text{critical value } 0.188$)
- VII. Frequency of Being Late and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|-0.015| < \text{critical value } 0.188$)
- VIII. Frequency of Being Late and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.057| < \text{critical value } 0.188$)

- IX. Appreciation/Motivation for Colleagues and Frequency of Smoking Habit has statistically positive correlation (coefficient = $|0.28| > \text{critical value } 0.188$)**
- X. Appreciation/Motivation for Colleagues and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|-0.044| < \text{critical value } 0.188$)
- XI. Appreciation/Motivation for Colleagues and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|-0.012| < \text{critical value } 0.188$)
- XII. Appreciation/Motivation for Colleagues and Frequency of Fast Food in Diet has statistically positive correlation (coefficient = $|0.14| < \text{critical value } 0.188$)
- XIII. Cheerfulness and Frequency of Smoking Habit has no statistically significant correlation (coefficient = $|0.081| < \text{critical value } 0.188$)
- XIV. Cheerfulness and Frequency of Vegetables in Diet has no statistically significant correlation (coefficient = $|0.012| < \text{critical value } 0.188$)
- XV. Cheerfulness and Frequency of Sugar in Diet has no statistically significant correlation (coefficient = $|-0.15| < \text{critical value } 0.188$)
- XVI. Cheerfulness and Frequency of Fast Food in Diet has no statistically significant correlation (coefficient = $|0.063| < \text{critical value } 0.188$)

6.2 Findings from Heatmaps

From the heatmap, we can derive the following list of Productivity Related Factor - Fitness Related Factor pairs with statistically significant correlation

- I. Task Satisfaction and Average Breakfast Time
- II. Task Satisfaction and Average Lunch Time
- III. Task Satisfaction and Resting Time
- IV. Task Satisfaction and Frequency of Smoking Habit
- V. Task Satisfaction and Frequency of Fast Food in Diet
- VI. Interaction Willingness and Frequency of Smoking Habit
- VII. Interaction Willingness and Average Sleep Duration

- VIII. Interaction Willingness and BMI
- IX. Decision Contribution and Frequency of Vegetables in Diet
- X. External Interaction and Average Sleep Duration
- XI. External Interaction and Average Dinner Time
- XII. External Interaction and BMI
- XIII. External Interaction and Frequency of Smoking Habit
- XIV. Deadline Crossing Frequency and Average Sleep Duration
- XV. Deadline Crossing Frequency and Average Sleep Starting Time
- XVI. Deadline Crossing Frequency and Average Breakfast Time
- XVII. Deadline Crossing Frequency and Average Lunch Time
- XVIII. Deadline Crossing Frequency and Sitting Time
- XIX. Overtime Frequency and Average Sleep Duration
- XX. Overtime Frequency and Average Sleep Starting Time
- XXI. Frequency of Smartphone Usage and Frequency of Physical Exercise
- XXII. Frequency of Smartphone Usage and Resting Time
- XXIII. Frequency of Being Late and Average Sleep Duration
- XXIV. Frequency of Being Late and Average Sleep Starting Time

- XXV. Frequency of Being Late and Average Breakfast Time
- XXVI. Frequency of Being Late and Average Lunch Time
- XXVII. Frequency of Being Late and Resting Time
- XXVIII. Frequency of Absence/Leave and Frequency of Physical Exercise
- XXIX. Frequency of Absence/Leave and Resting Time
- XXX. Appreciation/Motivation for Colleagues and Sitting Time
- XXXI. Appreciation/Motivation for Colleagues and Frequency of Smoking Habit
- XXXII. Cheerfulness and BMI

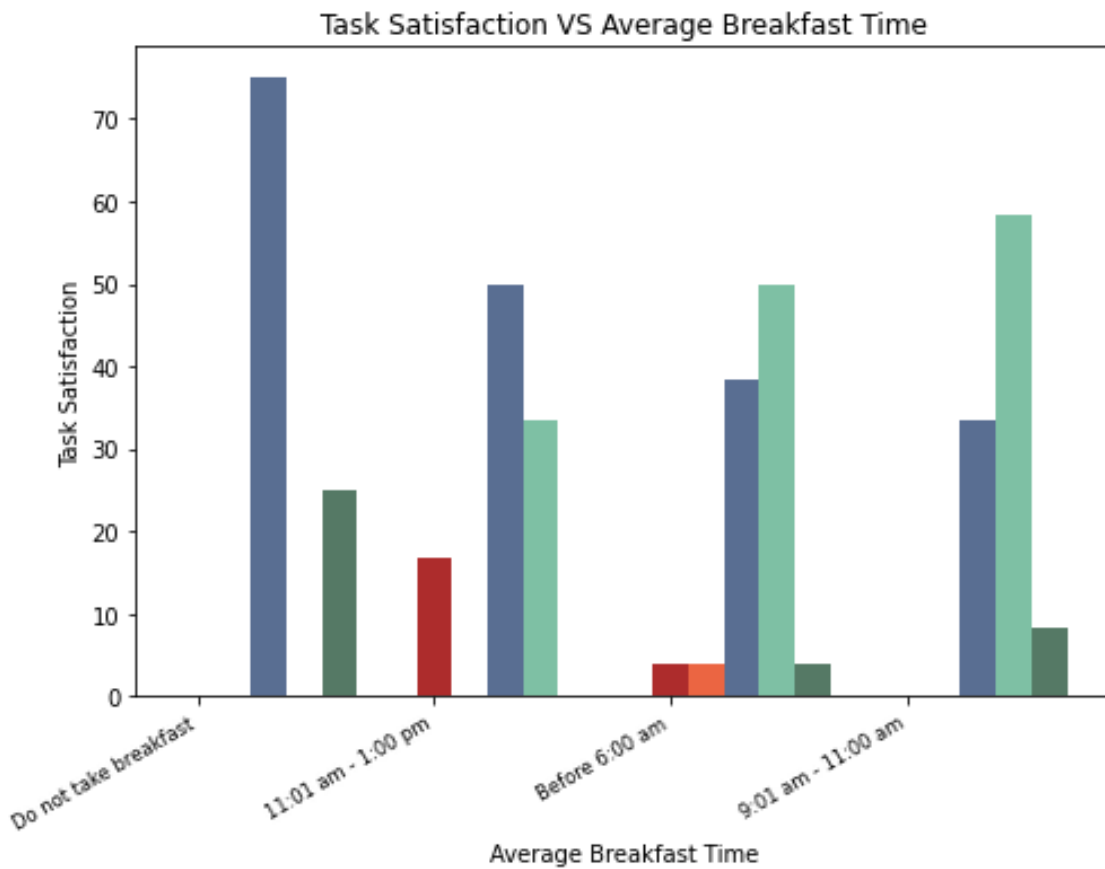
6.3 Findings from Bar Charts

For the productivity factor - recreation factor pairs with a statistically significant correlation, we prepared bar charts showing the relationship between them. From the bar charts, we analyzed the nature of their relationship.

Code for bar chart generation can be found here:

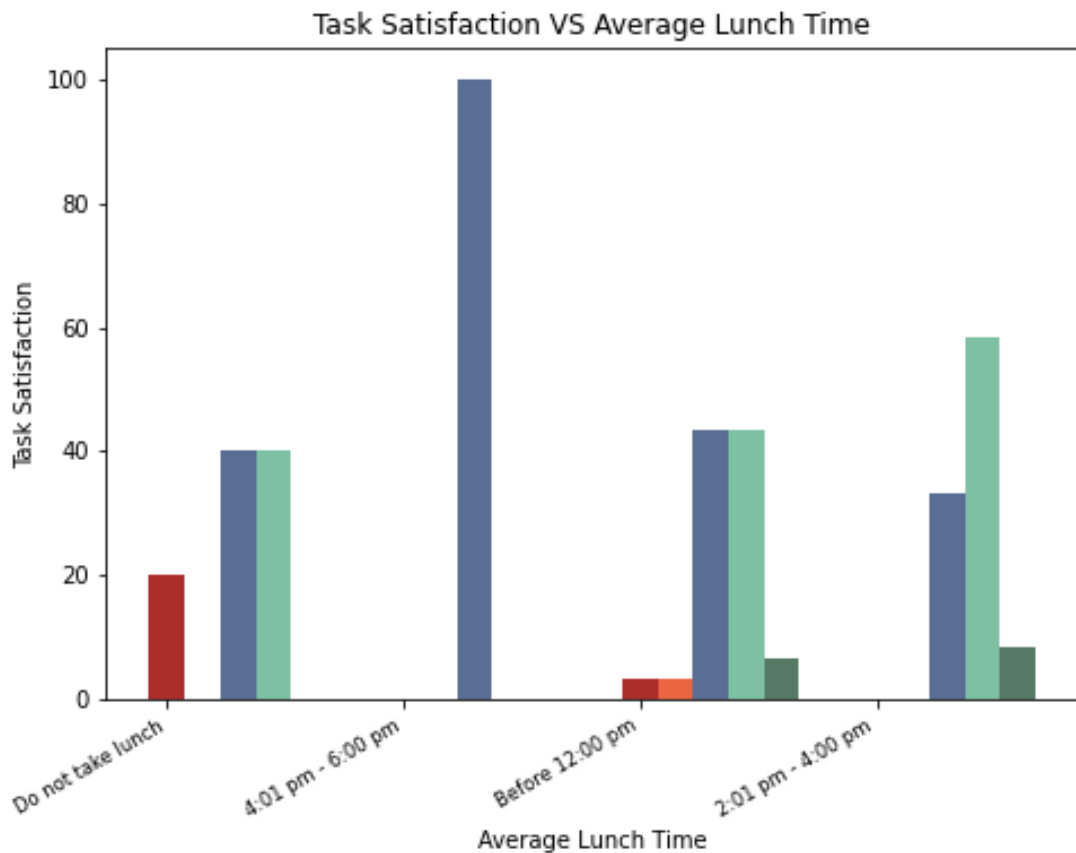
<https://github.com/bsse1006/ImpactOfPhysicalFitnessOnDeveloperProductivity/blob/main/barCharts.ipynb>

I. Task Satisfaction and Average Breakfast Time



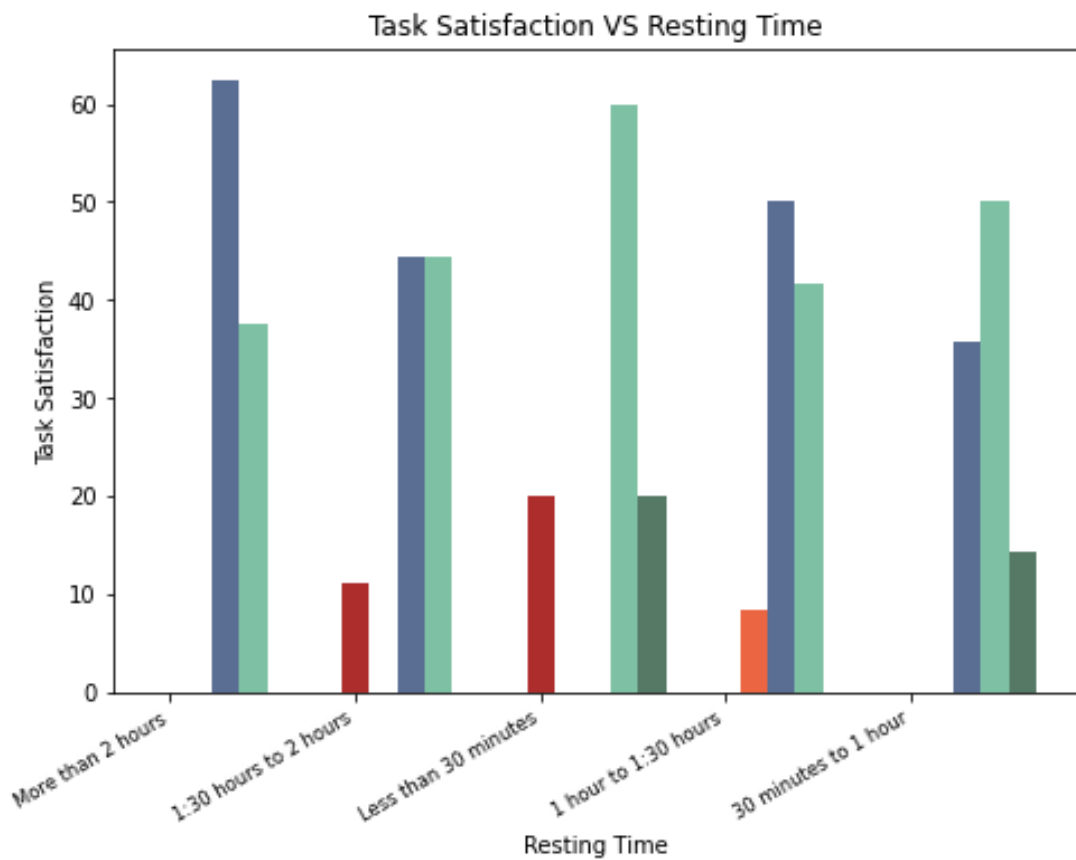
Here, we can see that as we approach more and more optimum value for breakfast time, the frequency of having task satisfaction increases; 'moderately satisfied', 'not at all satisfied' and 'slightly satisfied' decrease, 'very satisfied' and 'completely satisfied' increase. So we can conclude that **Breakfast Time** has a positive impact on having **Task Satisfaction** and has a **positive impact** on developer productivity.

II. Task Satisfaction and Average Lunch Time



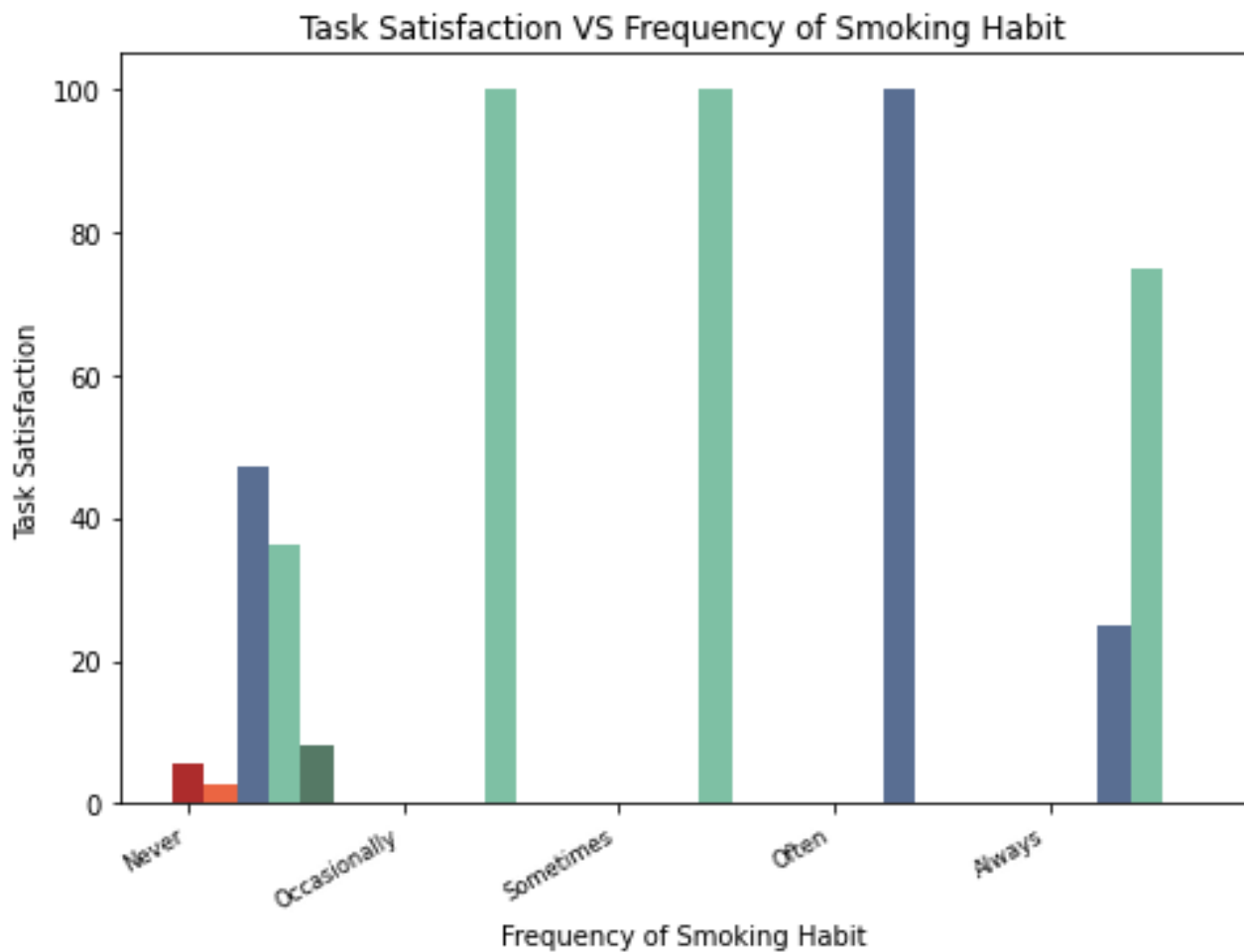
Here, we can see that as we approach more and more optimum value for lunch time, the frequency of having task satisfaction increases; 'moderately satisfied', 'not at all satisfied' and 'slightly satisfied' decrease, 'very satisfied' and 'completely satisfied' increase. So we can conclude that **Lunch Time** has a positive impact on having **Task Satisfaction** and has a **positive impact** on developer productivity.

