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Does caffeine consumption affect work performance across different job types?

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RSCH 202: Introduction to Research Methods

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Abstract

We propose executing a panel series case study for a large organization in Singapore over a year to examine how caffeine impacts work performance across different job types. Our research question is how does caffeine affect work performance under different conditions due to work type differences. Our dependent variable would be work performance as measured by employees' Key Performance Indicators (KPIs). We propose to gather data for two of our important independent variables: caffeine use through a recorded pantry system and average sleep hours from a survey. We will analyze the data by using two-factor ANOVA with replication to find the interaction between Caffeine and Work types, as well as regression analysis to determine the impact of key-independent variables. The findings of our study has the potential to influence safety regulations surrounding jobs relating to caffeine, similar to the regulations for alcohol.

Keywords: caffeine, work performance, work type

Introduction

Caffeine has been a staple of the human diet for millennia; it is a naturally occurring stimulant found in coffee, tea, cocoa, and various soft drinks. Coffee, energy beverages, and caffeine pills have the highest caffeine levels; tea is in the middle of the spectrum, and soft drinks have the lowest. (van Dam, 2020). We may have consumed caffeinated products daily, but unbeknownst to the general public, the impacts of caffeine may have affected our daily activity. Coffee is the most popular caffeine source among adults, while soft drinks and tea are the most popular caffeine sources among teens. (van Dam, 2020).

Caffeine, when consumed in caffeinated goods, acts as a chemical stimulant to the human neural network. It belongs to the xanthines group, which also includes theobromine and theophylline. The most important methylxanthines are caffeine, theobromine, and theophylline (Monteiro, 2016). Because of their bronchodilatory and stimulatory characteristics, methylxanthines are a purine-derived family of pharmacologic substances with therapeutic uses. There have been two techniques described for producing labeled caffeine: a full synthesis using [15N]urea3 and direct methylation of xanthine (or its methyl compounds) using 13CH3I 4,5 or CD3I.6-9 (Balssa, 2007).

Caffeine is well-known for its capacity to boost alertness, concentration, and cognitive performance. Caffeine is a methylxanthine that has been shown to enhance mood, vigilance, and awareness by speeding up motor processes via central and/or peripheral mechanisms (Beaven, 2013). Caffeine increases alertness and wakefulness by inhibiting the action of adenosine, a neurotransmitter that encourages relaxation and slumber. Caffeine is the most commonly ingested psychostimulant in the world, and it has been shown to influence basic and essential human processes such as sleep, arousal, intellect, learning, and memory; it acts as a nonselective blocker of adenosine receptors (A1, A2a, A2b, and A3) and

has been linked to heart rate modulation, cardiac and smooth muscle contraction/relaxation, and neuronal signaling in the central nervous system (CNS) (Rivera-Oliver, 2014).

Caffeine substances, due to the chemical impacts they have on neurological networks, are a dependent variable in individuals" energy levels and concentration span. However, the effectiveness of caffeine products on the neurological network varies depending on the individual. The liver cytochrome P450 1A2 metabolizes the bulk of caffeine, and various alleles of this gene have been shown to influence caffeine metabolism rates (Tunnicliffe, 2008). Due to its biological properties, it is undoubtedly that Caffeine could temporarily increase alertness, but it may not necessarily increase work performance. Caffeine withdrawal was related with various negative and severe consequences, such as increased tiredness, decreased mental alertness, and worse performance on basic reaction time, choice reaction time, and recognition memory tests (Rogers, 2013).

As there is an insufficient study on the impact of caffeine on work performance of different work types. It is worthwhile to investigate the impact of caffeine consumption on work performance from different work types as the findings of our study may influence workplace safety regulations pertaining to caffeine similar to alcohol.

Hence, we are proposing a study to analyse the impact of different caffeine consumption and different work types on work performance. The null hypothesis $(\boldsymbol{H_0})$ would be caffeine does not affects the consumer's work performance in different jobs, while our alternate hypothesis (H_1) is that caffeine does affect the consumer's work performance in different jobs.

We propose to have a panel series case study on an organization with multiple departments, such as Changi Airport Group, to identify the impact of caffeine and different work types on work performance across a period of one (1) year, to have a better quality and diversified responses. A longitudinal, or panel, data collection is one that observes a specific

group of people across time and so gives several observations on each person in the group (Hsiao, 2014).

The data collected would then be used for a Two-factor Analysis of Variance (ANOVA) with replication to analyse if there is an interaction between Caffeine Consumption and Work Types, and Regression Analysis to identify the impact of individual variables on work performance.