III. Task Satisfaction and Resting Time



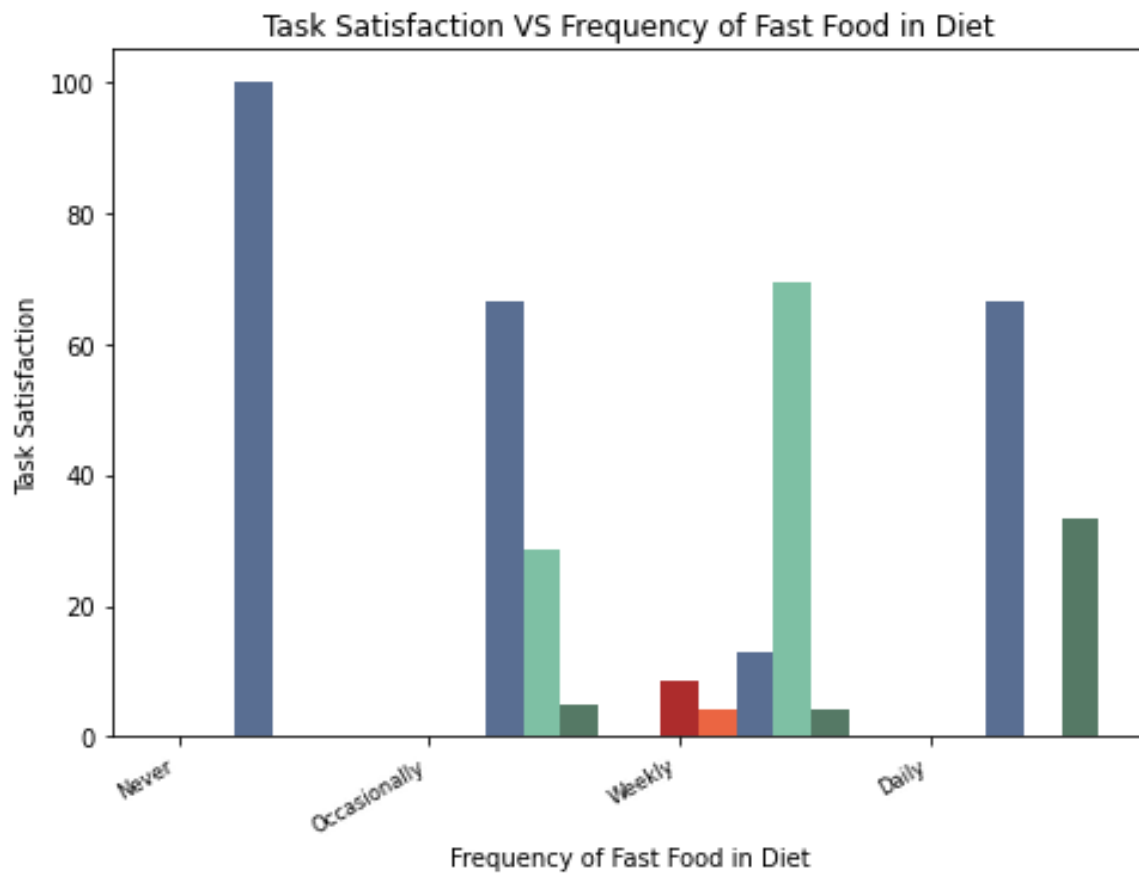
Here, we can see that as we approach more and more optimum values for resting time, the frequency of having task satisfaction increases; the collective frequency of 'very satisfied' and 'completely satisfied' increases. So we can conclude that **Resting Time** has a positive impact on having **Task Satisfaction** and has a **positive impact** on developer productivity.

IV. Task Satisfaction and Frequency of Smoking Habit



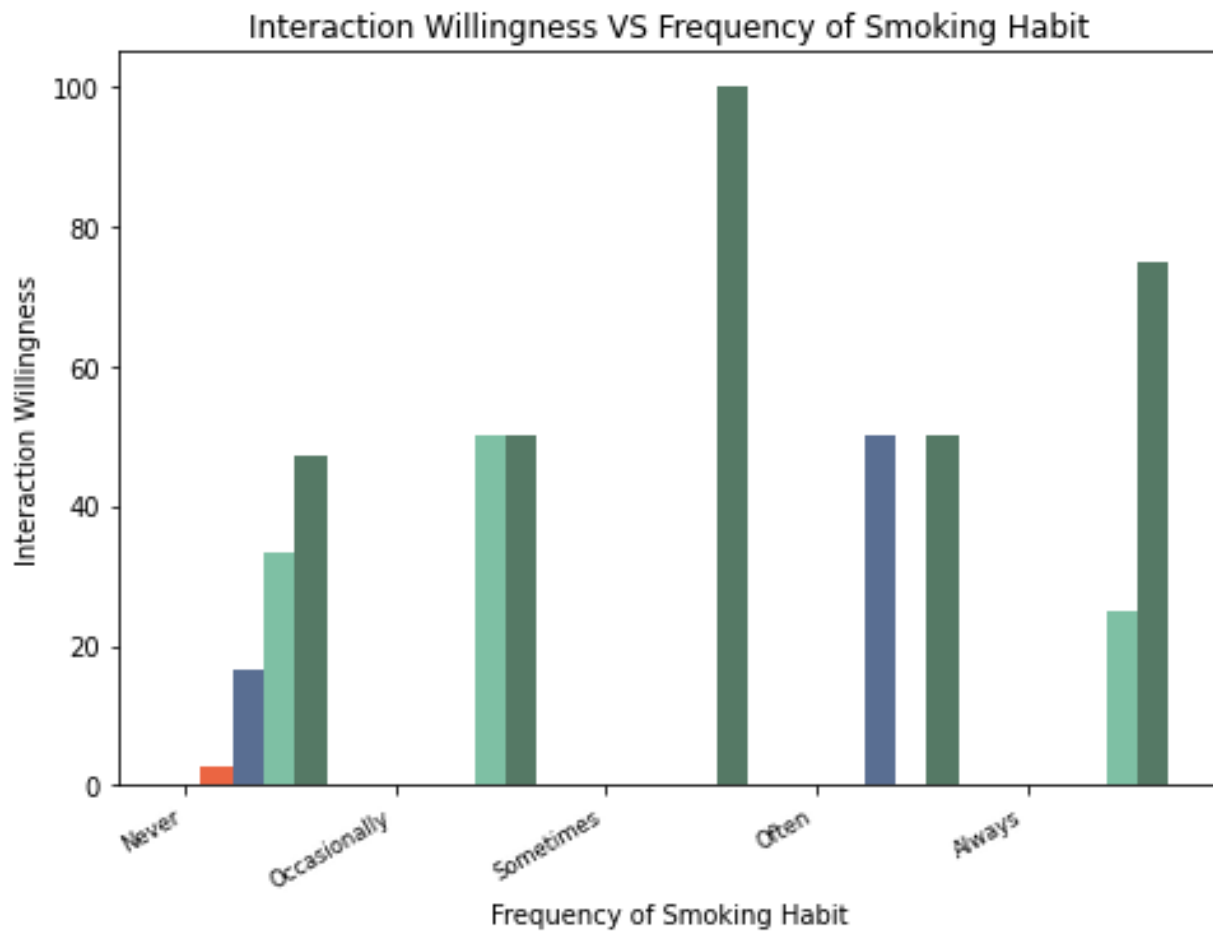
Here, we can see that when developers smoke occasionally or sometimes, task satisfaction is highest. Task satisfaction is moderate for developers who smoke often. For chain smokers, we see that task satisfaction is higher than those who smoke often. So we can conclude that **Smoking Habit** has a neutral impact on having **Task Satisfaction** and has a **neutral impact** on developer productivity.

V. Task Satisfaction and Frequency of Fast Food in Diet



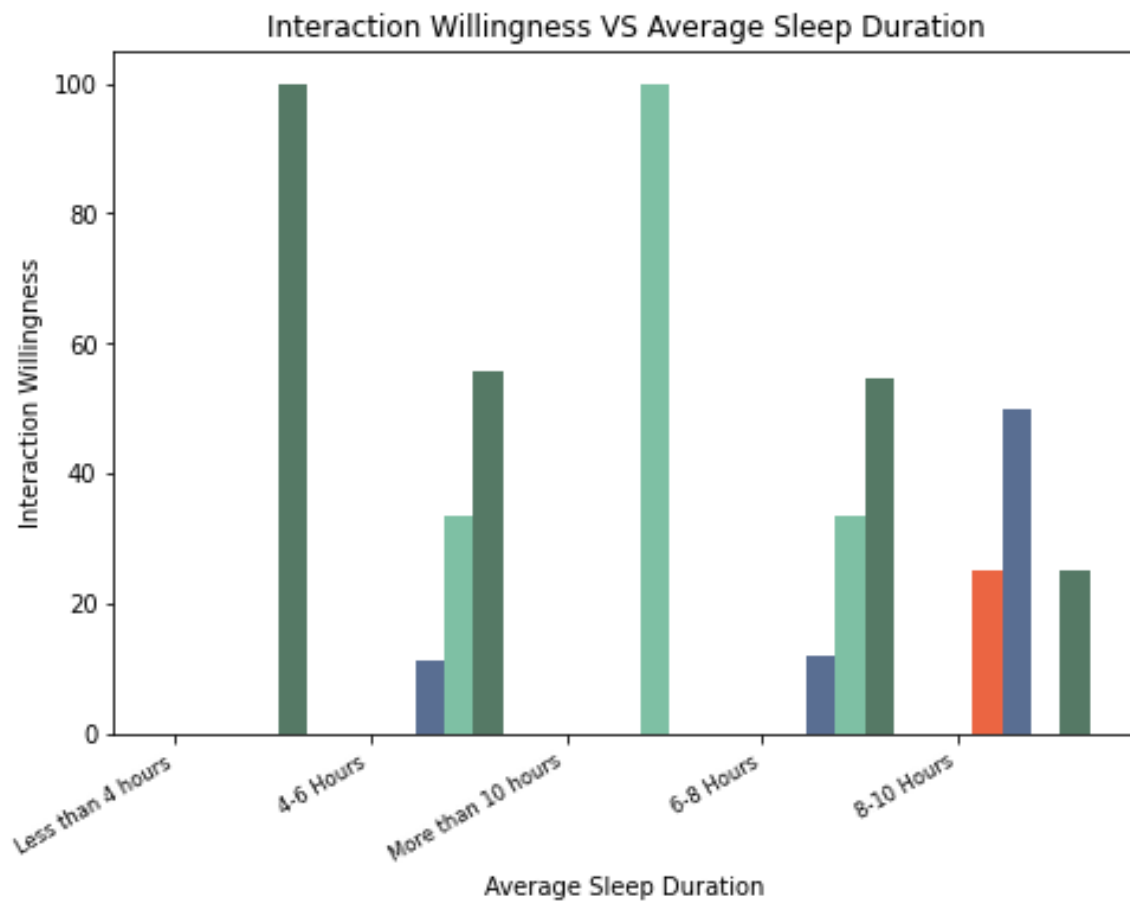
Here, we can see that there is no consistent increment or decrement in task satisfaction because of fast food. So we can conclude that **Fast Food** has a neutral impact on having **Task Satisfaction** and has a **neutral impact** on developer productivity.

VI. Interaction Willingness and Frequency of Smoking Habit



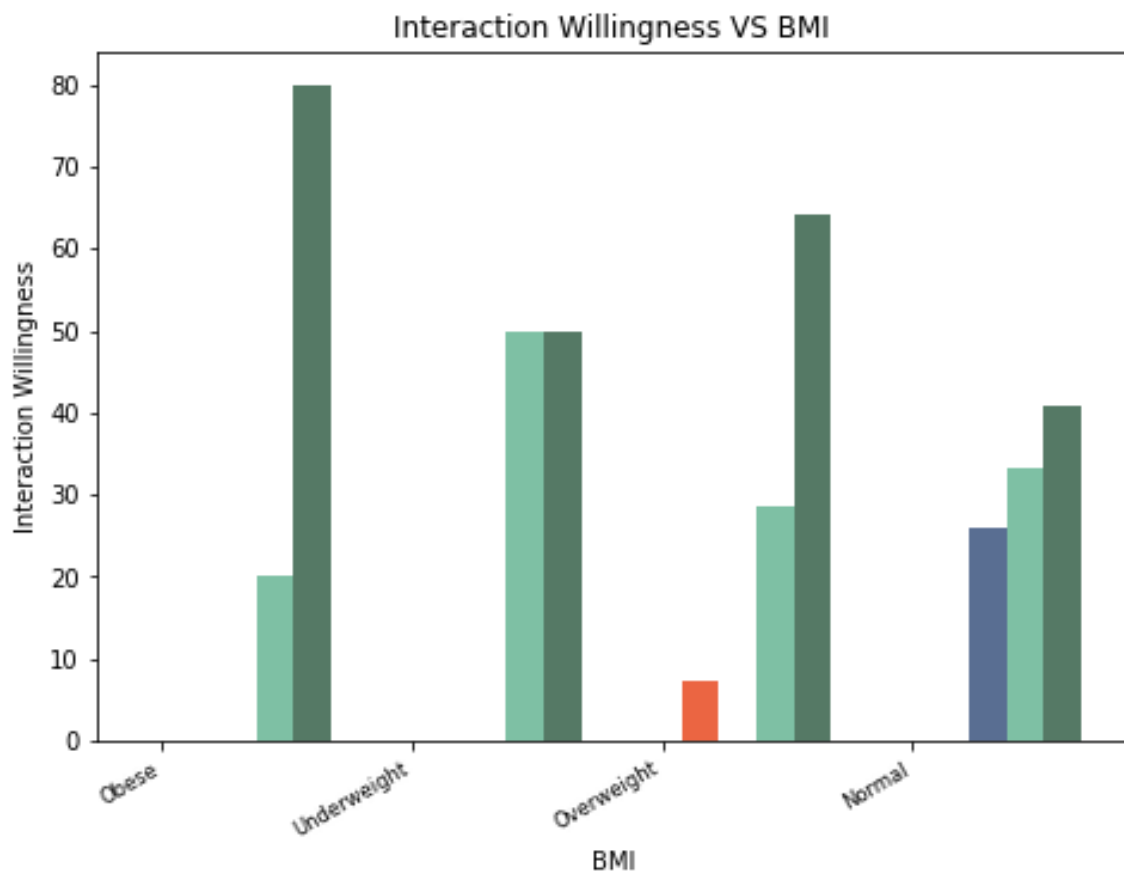
Here, we can see that high amount of interaction willingness do not change consistently, they increase from no smoking to occasional smoking, but decrease in case of smokers who smoke often. So we can conclude that **Smoking habit** has a neutral impact on **Interaction Willingness** and has a **neutral impact** on developer productivity.

VII. Interaction Willingness and Average Sleep Duration



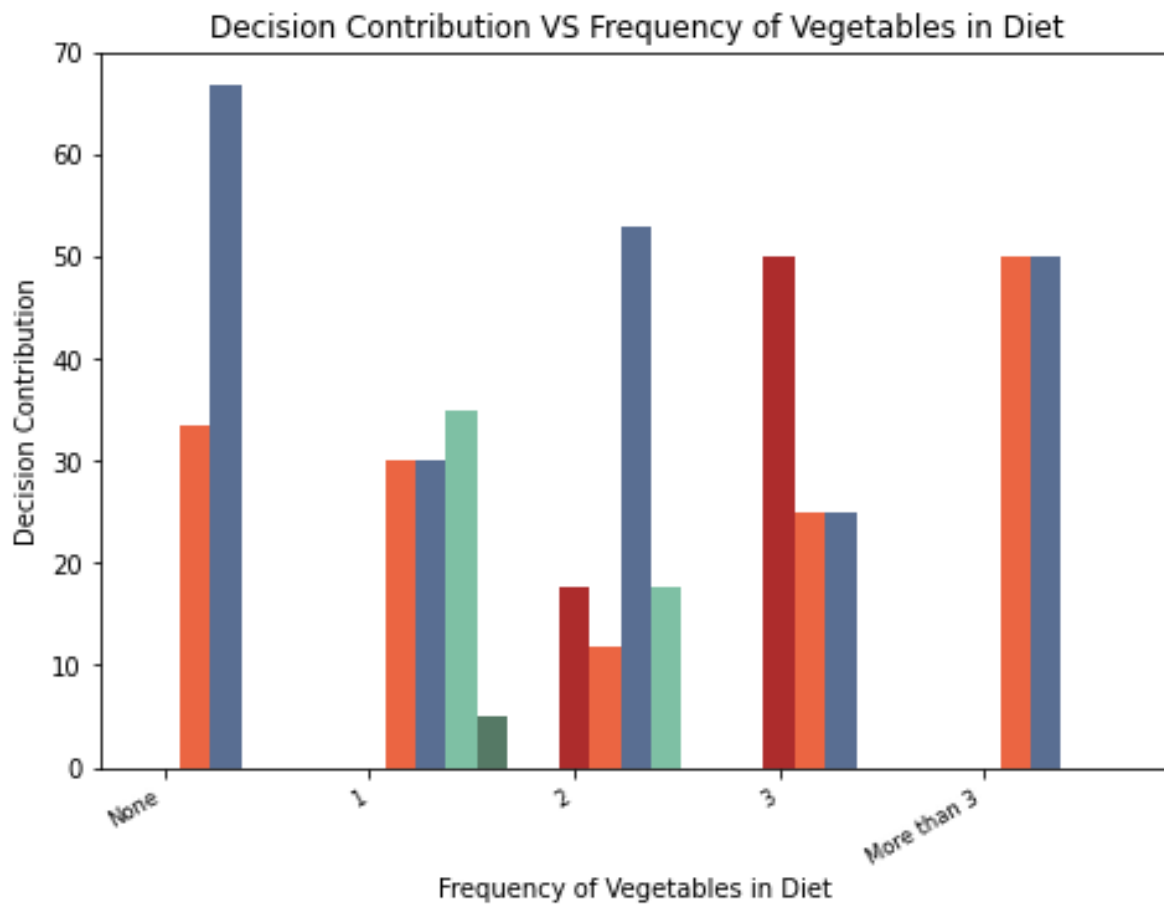
Here, we can see that interaction willingness is highest for the least optimum value and it decreases as we approach more and more optimum values. So we can conclude that **Sleep Duration** has a negative impact on having **Interaction Willingness** and has a **negative impact** on developer productivity.

VIII. Interaction Willingness and BMI



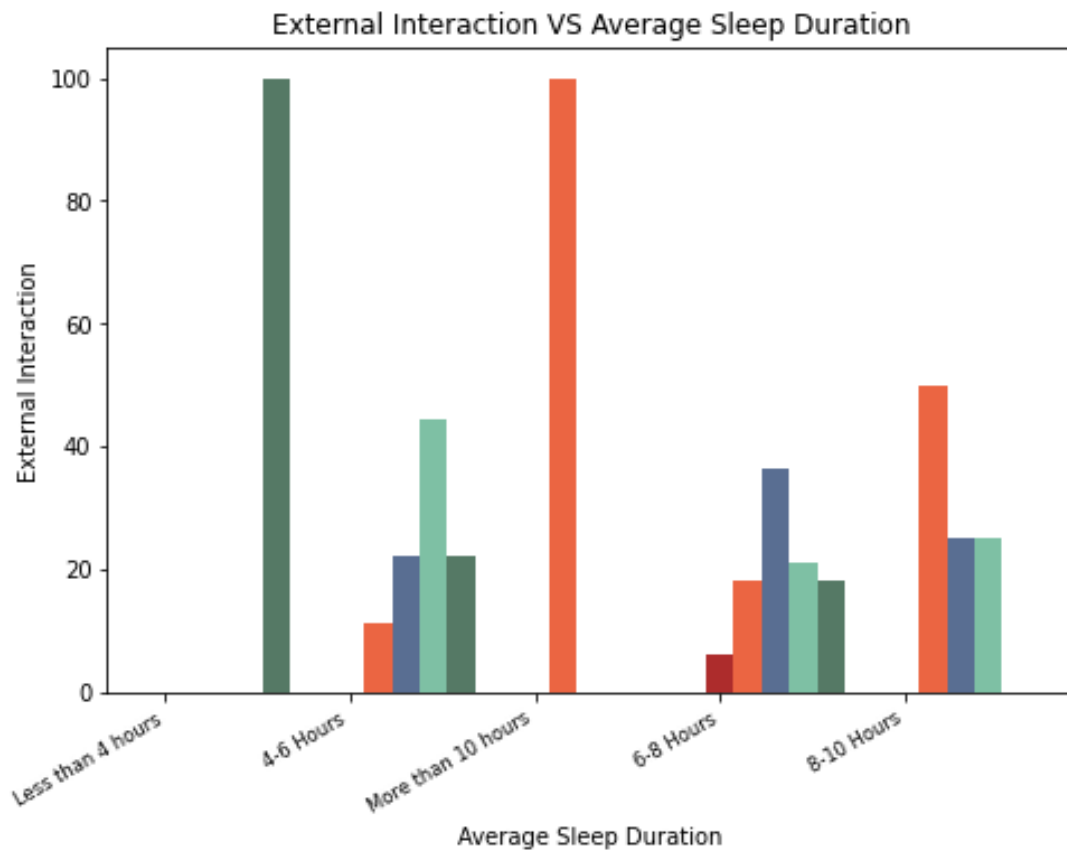
Here, we can see that the highest interaction willingness occurs in case of obesity. It decreases in case of normal BMI. But it increases for both underweight and overweight. So we can conclude that **BMI** has a neutral impact on **Interaction Willingness** and has a **neutral impact** on developer productivity.

IX. Decision Contribution and Frequency of Vegetables in Diet



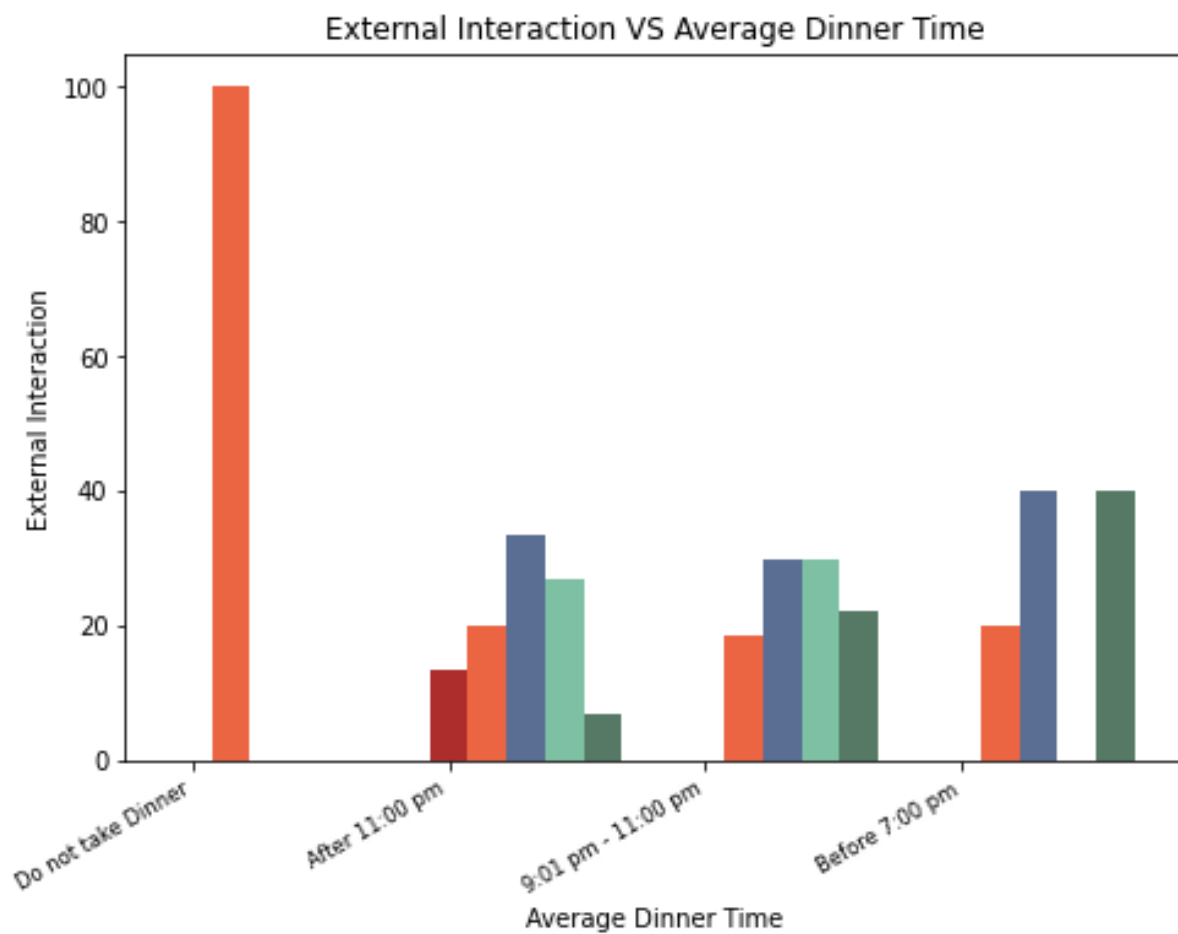
Here, we can see that the amount of decision contribution decreases with more frequent vegetable intake. Least decision contribution comes in case of high (3) intake of vegetables, but decision contribution is higher in case of relatively lower (1, 2) intake of vegetables. So we can conclude that **Vegetables in Diet** has a negative impact on **Interaction Willingness** and has a **negative impact** on developer productivity.

X. External Interaction and Average Sleep Duration



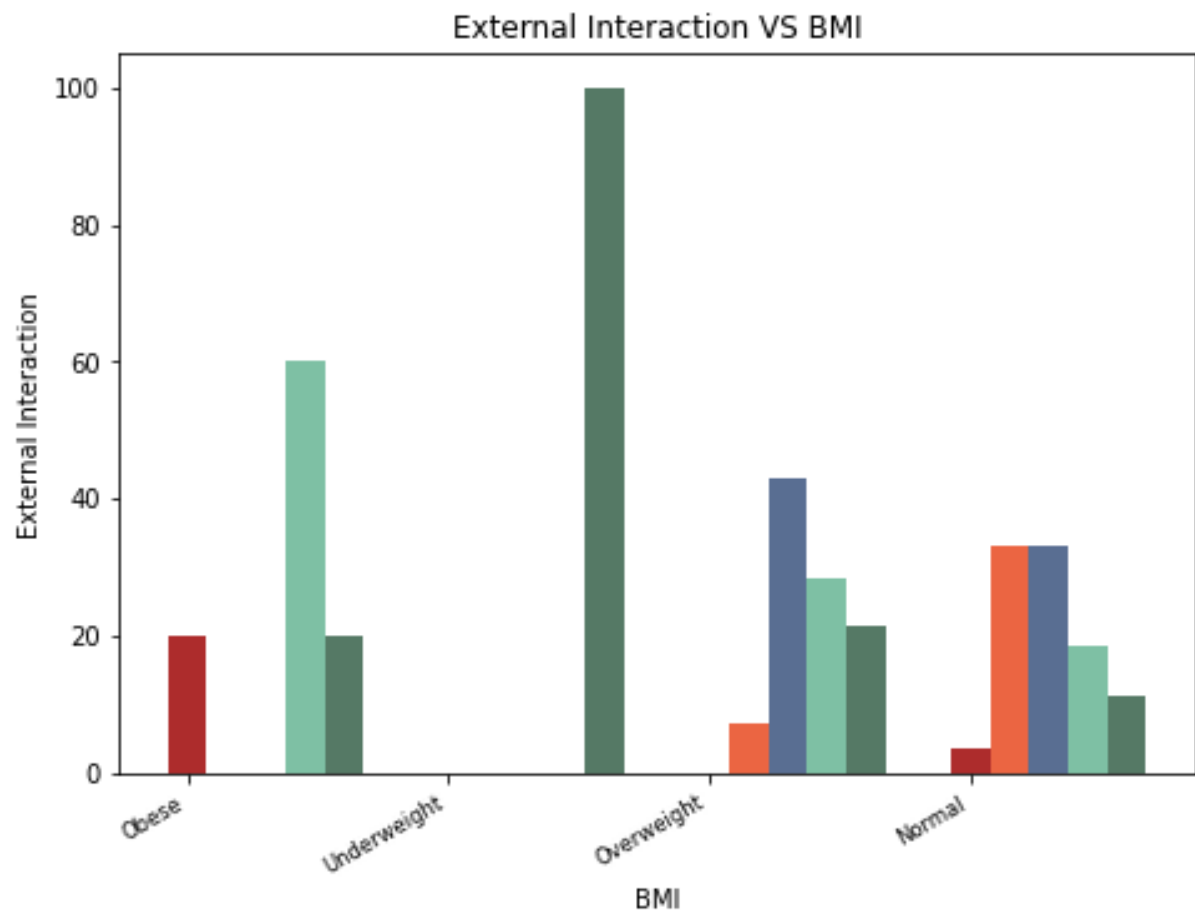
Here, we can see that external interaction is highest for the least optimum sleep duration. On the other hand, least external interaction increases with more and more optimum sleep duration. So we can conclude that **Sleep Duration** has a negative impact on **External Interaction** and has a **negative impact** on developer productivity.