Literature Review

Past Studies

Past studies have been done on the topic of caffeine and how it affects an individual's work performance. While this study aims to research the various effects caffeine has on an individual's work performance across different job types.

A detailed double-blind experiment has been conducted previously to analyze the impact of caffeine in a 4-day period on energy expenditure. They had a control and variable group in their experiment with a set of control variables such as eating habits and activity. It was found that a modest dose of caffeine consumption had no immediate or long-term impact on Energy Expenditure or Physical Activity, but it did cause a significant decrease in total sleep duration during free-living conditions in healthy young men who were not acclimated to caffeine (Júdice, 2013). The research was fairly unbiased by implementing a double-blind experiment, however, the research studies were only specific to non-obese males and may not be a good representation of the general population that we wish to study.

Another past research looked at the impact of varying caffeine consumption on alertness and performance over the course of a working day. It analyzed data from three previous secondary databases, each with a sample size of 110, 1253, and 1555 employees

respectively. The analysis found that those who consumed more caffeine reported significantly greater increases in alertness throughout the working day and a significantly smaller slowing of reaction time, as well as significant associations between caffeine consumption and fewer cognitive failures and workplace accidents (Smith, 2005). Secondary sources may be more reliable than primary sources, depending on the source's credibility; nonetheless, analyzing secondary sources may restrict the parameters of research.

However there are also previous studies that suggest caffeine has negative effects on work performance. A double blind study was conducted and the findings suggested that Caffeine may not necessarily increase work performance as Caffeine withdrawal can impede normal functioning, due to weariness and performance declines caused by abrupt caffeine abstinence may have serious consequences for safety (Juliano, 2012). Caffeine withdrawal has its effect on alertness level and cognitive ability which affects work performances as research suggests that Caffeine use that is not sensibly controlled during the first daytime will result in sleep deprivation and performance deficiencies during the second daytime (O'Callaghan, 2018).

Aside from caffeine consumption studies, there are various methods of study to measure and quantify work stress levels. One of which is Experience sampling methods, to measure workplaces stress. An research study developed and tested measures of instantaneous stressors (Task Demand and Task Control) and the Multidimensional Mood Questionnaire as a measure of momentary strain (Negative Valence, Tense Arousal, and Fatigue) across a sample of 215 Italian-speaking full-time office workers (Menghini, 2022).

There was a past study that measured alertness level with data from a questionnaire with an array of different alertness measurement scales across 3 different periods of the day for 4 weeks. The morning session included the Karolinska Sleep Diary (KSD), a modified version of the Morning Need of Recovery Scale, the Karolinska Sleepiness Scale (KSS), and

the Rating Scale Mental Effort (RSME), while the lunchtime session repeated KSS and RSME, and lastly the evening session included the Headache and Eye Strain Scale (H&ES), the Positive and Negative Affect Scale (PANAS), the KSS, and the RSME (Viola, 2008). Another study utilizes mobile applications and softwares to measure alertness level in hospitals. The alertness program was installed on a computer immediately outside the emergency room, and individuals took the test at the start and end of shifts (Ferguson, 2020). The application measures alertness level based on reaction speed and time across stimulated tasks on the software. The AlertMeter exam measures users' response speed and accuracy in recognizing whether provided collections of shapes are the same among distracting characteristics and graphical components to assess cognitive abilities (Ferguson, 2020).

Based on previous research, the most common techniques of the investigation were experiments to assess the effects of coffee on work performance or individual cognitive capacity. They derived their findings using analytical approaches such as regression or analysis of variance (ANOVA). The information gathered is largely from panel series or cross-sectional studies to determine the effects of caffeine on work before and after ingestion. Because age influences caffeine metabolism, the age group is commonly used as a control variable in research, while the independent variables are usually caffeine dosage and frequency and the dependent variables are work performance or cognitive ability to determine the effects of caffeine on work performance or cognitive ability.

Our Contributions

What our study is trying to find is the effectiveness of caffeine on different categories of jobs and prove if caffeine provides an overall benefit in terms of work performance. Factors such as the number of sleep hours, daily caffeine intake, or the different effects caffeine has on certain people have been common limiting factors in other research and this study aims to find the most reliable conclusion after taking into account these external issues.