XI. External Interaction and Average Dinner Time



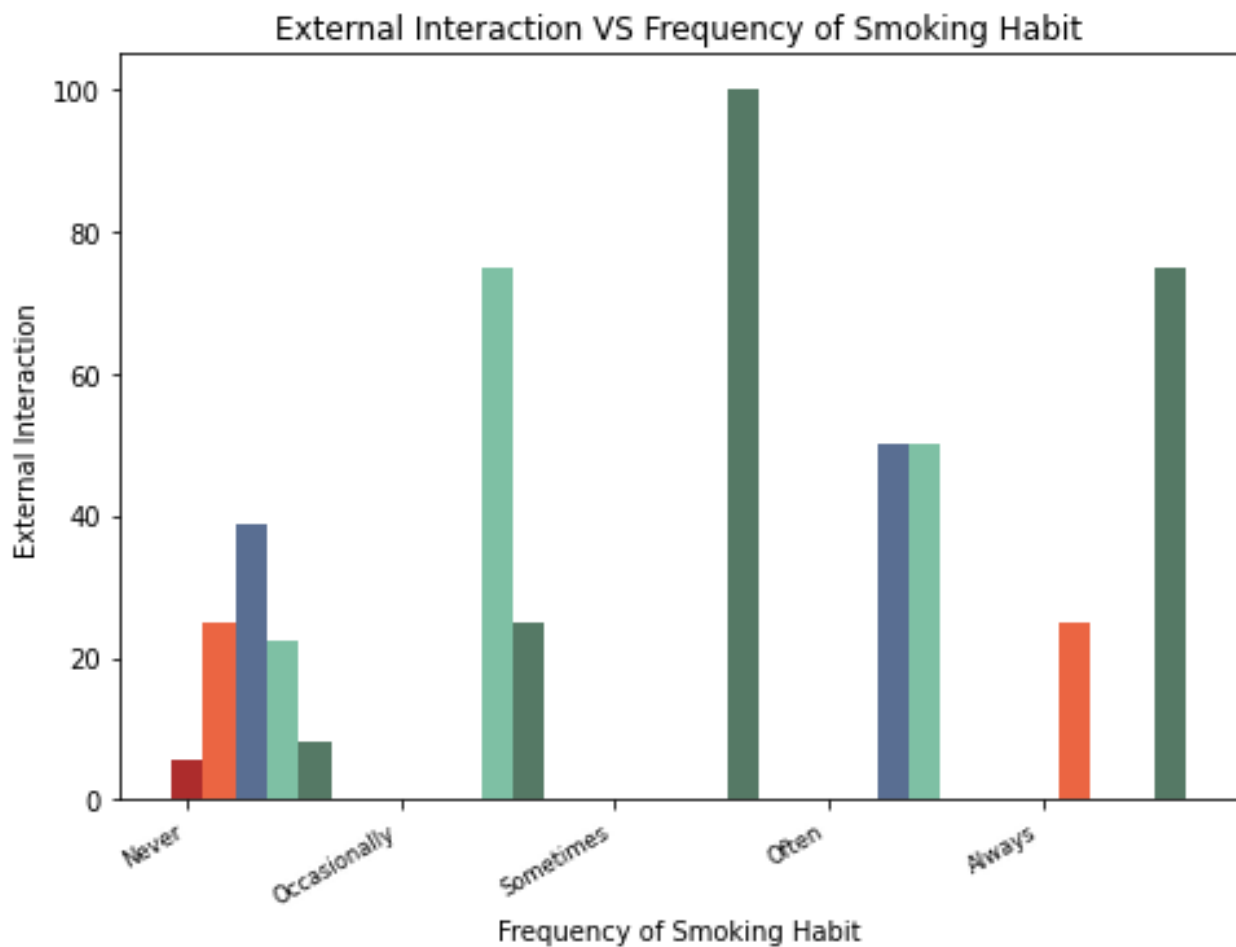
Here, we can see that external interaction is highest for the most optimum dinner time. On the other hand, least external interaction occurs with less and less optimum dinner time. So we can conclude that **Dinner Time** has a positive impact on **Interaction Willingness** and has a **positive impact** on developer productivity.

XII. External Interaction and BMI



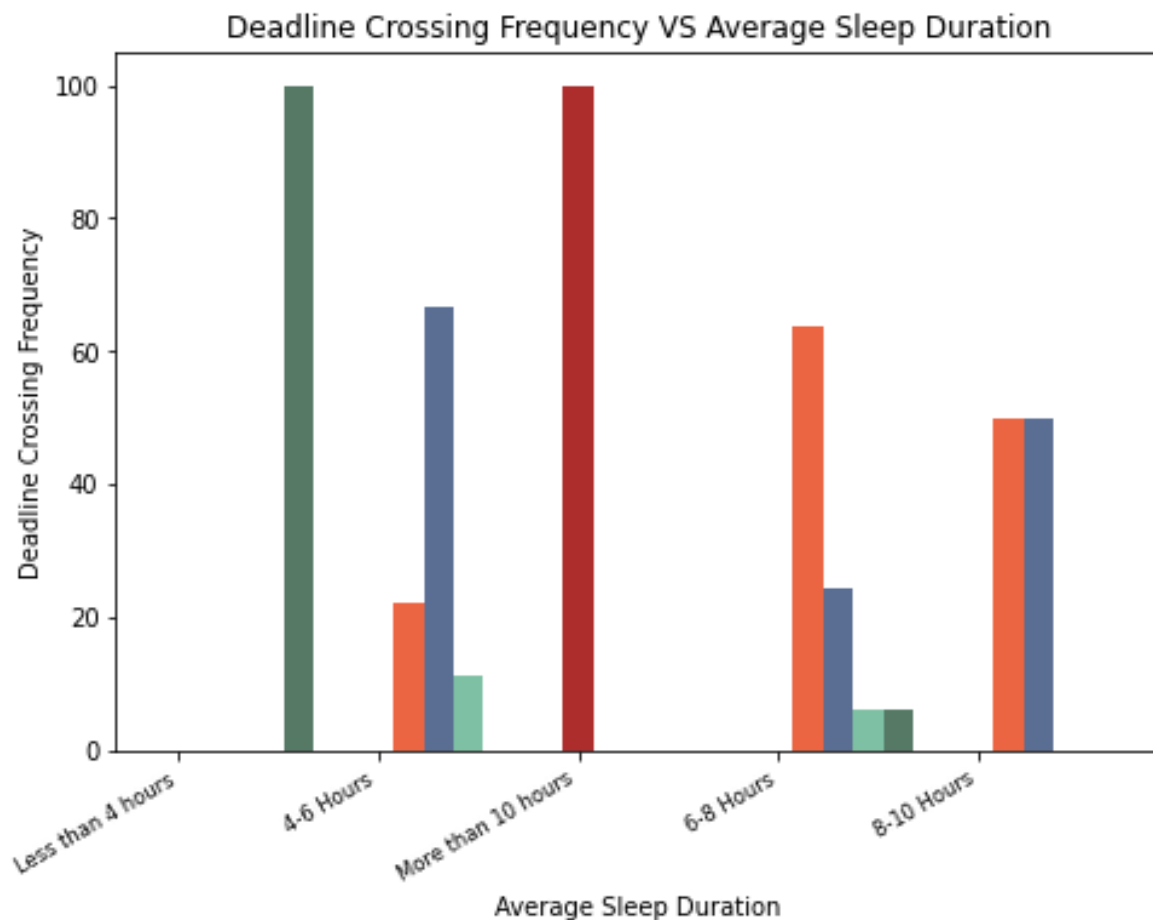
Here, we can see that there is no consistent relation between optimum BMI and external interaction. So we can conclude that **BMI** has a neutral impact on **External Interaction** and has a [neutral impact](#) on developer productivity.

XIII. External Interaction and Frequency of Smoking Habit



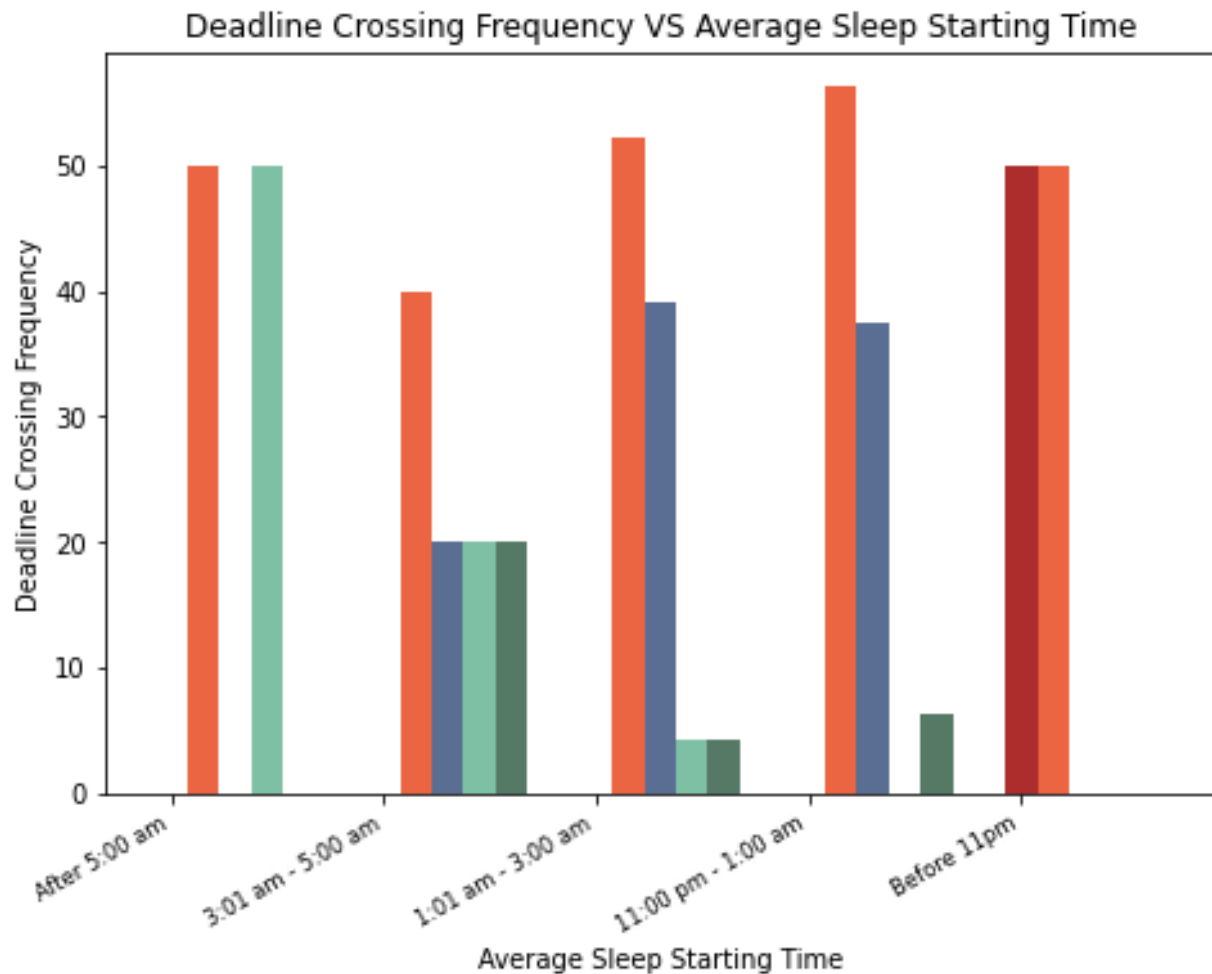
Here, we can see that there is no consistent relation between smoking habit and external interaction. External interaction increases at first, but decreases in case of developers who smoke often or always. So we can conclude that **Smoking habit** has a neutral impact on **External Interaction** and has a [neutral impact](#) on developer productivity.

XIV. Deadline Crossing Frequency and Average Sleep Duration



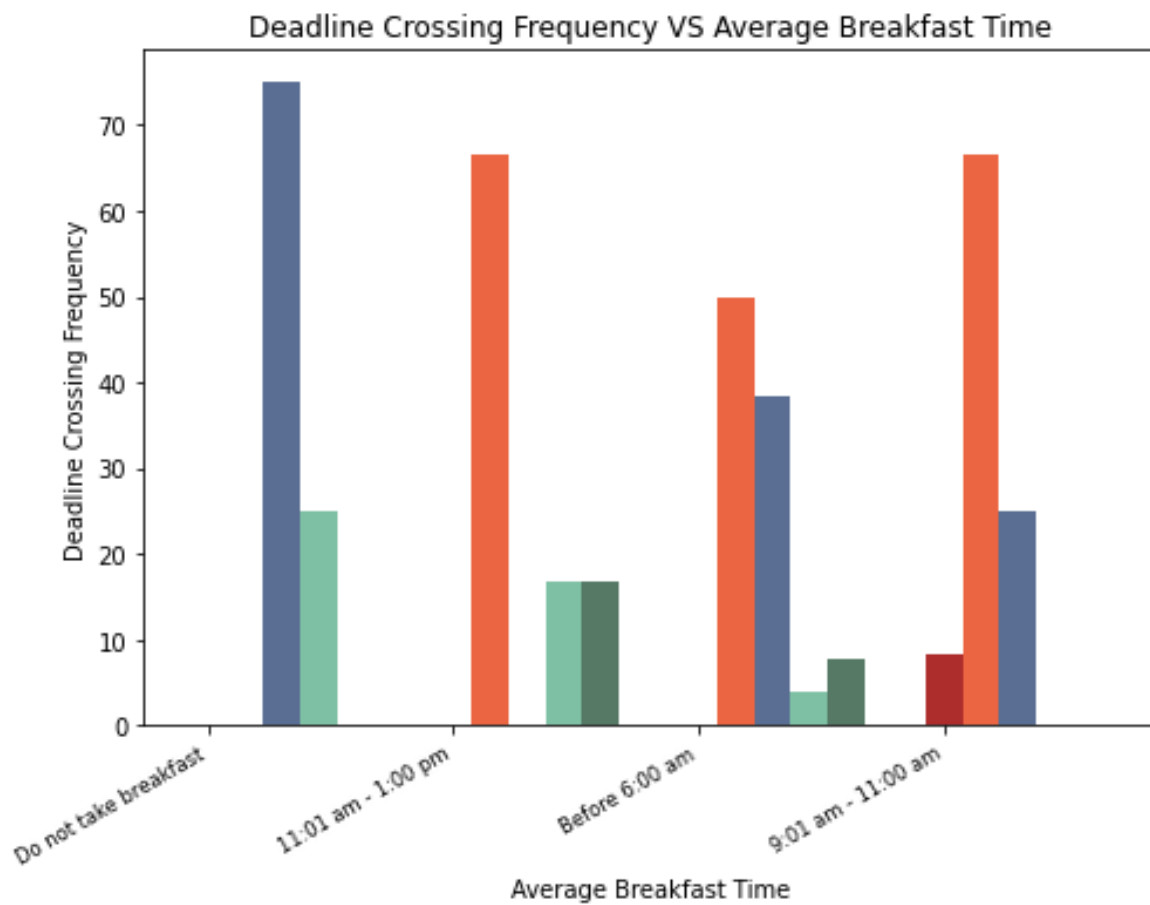
Here, we can see that there is no consistent relation between sleep duration and deadline crossing frequency. Most deadlines are crossed in case of least optimum value of sleep duration. Least deadlines occur in case of moderately optimum sleep duration and moderate amount of deadlines occur in case of most optimum sleep duration. So we can conclude that **Sleep Duration** has a neutral impact on **Deadline Crossing Frequency** and has a [neutral impact](#) on developer productivity.