The past studies try their best to level the playing field by controlling variables such as their sleep and caffeine intake, adjusting for weight, and monitoring their vitals while recording their performance, such as pattern recollection, reaction time, and concentration. The past studies successfully identified the issue which is that the dosage of caffeine affects people of different weights and body types differently and adjusted for their weight. They also controlled the participants' sleep to try and level their levels of rest. However, sleep time or sleep quality varies for different individuals. They also issued the same standardized tests for everyone. Our research aims to find which jobs would benefit from caffeine intake more and which might actually suffer from it. The results of our study could impact workplace safety regulations pertaining to caffeine consumption similar to alcohol depending on the outcome of the study.

Research Question

We wanted to find out if caffeine affects the human body under extreme conditions, such as sleep deprivation or high-stress load levels in the context of various work settings or the nature of work. Hence our research question is "Does caffeine consumption affect work performance across different job types?"

Since most of the previous studies have extensively researched the effects of caffeine on work performance and cognitive ability, it is worthwhile to expand on the existing topic and investigate how caffeine and different working environments, such as profession and nature of work, affect their respective work performance.

Hypothesis

The null hypothesis would be Caffeine does not affect the consumer's work performance in different jobs, while our alternate hypothesis would be Caffeine does affect the consumer's work performance in different jobs.

H_0: Caffeine does not affect the consumer's work performance in different jobs

H_1: Caffeine does affect the consumer's work performance in different jobs.

Since caffeine consumption has been shown in past studies to have an effect on cognitive capacity in the past, while various occupations have varying cognitive capacity requirements, which may impact perceived work performance.

Population and Sample

Population

The population of this study consists of adults in the workforce who consume caffeine regularly. Based on our control variables, we are explicitly selecting experienced working adults between the ages of 25 and 40 with a minimum of three years of work experience as our population. Given that our research question revolves around the impact of caffeine on the work performance of individuals from various work types, our study population must be between the ages of 25 and 40 to ensure fairness of the findings between our two study groups, physical and mental labor, so that it is not subjected to the effects of aging, especially in physical labor. The aging process is associated with progressive changes in the human body, such as a loss of muscle mass and a decline in muscular strength. Recent research has shown that severe losses in muscle strength reliably predict functional limits, disability, and

death (Bertoni, 2018). Subsequently, we specifically targeted individuals with at least three years of work experience since we did not want the lack of experience to influence the findings of our study, which is mainly contingent on their individual work performance. Given that we implemented the following parameters in our study, specifically selecting working adults between the ages of 25 and 40 with at least three years of job experience, it would be deceitful to claim that our findings correctly represent the total work population, hence we intentionally chose the above-mentioned as our study's population.

Sample

We propose adopting a purposive sampling method to select an organization that we consider best fits our research specifications, notably organizations with varied departments of diverse job type, such as Changi Airport Group. Although purposive sampling is a non-probability sampling approach, and it cannot accurately reflect the population due to the possibility of selection bias. However, for an organization like Changi Airport Group with a diverse work department, the choice of Changi Airport Group should not directly impact the caffeine consumption and metabolism of the sample, unless shift-work hours were considered. This will also allow us to observe the impacts of caffeine on the work performance of individuals from different work types. The departments within Changi Airport Group are Airhub Development, Airport Emergency Service, Airport Management, Changi East Development, Commercial sector, Corporate sector, Engineering and Development sector and Enterprise Performance and Development sector (Changi Airport Group, n.d.). Although based on the Central Limit Theorem (CLT), a minimal sample of 30 individuals would be sufficient for a decent statistical study so as to give us a more accurate result. If the organization utilizes a recorded pantry system that records information on individual employee consumption, we would propose to have access to the required data of

every employee that falls within the population of study (working adults aged 25 to 40 with a minimum of three years of work experience). Changi Airport has already employed over 4,000 individuals in the first six months of 2022, bringing the total number of employees to almost 29,000 people (Yong, 2022). This is done to maximize the potential of the data made available by the recorded pantry system in order to improve the quality of our findings.