XV. Deadline Crossing Frequency and Average Sleep Starting Time



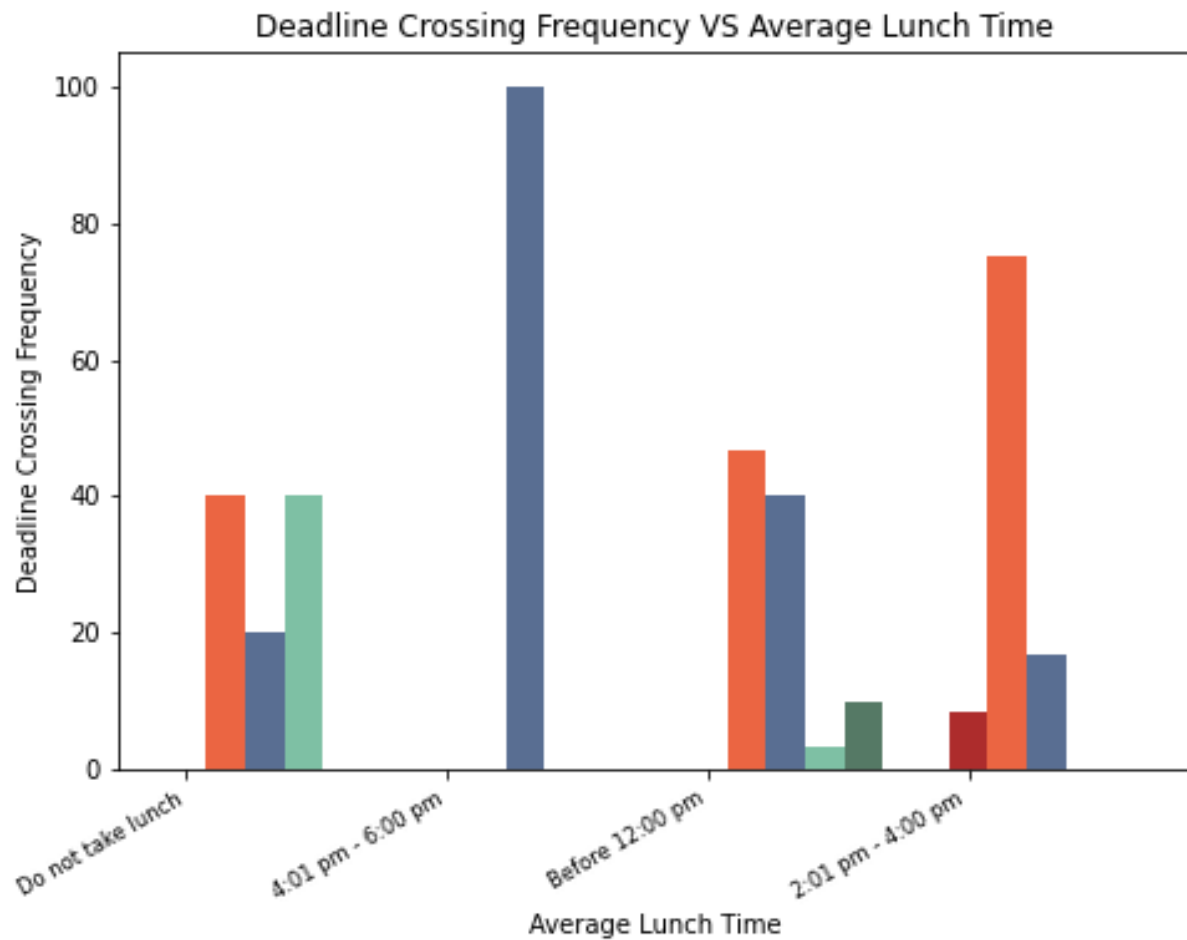
Here, we can see that deadline crossing frequency decreases as we approach more and more optimum sleep starting time. Least amount of deadlines are crossed in case of optimum sleep starting time. So we can conclude that **Sleep Starting Time** has a negative impact on **Deadline Crossing Frequency** and thus has a **positive impact** on developer productivity.

XVI. Deadline Crossing Frequency and Average Breakfast Time



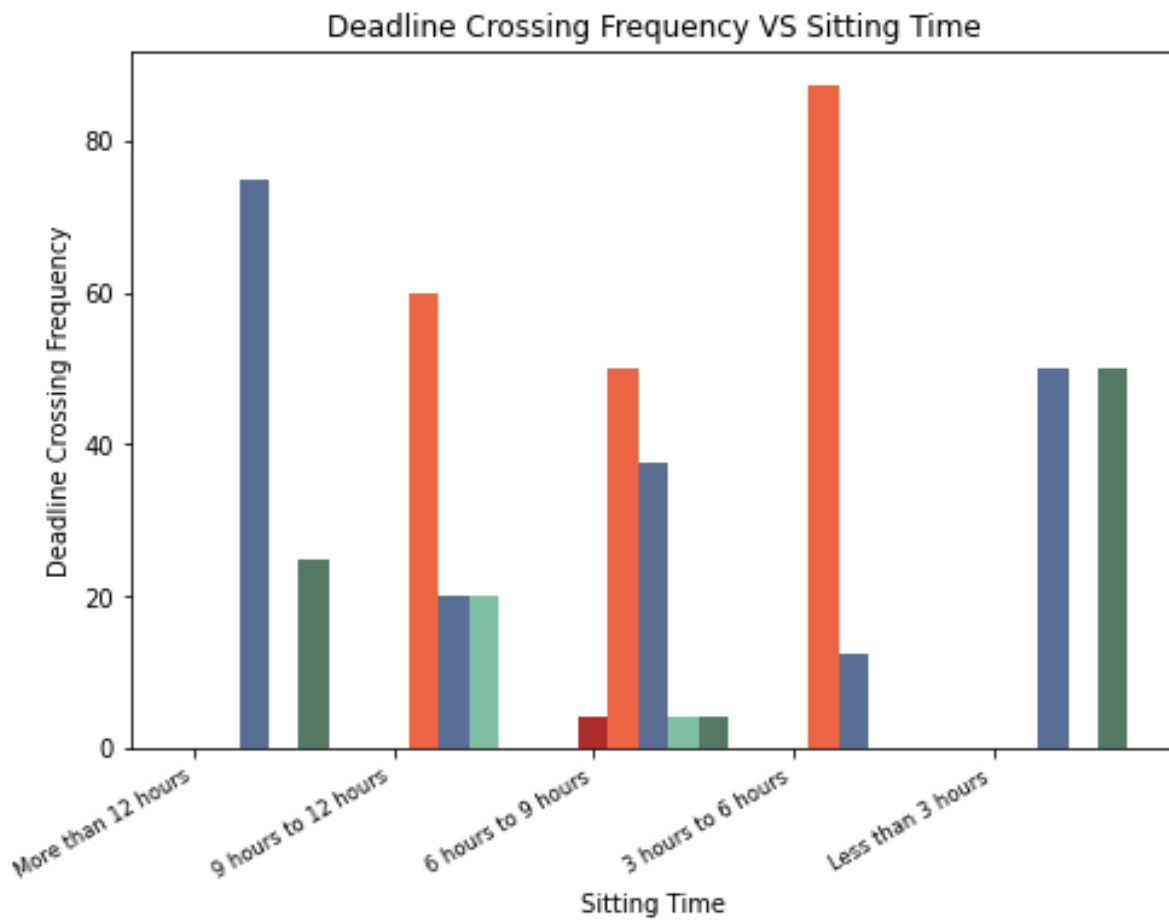
Here, we can see that deadline crossing frequency decreases as we approach more and more optimum breakfast time. So we can conclude that **Breakfast Time** has a negative impact on **Deadline Crossing Frequency** and thus has a **positive impact** on developer productivity.

XVII. Deadline Crossing Frequency and Average Lunch Time



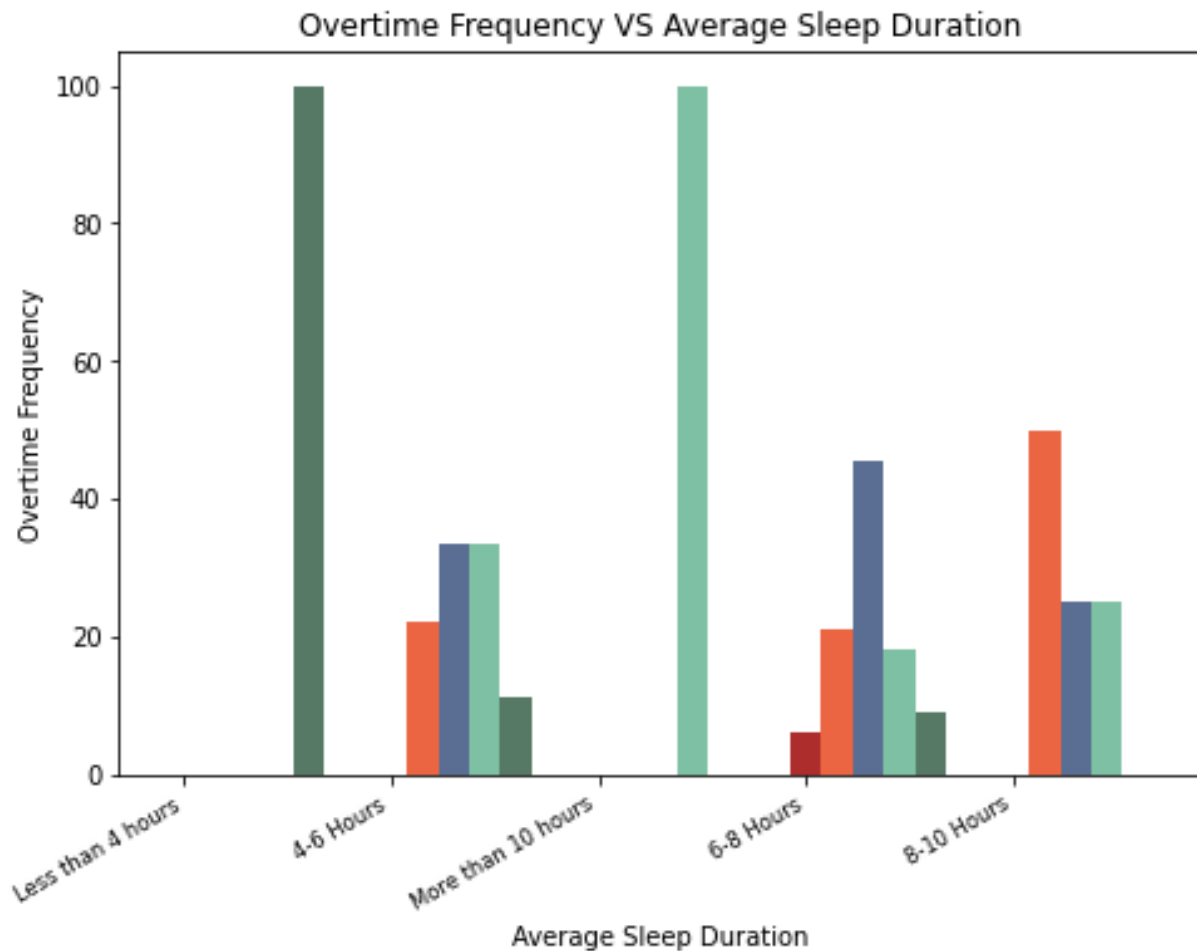
Here, we can see that deadline crossing frequency decreases as we approach more and more optimum lunch time. Most deadlines are crossed in case of least optimum lunch time and least deadlines are crossed in case of optimum lunch time. So we can conclude that **Lunch Time** has a negative impact on **Deadline Crossing Frequency** and thus has a **positive impact** on developer productivity.

XVIII. Deadline Crossing Frequency and Sitting Time



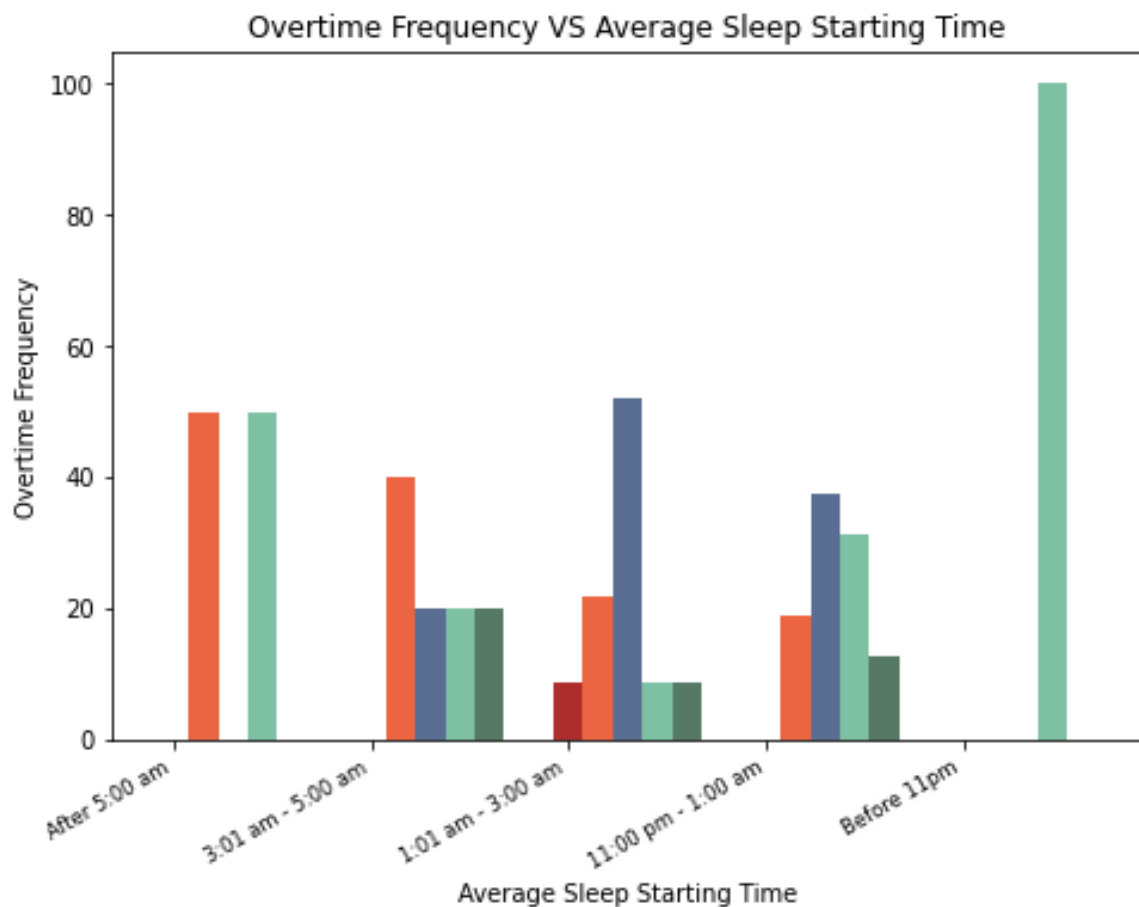
Here, we can see that there is no consistent relation between sitting time and deadline crossing frequency. Most deadlines are crossed in case of most optimum value of sitting time. Least deadlines occur in case of moderately optimum sitting time and moderate amount of deadlines occur in case of least optimum sitting time. So we can conclude that **Sitting Time** has a neutral impact on **Deadline Crossing Frequency** and has a [neutral impact](#) on developer productivity.

XIX. Overtime Frequency and Average Sleep Duration



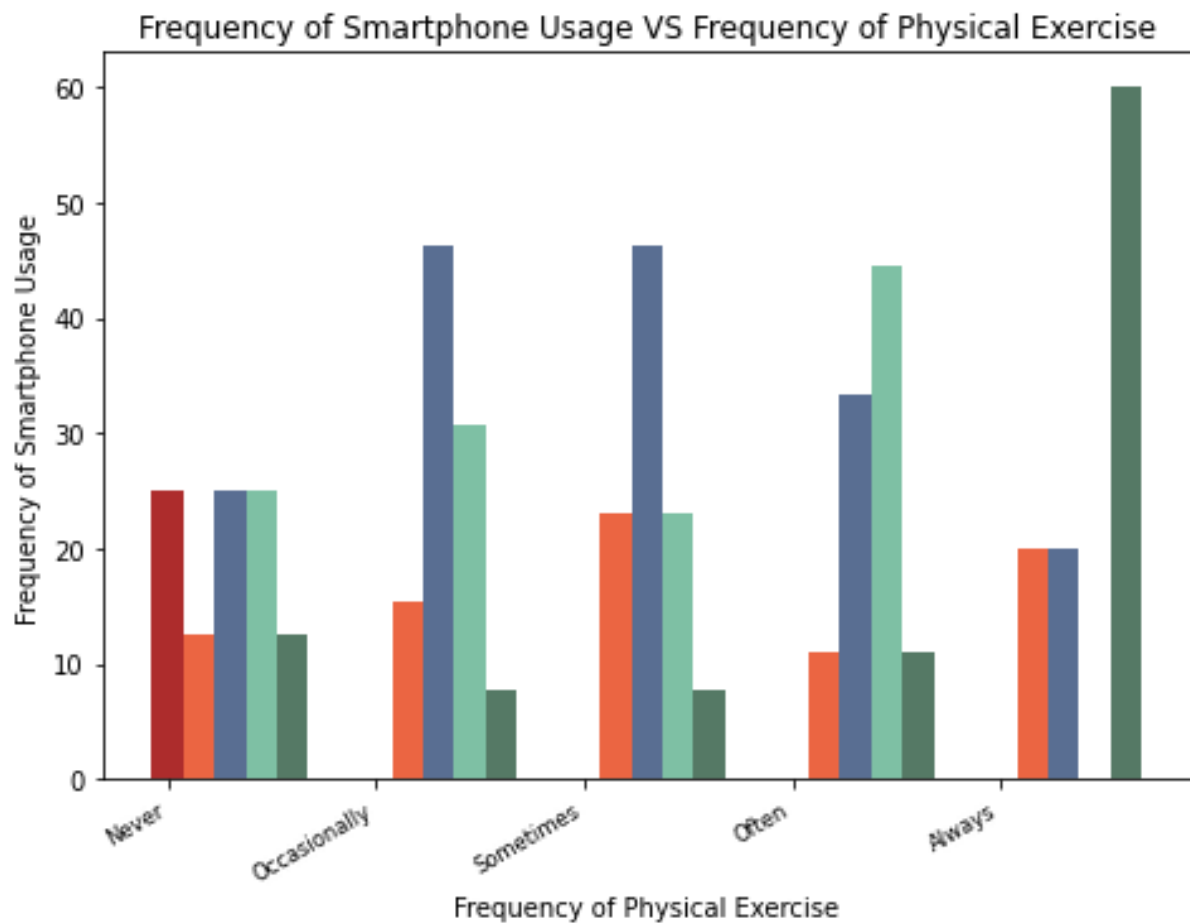
Here, we can see that overtime frequency decreases as we approach more and more optimum sleep duration. Most overtimes occur in case of least optimum sleep duration and least overtimes occur in case of optimum sleep duration. So we can conclude that **Sleep Duration** has a negative impact on **Overtime Frequency** and thus has a **positive impact** on developer productivity.