Should the collaborated organization not have a recorded pantry system, we propose to use a stratified/quota sampling approach with a minimum of 30 individuals with minimum of 3 years working experience (as a quality study of any T statistics would require a sample of 30 or more data) from each sector/department from our collaborated organizations. This is because we learnt that by using Central Limit Theorem (CLT), the value should be considered to have a bigger sample size of which is larger than 30, in order to ensure more accurate results when doing correlation tests (a sample larger than 30 would be considered normally distributed by CLT). In addition, having a sample size of which is more or equal to 30 will allow us to have a better idea of the final results as well as give us a better prediction as compared to having smaller sample sizes. Having smaller sample sizes would mean that the data results we get would be less accurate and significant. However, a limitation of employing survey methods to collect data on the consumption of caffeine is that the number of responses limits the quality of the study. To determine the appropriate sample size for this outcome, we will utilize the sample size formula (Qualtrics, 2020):

$$Necessary\ Sample\ Size, n = \frac{(z-score)^2 \times (standard\ deviation) \times (1 - standard\ deviation)}{(margin\ of\ error)^2}$$

Considering safety may be of concern depending on the outcome of the study, our proposed confidence level for this approach of study would be set at a confidence level 99%.

Variables and Measures

The dependent variable(s) is/are:

1. The mental state of the individual (based on a weekly survey on their alertness level)
2. The comfort level of the individual (based on a weekly survey on their stress level)
3. The work performance of the individual (based on Key Performance Index).

As our study revolves around how caffeine and different work types affect work performance, we need to take into consideration the other different factors that come into play that affect work performance. When analysing work performance itself, we have to take into account the mental state as well as the comfort level of the individual. These dependent variables do affect how an individual works, as well as how the individual copes with his or her job. We will look to access these dependent variables with the use of having weekly surveys, as there is no other feasible way to determine an individual's stress and comfort level.

We will first determine what scale level is considered to be stressful and then conduct weekly surveys to the participants and get them to rate their stress level and comfort level at the end of every week by comparing it to the Experiencing Sampling Method (ESM)' s scaling levels. Workplace stress levels could be measured using an Experience sampling methods (ESM) scale ranging from 1 to 7 to rate stress levels across multiple elements of workplace stress. ESM scales were created after reviewing current instruments in workplace stress and emotional studies, stressors and strain were assessed on a 7-point slider scale with 1 = not at all and 7 = very much for stressor items alone (Menghini, 2022). Whereas for the alertness level, we intend to use Karolinska Sleepiness Scale (KSS) to define the individual alertness level. The KSS is divided into nine levels: 1 = highly alert, 2 = very alert, 3 = alert,

4 = quite alert, 5 = neither alert nor sleepy, 6 = some indications of tiredness, 7 = drowsy, but little effort to stay awake, 8 = sleepy, some effort to stay awake, 9 = very sleepy, tremendous effort to stay awake, fighting sleep (Miley, 2016).

Another dependent variable that was acknowledged by our group was the work performance of the individual who participated in this experiment. Work performance can be accessed differently by different individuals. One may think that his/her work is up to standards, while another may not consider it to be up to standards. Hence, we need to ensure that there is consistency when rating the individual's work performance. That is why we propose to use the individual employee's Key Performance Index as a measure of their work performance. This will better allow us to identify the work performance of the anonymous individuals in comparison with the colleagues in the same and different departments based on the standardized scale of Key Performance Indexes. Additionally the Personal Data Protection Act defines an employee to be inclusive of volunteers and are excluded from the application of the Data Protection Provisions (Personal Data Protection Commission, 2021). Henceforth, it is legal and does not contravene the Personal Data Protection Act for an organization to collect and disclose employees' Key Performance Index.

The key independent variable(s) is/are:

1. Caffeine consumption in milligrams (mg) (data will be collected based on vending machine allowance/surveys).
2. The type of job the individual works.

Because our study is focused on how caffeine and different work types affect work performance, we chose caffeinated drinks and job types as our key independent variables so that we could isolate and observe the effects of caffeine and work types on work performance.

The data on caffeine consumption could be collected via the data from the individual usage of pantry entitlement, such as from a recorded vending machine that entitles and records individual usage on pantry allowance, or through a weekly survey should the company not have any recorded pantry system.

Subsequently, as the other independent variable is the different job types, we propose to request for a nominal roll from the Human Resource Department that corresponds their employee ID with their work type. Subsequently, the work type would be divided into “physical” or “mental” strenuous labour and into their respective departments. This allows us to help study caffeine's effects on the 2 main types of jobs.

The Control variable(s) is/are:

1. Dosage of Caffeine in caffeinated consumables in milligrams (mg)
2. The age of the individual (25-40) in years.
3. Work Experience / Work Proficiency (minimum 3 - 10 years of work experience)
4. Amount of sleep/rest during off-work hours in hours.