XX. Overtime Frequency and Average Sleep Starting Time



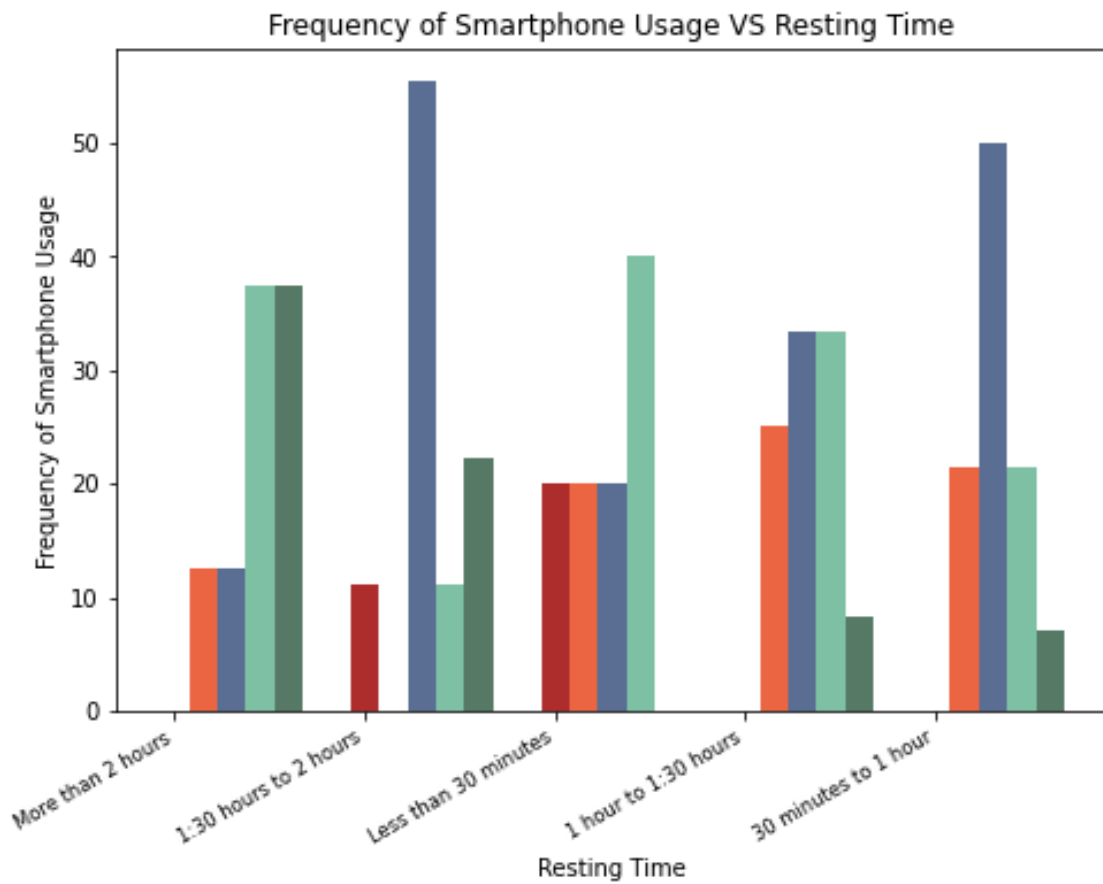
Here, we can see that overtime frequency increases as we approach more and more optimum sleep starting time. Most overtimes occur in case of most optimum sleep starting time and least overtimes occur in case of least optimum sleep starting time. So we can conclude that **Sleep Starting Time** has a positive impact on **Overtime Frequency** and thus has a **negative impact** on developer productivity.

XXI. Frequency of Smartphone Usage and Frequency of Physical Exercise



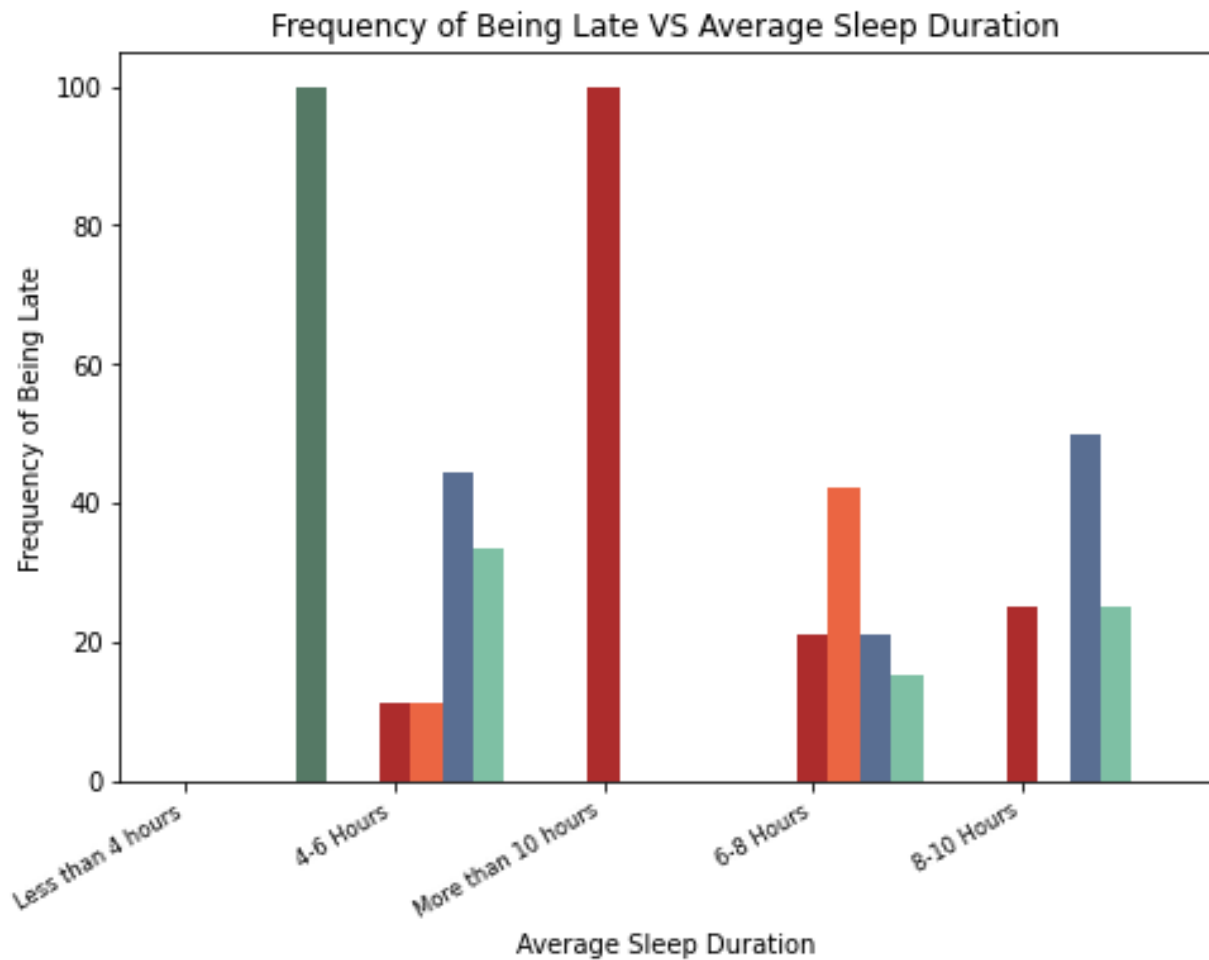
Here, we can see that there is no consistent relation between sitting time and deadline crossing frequency. So we can conclude that **Physical Exercise** has a neutral impact on **Smartphone Usage** and thus has a [neutral impact](#) on developer productivity.

XXII. Frequency of Smartphone Usage and Resting Time



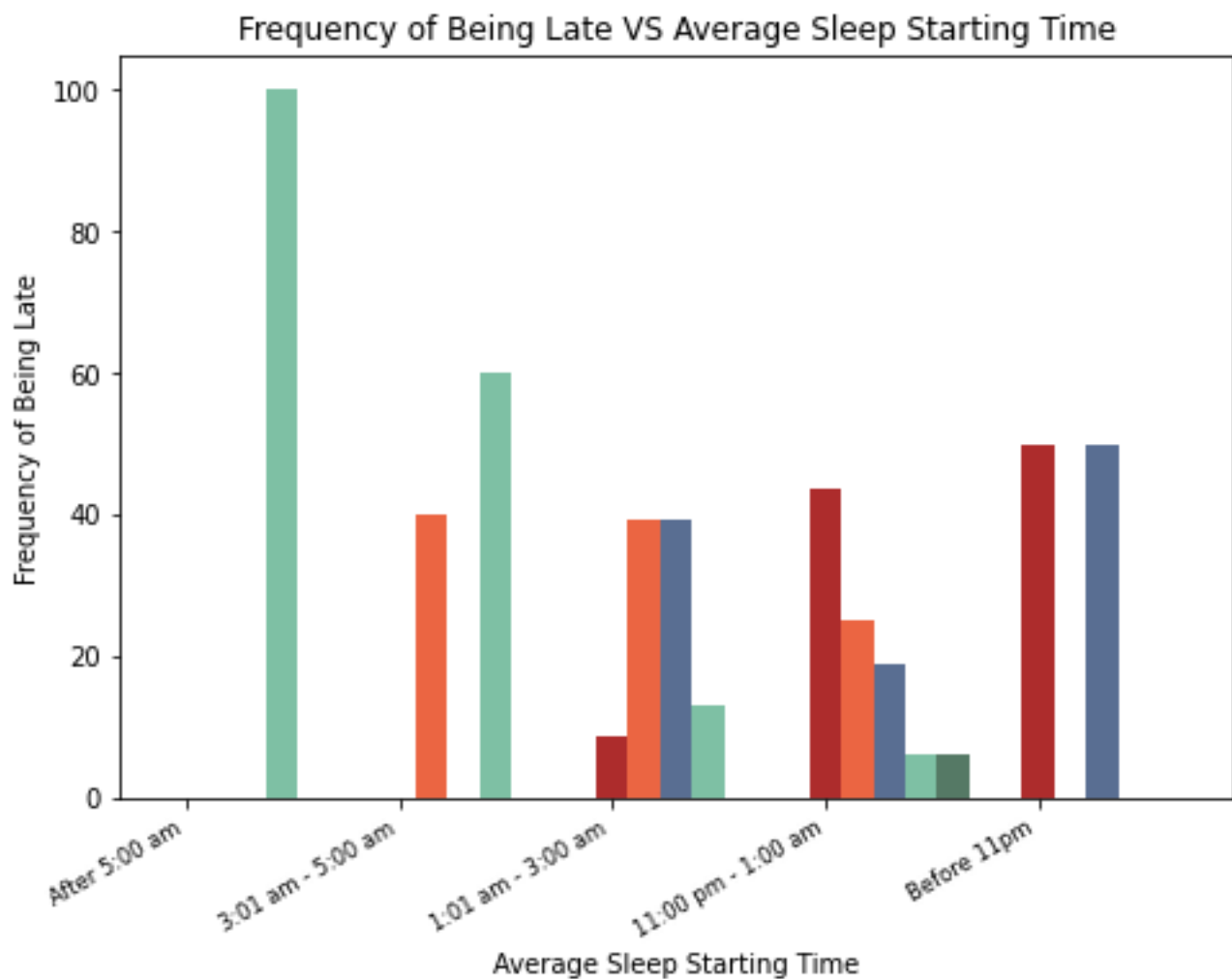
Here, we can see that initially smartphone usage decreases with more and more optimum resting time, but increases in case of most optimum resting time. So we can conclude that **Resting Time** has a neutral impact on **Smartphone Usage** and thus has a [neutral impact](#) on developer productivity.

XXIII. Frequency of Being Late and Average Sleep Duration



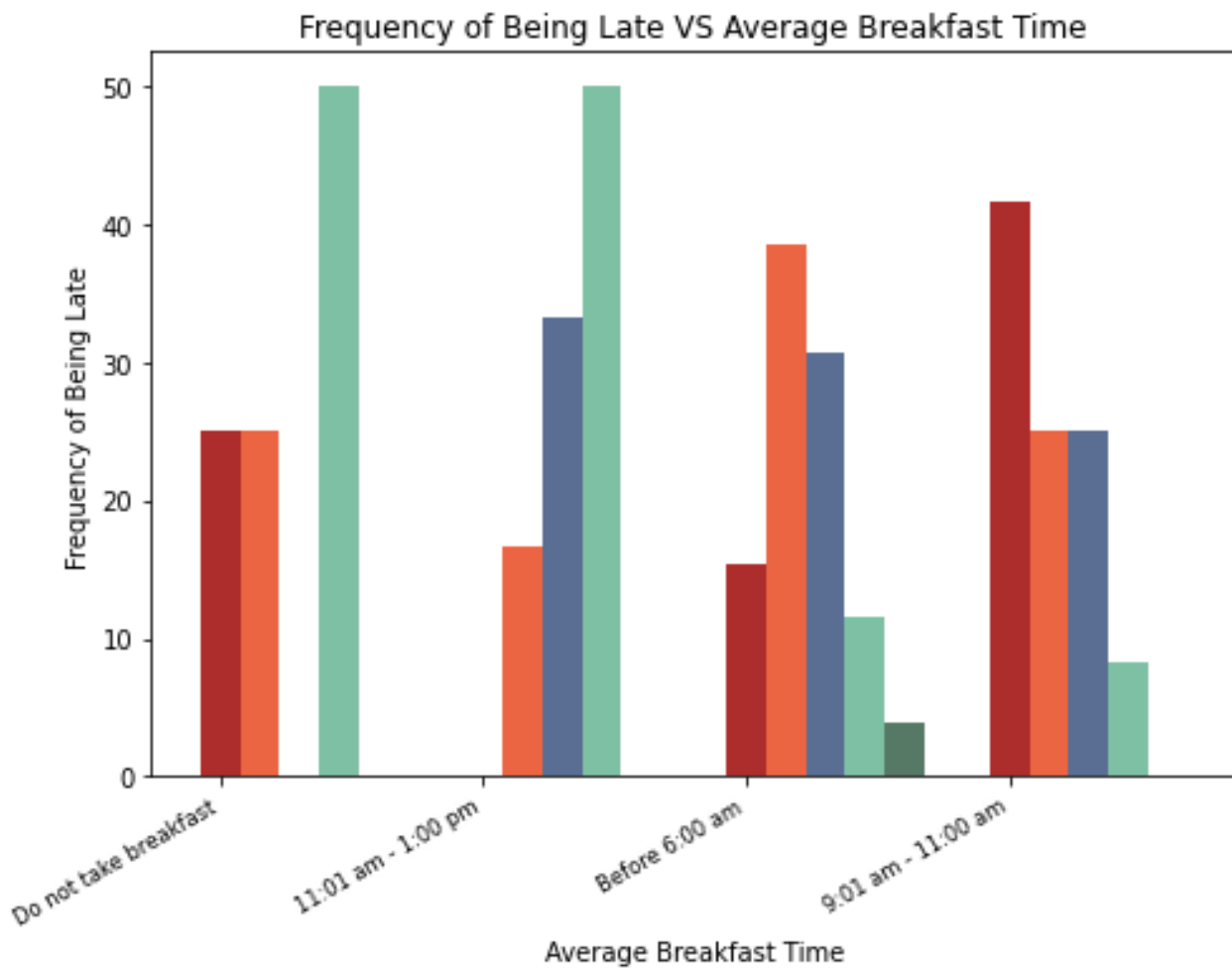
Here, we can see that there is no consistent relation between sleep duration and frequency of being late. Most late frequency occurs in case of least optimum value of sleep duration. Least late frequency occurs in case of moderately optimum sleep duration and moderate amount of late occurs in case of most optimum sleep duration. So we can conclude that **Sleep Duration** has a neutral impact on **Frequency of Being Late** and has a [neutral impact](#) on developer productivity.

XXIV. Frequency of Being Late and Average Sleep Starting Time



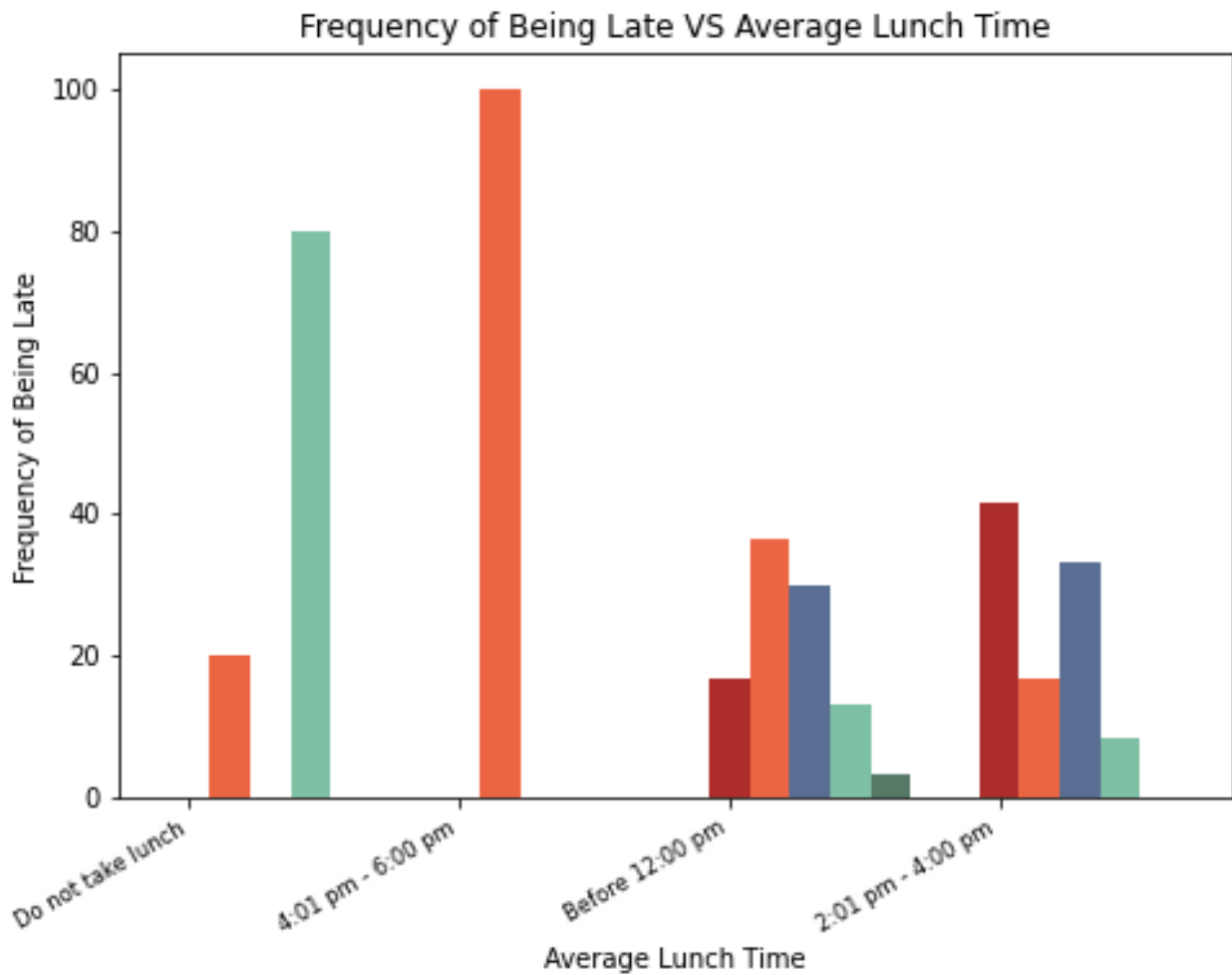
Here, we can see that the most amount of late occurs in case of least optimum sleep starting time, then gradually decreases and least amount of late occurs in case of most optimum sleep starting time. So we can conclude that **Sleep Starting time** has a negative impact on **Frequency of Being Late** and has a positive impact on developer productivity.

XXV. Frequency of Being Late and Average Breakfast Time



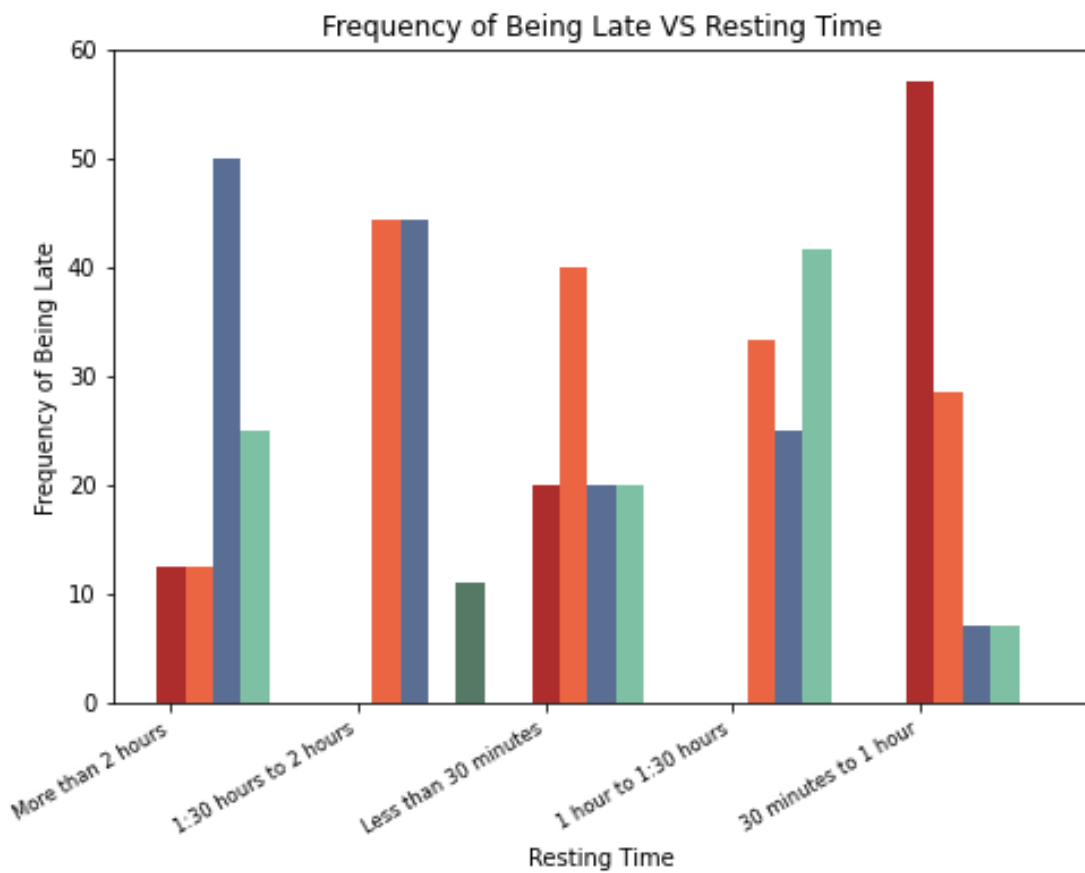
Here, we can see that less frequency of late occurs as we approach more and more optimum breakfast time. So we can conclude that **Breakfast Time** has a negative impact on **Frequency of Being Late** and has a **positive impact** on developer productivity.

XXVI. Frequency of Being Late and Average Lunch Time



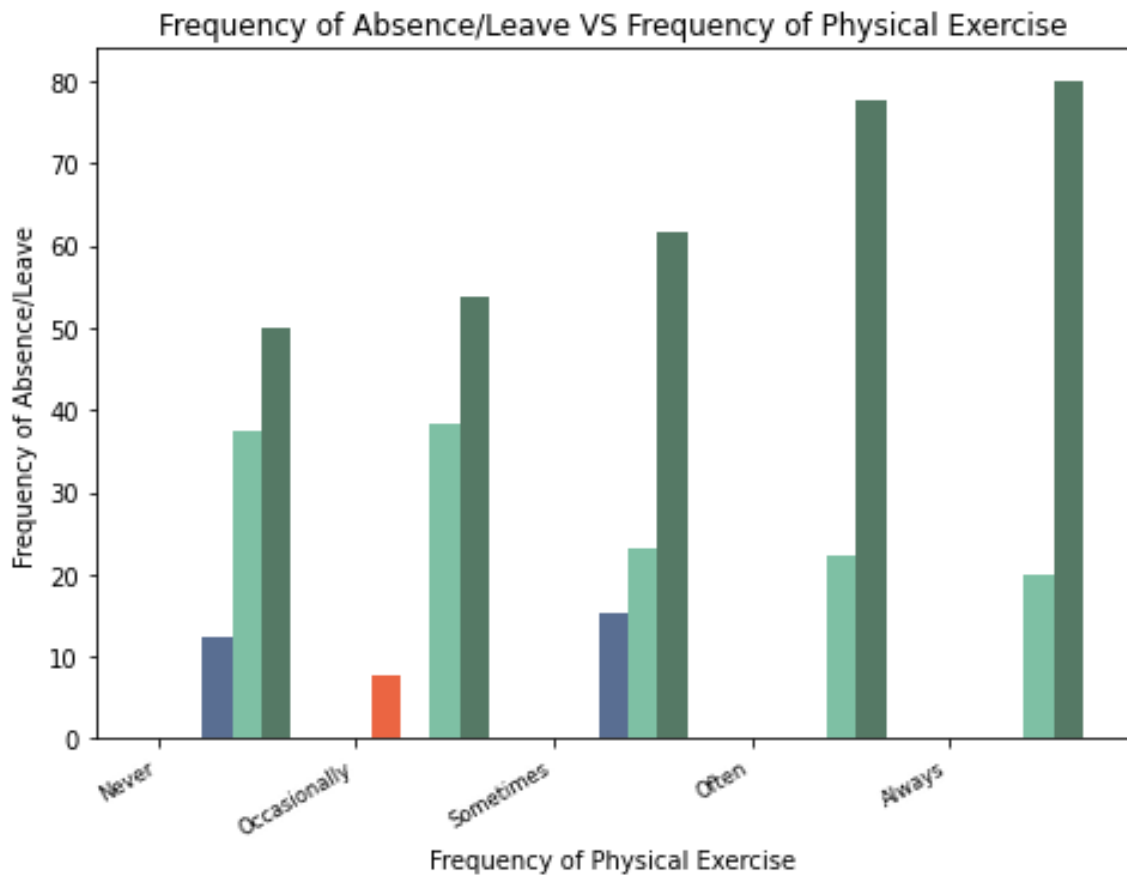
Here, we can see that less frequency of late occurs as we approach more and more optimum lunch time. So we can conclude that **Lunch Time** has a negative impact on **Frequency of Being Late** and has a **positive impact** on developer productivity.

XXVII. Frequency of Being Late and Resting Time



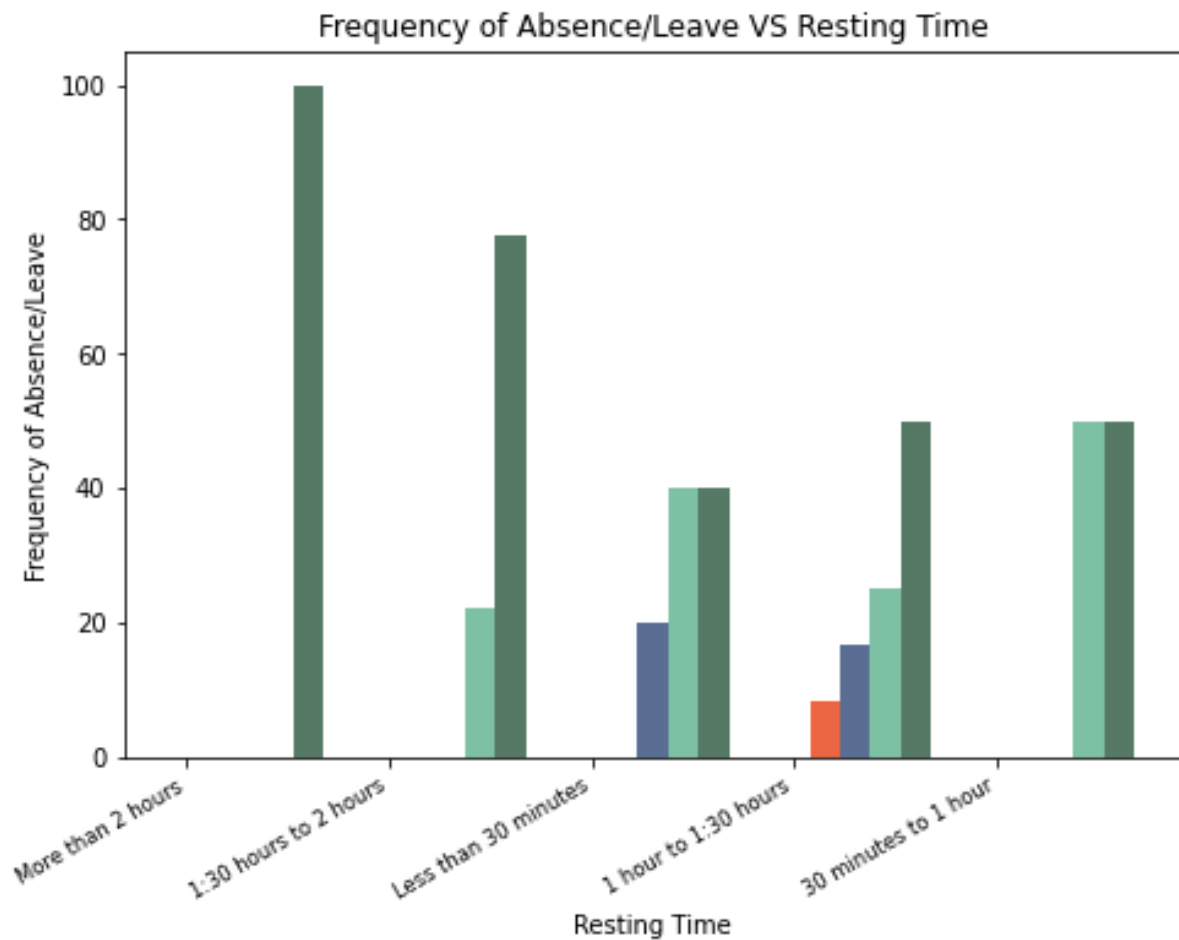
Here, we can see that there is no consistent relation between resting time and frequency of being late. So we can conclude that **Resting Time** has a neutral impact on **Frequency of Being Late** and has a [neutral impact](#) on developer productivity.