As we are studying caffeine's effects on various types of work, we would like to be able to monitor and “control” how much caffeine is in each serving of caffeinated beverages. By using a prepared drink dispensed by a machine, we would be able to find out how much caffeine is in each can of coffee, energy drink, etc. based on the nutritional facts label attached to each consumable product. The pantry across all locations and departments would then be equipped with the same type of caffeinated consumables options to ensure the fairness of the case study. The only caveat of this would be people who might not like to finish their coffee. E.G. (people who drink once a day but only half a can.)

Additionally, since caffeine would have an effect on sleep quality, we would like to know if the after-effects of caffeine indirectly affects work performance the next day due to compromise in sleep hours. We would then record the amount of sleep in the weekly survey during our weekly interactions with the participants. This would allow us to compare if there is interaction between caffeine consumption and sleep on work performance. Subsequently, we can also compare the relationship between an individual's work performance with the different job types and different caffeine consumption after standardizing their sleeping/rest hours.

Additionally, we also intend to select individuals who have some job experience as we do not want less experienced employees to have a lower KPI due to inexperience, hence we decided to propose a 3 year minimum work experience. The study will also focus on the

age group of 25-40 years, as this is the prime working age where caffeine consumption and its impact are most significant. Subsequently, individuals over the age of 40 may be at a disadvantage, especially for those that work in the physically strenuous labour category and will affect the work performance and the integrity of our research.

With the control variables of caffeine dosage, age, sleep hours, and work experience/proficiency in mind, we will be able to conduct an isolated study to examine the effects of caffeine on different types of work.

Data Collection Method

To reach out to an established organization such as Changi Airport Group, we would approach the Career Services, Alumni and Corporate Relations & Professional Education and Training department of Embry-Riddle Aeronautical University - Asia, to share our proposal for advice and assistance for reaching such an establishment that fits our study.

We propose to do a panel series case study across 1 year to also account for the difference in day cycles across the period of the year, that may affect the circadian sleep cycle. To begin any data collection, we must create a nominal roll in order to record the accurate data that corresponds with the correct individual. We would propose to request a nominal roll from the human resource department of the participants of our study. The nominal roll should consist of the following information: employee ID, work email address, work department, years of experience, Key Performance Index, and age (Refer to appendix B).

We have to keep in mind that some of the information we gather might be too sensitive to the employee’s personal privacy. The information we have would be through

their consent as well as not in violation of privileged information within the company as it would also be irrelevant to our study (Nielsen, 2014). The survey will only allow us to collect the data on control variables and independent variables that we are unable to collect from the vending machines. The Protection Act defines an employee to be inclusive of volunteers and are excluded from the application of the Data Protection Provisions (Personal Data Protection Commission, 2021). Written Consent from companies to collect employees' KPI is legal in Singapore as long as the employees sign a document to allow sharing of information. Subsequently, according to the Personal Data Protection Act (PDPA) of Singapore, whether KPIs are considered personal data depends on the specific context and the type of information collected (Personal Data Protection Commission, n.d.).

Caffeine Consumption

Some companies, such as Changi Airport Group, have a recorded pantry system, for example, vending machines that serve caffeinated beverages such as coffee or energy drinks like Red Bull, which may be purchased by an employee through his or her staff card. This will help us collect information about the employee’s caffeine consumption that correspond with their employee ID from the vending machine. This information would be accessed through the permission of the companies’ management for the purpose of our research, the data would then be reflected on the nominal sheet for data analysis.

Sleep Hours, Stress level and Alertness level

After collecting data from the vending machines, we created a survey (refer to appendix A.) in order to assess the respective individuals' sleep quality, alertness level and stress level that could impact their work performance. The survey would be disseminated via the individual work email address at the end of every week.

Main Proposal

We aim to conduct a study on employees of Changi Airport group or any company that has a wide variety of job types. (Mentally and Physically Laborious). To conduct a survey of Changi Airport Group employees regarding the effects of caffeine on work performance, we would need to obtain permission from the company first. It would be best to contact the Human Resources department of Changi Airport Group to request permission to conduct the survey. We wish to approach our Career Services, Alumni and Corporate Relations & Professional Education and Training department of Embry-Riddle Aeronautical University - Asia for assistance to establish communications with Changi Airport Group, given the past collaborations between both organization and university over the past years.

We understand that Changi Airport Group would not recklessly allow students to do a survey so openly just for the benefit of our grades at the risk of a data breach. However, as Changi Airport has a diversified population of employees with different work environments and nature, our study would be greatly beneficial for Changi Airport interests. This is because by conducting the case study, Changi Airport group would be able to understand how to better maximize the work performance of their employees with the use or limitation of caffeinated drinks. This will also allow the Changi Airport Group to better understand if their employees are maximizing work performance with caffeine, should the experiment prove that caffeine ultimately affects work performance. The company/organisation would be able to make caffeine more or less easily accessible to their employees which would be determined by the results of the study.

The HR department can provide guidance on the procedures for conducting the survey and may also be able to facilitate the survey process. They can also help ensure that the survey is conducted in a manner that respects the privacy of the employees and complies with

any relevant data protection regulations. Since the KPI would be provided by Changi Airport Group, based on the nominal roll, the survey results would be added corresponding to a specific identifier such as work email address or employee ID.

Alternative Proposal

Alternative methods include convenience surveys on the general population. This would be done in an event whereby we do not get the CAG's management's approval or if we cannot collect enough data from the vending machines since some employees get their caffeinated drinks from different sources e.g., Starbucks, coffee shops, home-brewed, energy supplements etc. Should our group not be able to gain access to the data regarding the work performances of employees and final survey results from the Changi Airport Group, an alternative solution would be to find another company with different sectors/ departments to prove how caffeine will affect the work performance of individuals with different jobs. In terms of finding these other companies as our backup plans, we would be approaching companies such as our own companies or companies that belong to our family and friends.

Data Analysis Method

Linear Regression Analysis

Since we are mainly identifying the impact between multiple variables on work performance: caffeine consumption, job types, caffeine content and sleep, age and work experience. We propose to use a linear regression analysis to identify the impact and significance between the variables on work performance. A regression analysis also allows us to identify the impact of each independent variable on the work performance, to identify what are the key affecting factors. The linear regression formula would be:

$$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

Dependent Variables (y):

- Key Performance Index
- Stress Level
- Alertness Level

Independent Variables:

- X_1: Caffeine consumption in Milligrams (mg)
- X_2: Type of Jobs (Physical = 0/Mental = 1, or Departments)

Control Variables:

- X_3: Dosage of Caffeine in caffeinated consumables in Milligrams (mg)
- X_4: Age in years
- X_5: Work Experience in years
- X_6: Amount of sleep/rest during off-work hours in hours.

This Linear Regression Analysis would allow us to breakdown the individual impact of each key variable and identify amongst them, which would penultimately affect work performance the most. Should the results show that caffeine has a strong impact on work performance, workplace safety regulations may be amended regarding caffeine consumption similar to alcohol depending on the direction of the impact.

Two factor ANOVA with replication

We also intend to use two factor Anova with replication to do an analysis on the collected data, mainly to identify if there is an interaction between Caffeine consumption and Work types on work performance. Our group does note that there are many external variables

that come into play when doing this experiment and survey, considering that sleep quality may be influenced by caffeine consumption which may affect work performance. Hence the two factor ANOVA with replication analysis would also allow us to observe any interaction between the many sub-variables and give us a better look at how each sub-variables play their role in this experiment by observing any signs of interaction.

Conclusion

This panel series case study is designed to compare the effects caffeine has on an individual's work performance across different job types, which are categorised by being either physically or mentally strenuous or into their individual departments. The key independent variables are the caffeine consumption (mg) an individual consumes in a day, and the type of job he or she does, while the dependent variables are the mental state and comfort level of the individual (based on weekly surveys), as well as the work performance of the individual (based on Key Performance Index). We implemented a few control variables such as Age, Caffeine Content in available beverages, Sleep hours, and work experience to isolate the impact of caffeine consumption and job types on work performance.

However, there are some limitations of our study that we wish to acknowledge, there are numerous external factors that could affect work performance heavily that we would not be able to measure much due to the invasion of privacy or impracticality. Some of those factors are:

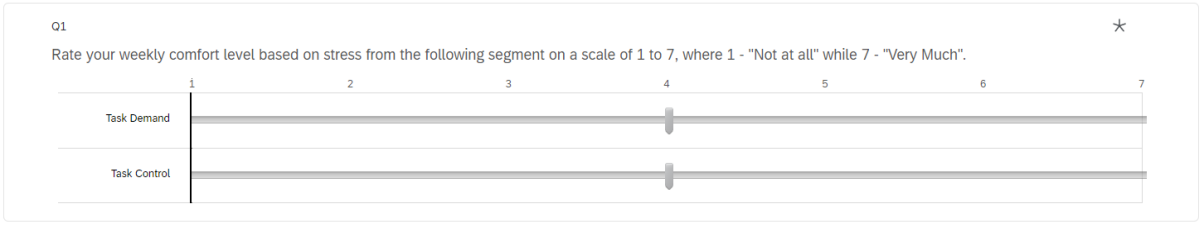
1. Work Environment: The physical surroundings, such as noise levels, lighting, temperature, and office layout, can impact concentration, focus, and overall productivity.