XXVIII. Frequency of Absence/Leave and Frequency of Physical Exercise



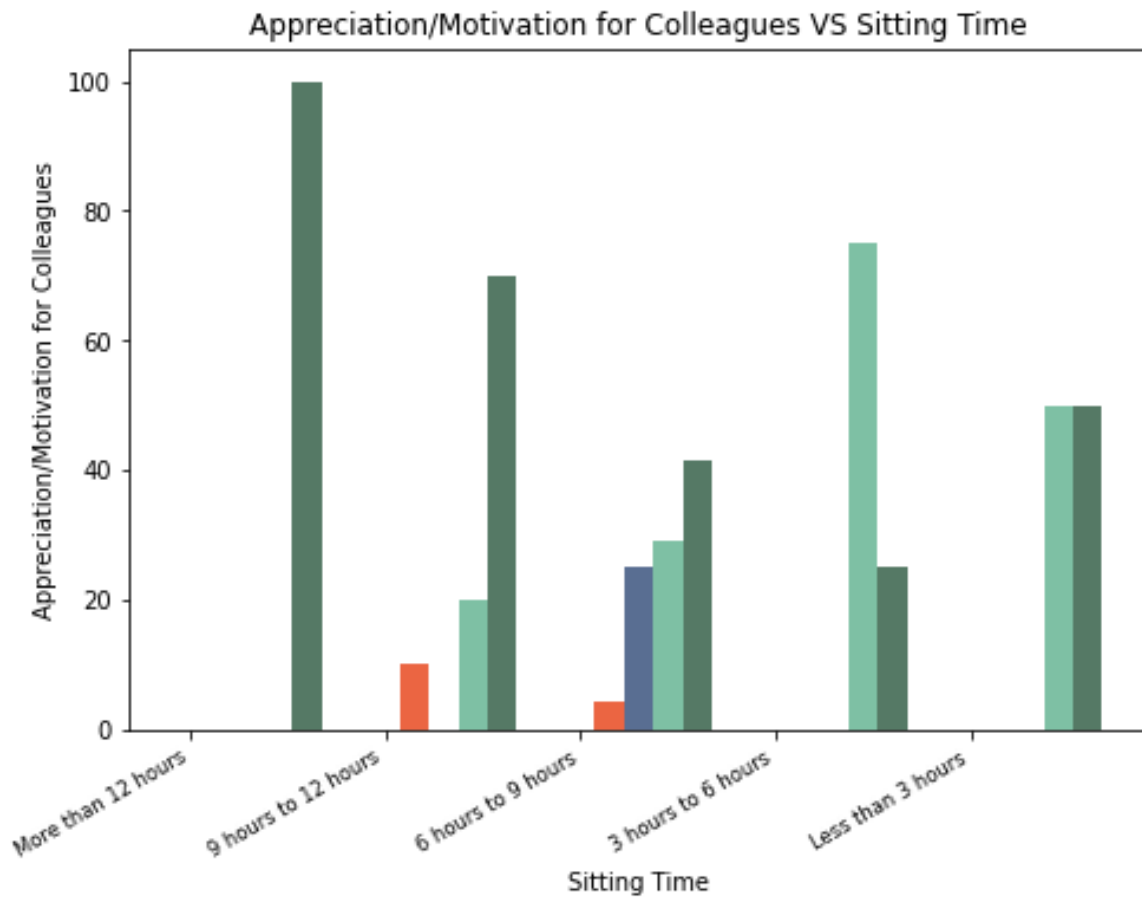
Here, we can see that the frequency of leave increases as we approach more and more amounts of physical exercise. So we can conclude that **Physical Exercise** has a positive impact on **Frequency of Absence/Leave** and has a **negative impact** on developer productivity.

XXIX. Frequency of Absence/Leave and Resting Time



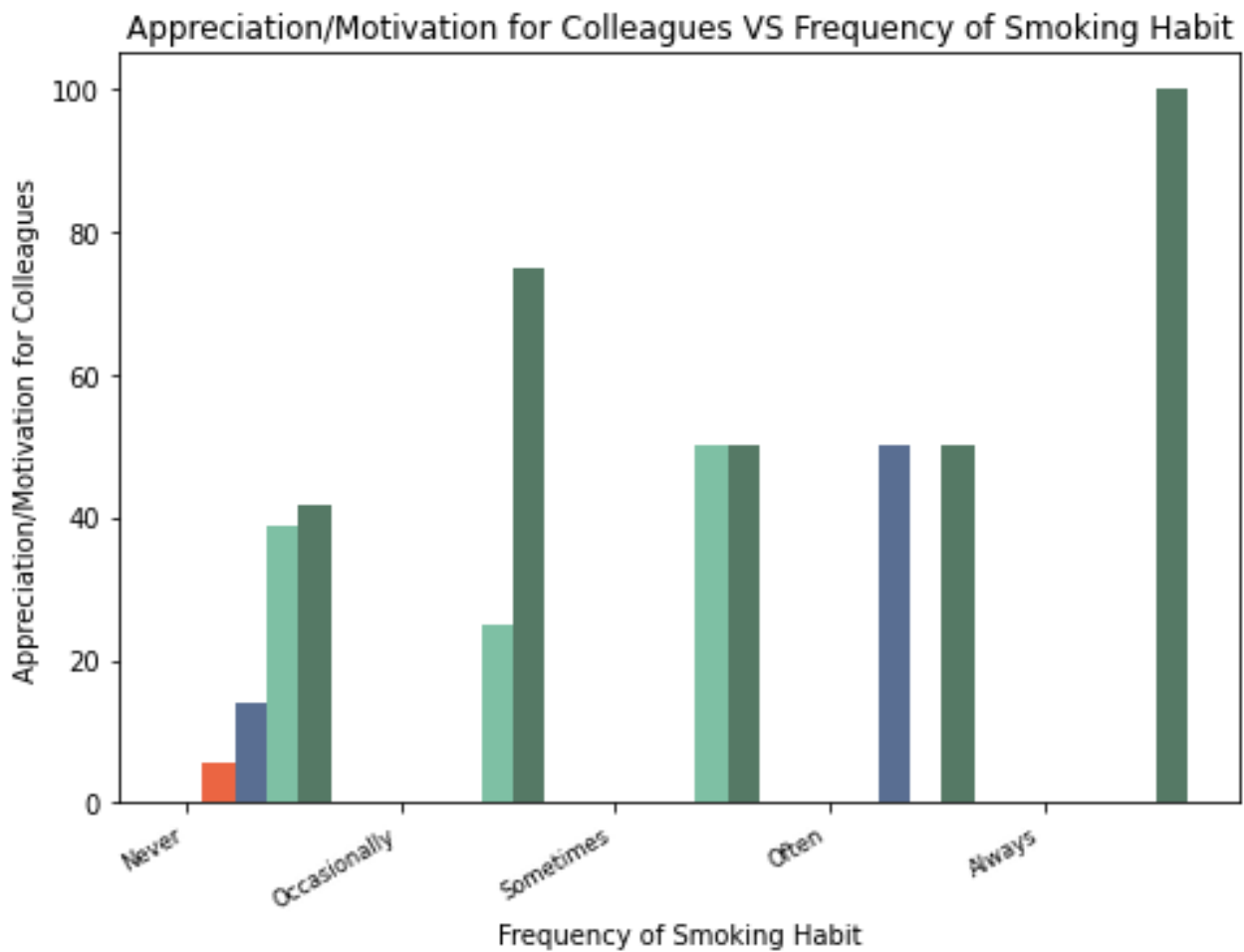
Here, we can see that there is no consistent relation between resting time and frequency of leave. Frequency of leave decreases initially and then increases as we approach most optimum value for resting time. So we can conclude that **Resting Time** has a neutral impact on **Frequency of Absence/Leave** and has a [neutral impact](#) on developer productivity.

XXX. Appreciation/Motivation for Colleagues and Sitting Time



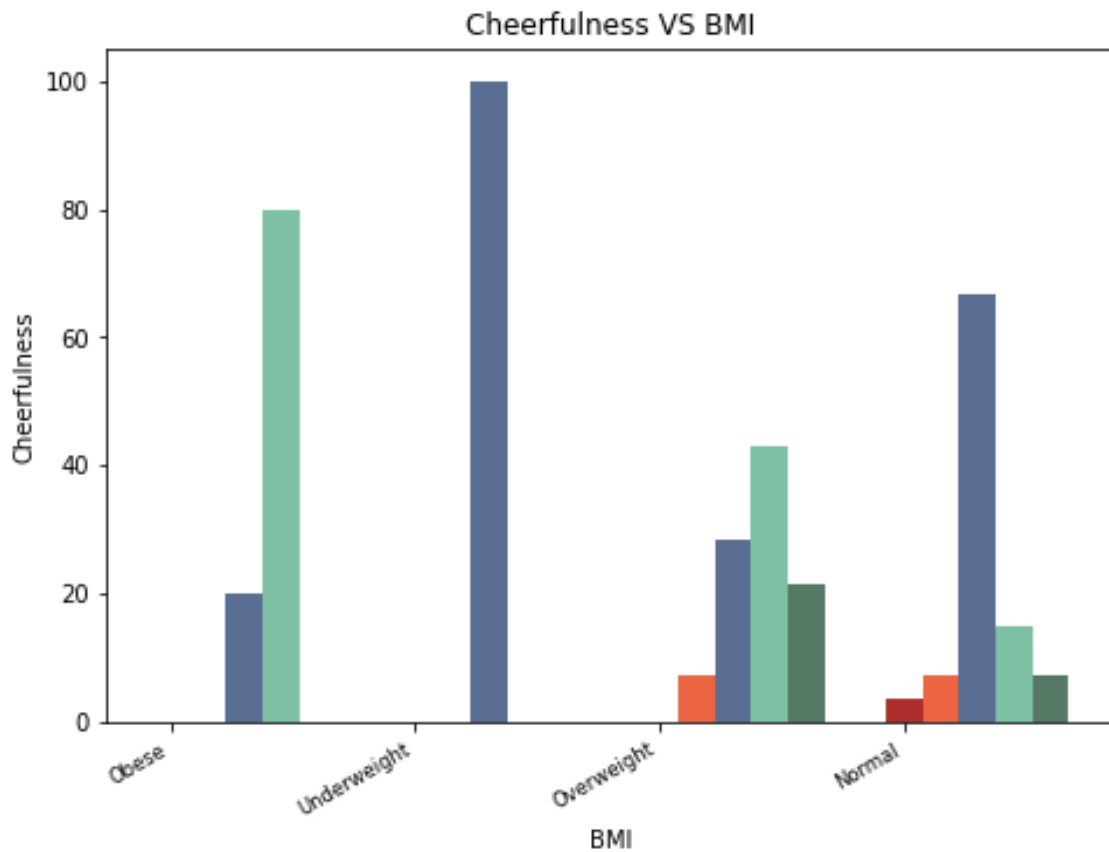
Here, we can see that there is no consistent relation between sitting time and motivation for colleagues. Motivation for colleagues decreases initially and then increases as we approach most optimum value for sitting time. So we can conclude that **Sitting Time** has a neutral impact on **Appreciation/Motivation for Colleagues** and has a [neutral impact](#) on developer productivity.

XXXI. Appreciation/Motivation for Colleagues and Frequency of Smoking Habit



Here, we can see that there is no consistent relation between smoking habit and motivation for colleagues. So we can conclude that **Smoking habit** has a neutral impact on **Appreciation/Motivation for Colleagues** and has a [neutral impact](#) on developer productivity.

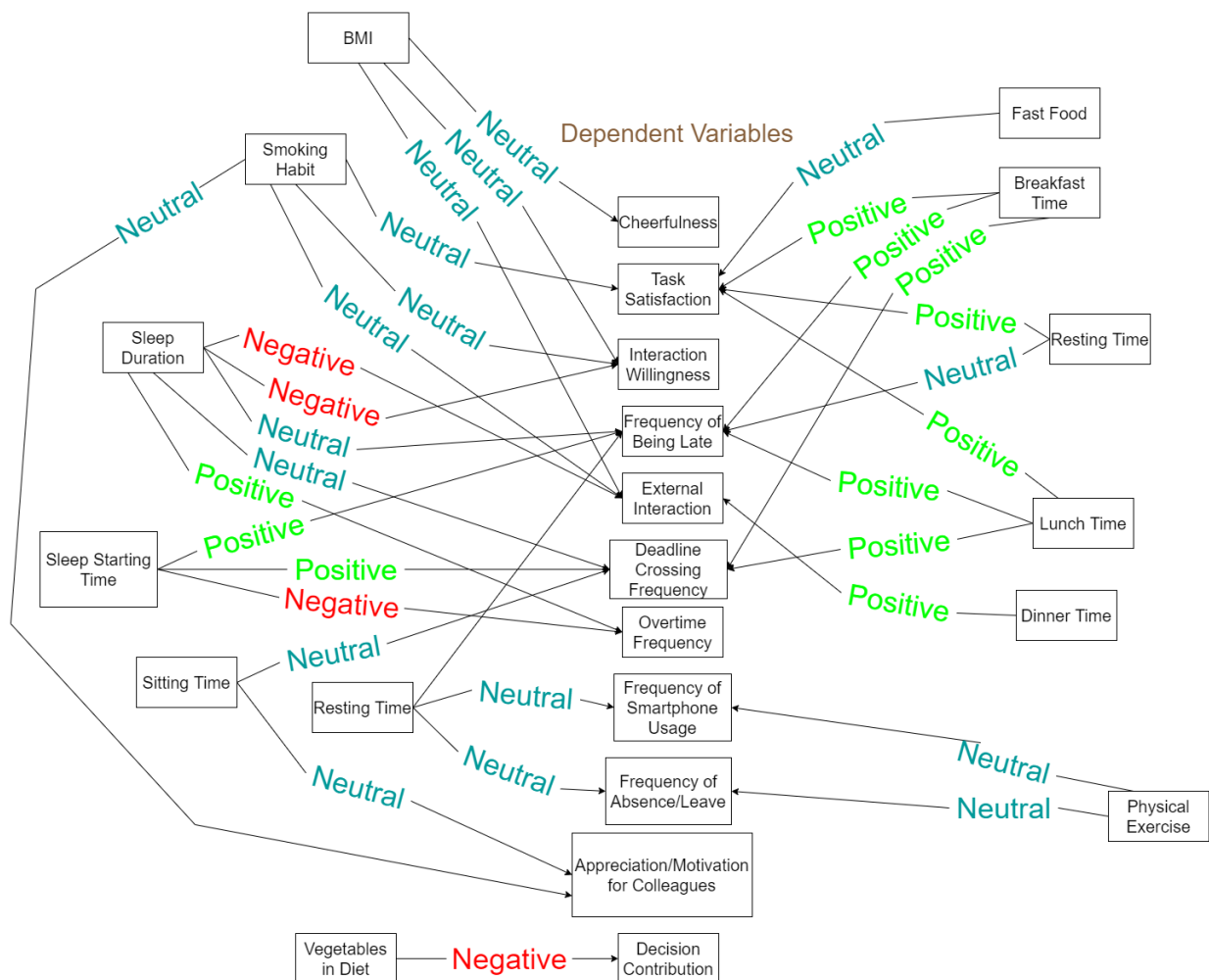
XXXII. Cheerfulness and BMI



Here, we can see that there is no consistent relation between BMI and cheerfulness. So we can conclude that **BMI** has a neutral impact on **Cheerfulness** and has a [neutral impact](#) on developer productivity.

7. Result Summary and Conclusion

We started our analysis with 14 independent variables and 12 dependent variables. After correlation analysis, we found 32 pairs of productivity and physical health factors. After creating bar charts, we found that there are 11 cases when physical health factors have a positive impact on productivity. In 17 cases, we concluded that the physical health factors have a neutral impact on productivity. We also concluded that productivity is negatively impacted by physical health factors in 4 cases. So we can see that there is not significant evidence to say if physical health factors have any kind of impact on developer productivity. However, we also see that food habits like meal timing mostly have a positive impact on productivity. Sleep habits have both positive and negative impact on productivity factors.



The arrows in this picture show impact on productivity

8. Resources

8.1 Survey Questionnaire Link

<https://forms.gle/W4MxK2iwoQ1rggQ19>

8.2 Project Source Code

The code for this project can be found here:

<https://github.com/bsse1006/ImpactOfPhysicalFitnessOnDeveloperProductivity>