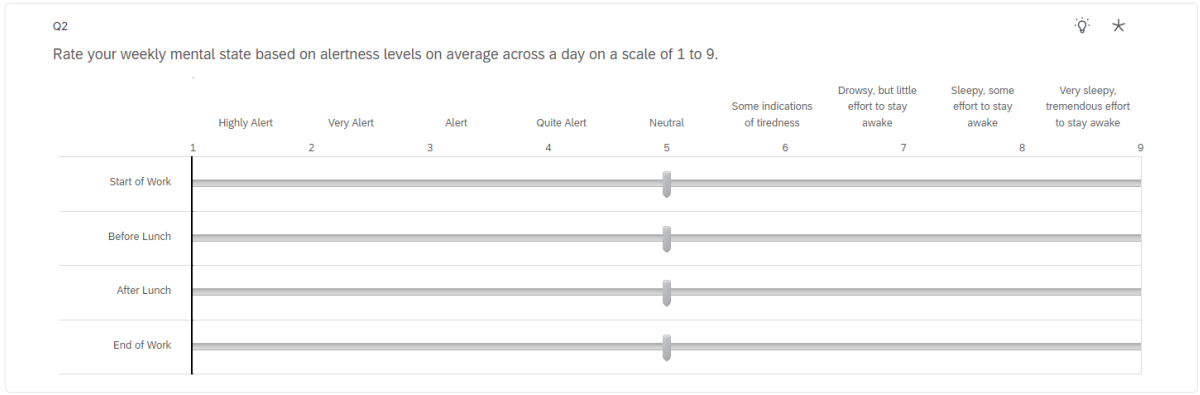
2. Leadership and Management: Effective leadership and management styles play a vital role in employee performance. Good leaders provide guidance, support, and resources, while poor leadership can lead to confusion, demotivation, and a lack of direction.
3. Work-Life Balance: Striking a healthy work-life balance is crucial for sustained performance. Factors such as long working hours, lack of flexible work arrangements, and inadequate support for personal commitments can lead to burnout and decreased productivity.
4. Compensation and Rewards: Fair and competitive compensation, as well as recognition and rewards for good performance, can motivate employees and enhance their commitment to achieving goals. Vice versa, low compensation or a lack of recognition may reduce motivation and job satisfaction.
5. Social Support: The relationships and interactions with colleagues and superiors can impact work performance. Positive social support networks, teamwork, and effective communication enhance collaboration and overall productivity.
6. External Events and Distractions: External factors like political events, natural disasters, personal crises, or major world news can distract employees, disrupt routines, and affect concentration and focus.

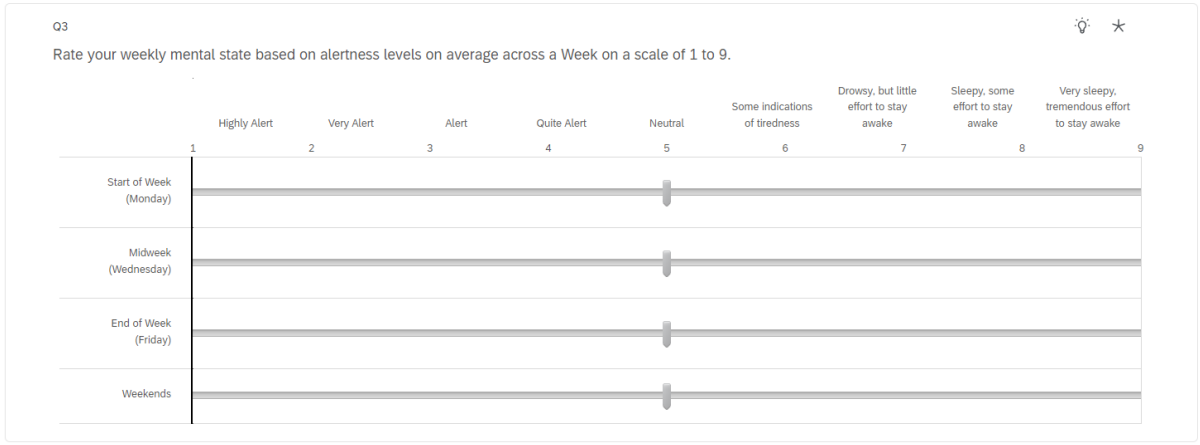
These are some factors that we acknowledge that do affect work performance but are impractical or impossible to quantify across the groups and individuals. Some of these factors such as external events or Company policies are likely to be companywide or affect everyone so the effects are universal and not going to affect any one or few individuals. Subsequently, we are unable to track caffeine consumption outside of the recorded pantry system due to accessibility inconvenience, individuals preferences and consumption habits.

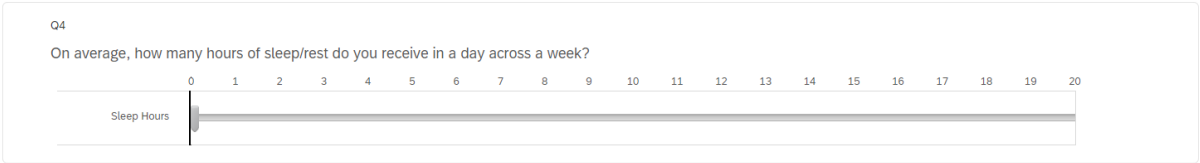
Aside from the limitations, our research study focuses on the key independent variables of our study, which is to observe the effects of caffeine consumption on work performance across various work types while considering various measurable and implementable control variables such as age, work experience, sleep hours, and caffeine content in caffeinated consumables. These control variables are either factual, cannot be fabricated, or present no personal interest to be fabricated. These are implemented to maximize the authenticity and accuracy of our results findings, as the outcome of our study may contribute to workplace safety regulations regarding caffeine and performance depending on the direction of the outcome. Organizations can make use of the data found in this research to implement caffeine concession or restrictions to be more readily accessible or inaccessible.

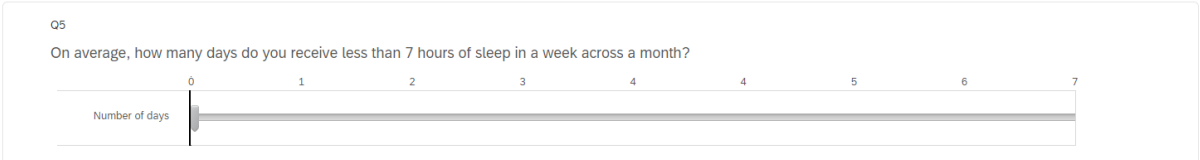
Appendix A.


Q1
Rate your weekly comfort level based on stress from the following segment on a scale of 1 to 7, where 1 - "Not at all" while 7 - "Very Much".
1
2
3
4
5
6
7
Task Demand
Task Control


Q2
Rate your weekly mental state based on alertness levels on average across a day on a scale of 1 to 9.
Highly Alert
Very Alert
Alert
Quite Alert
Neutral
Some indications of tiredness
Drowsy, but little effort to stay awake
Sleepy, some effort to stay awake
Very sleepy, tremendous effort to stay awake
1
2
3
4
5
6
7
8
9
Start of Work
Before Lunch
After Lunch
End of Work


Q3
Rate your weekly mental state based on alertness levels on average across a Week on a scale of 1 to 9.
Highly Alert
Very Alert
Alert
Quite Alert
Neutral
Some indications of tiredness
Drowsy, but little effort to stay awake
Sleepy, some effort to stay awake
Very sleepy, tremendous effort to stay awake
1
2
3
4
5
6
7
8
9
Start of Week (Monday)
Midweek (Wednesday)
End of Week (Friday)
Weekends


Q4
On average, how many hours of sleep/rest do you receive in a day across a week?
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Sleep Hours


Q5
On average, how many days do you receive less than 7 hours of sleep in a week across a month?
0
1
2
3
4
4
5
6
7
Number of days

Appendix B.

Employee ID	**Work email address**	**Work department**	**Years of experience**	**Week 1**						**…**	
				Key Performance Index	**Age**	**Stress Level (1-7)**	**Alertness Level (1-9)**	**Sleep Hours**	**Caffeine Consumption (mg)**	**…**	**Remarks**
XXX	XXX@abc.com	Sales	5	96%	27	6.4	5.4	7	60	…	NIL
XXX	XXX@abc.com	Maintenance	7	78%	30	6.8	5.2	8	46	…	NIL

Employee ID	Work email address	Work department	Years of experience	Week 1						…	
				Key Performance Index	Age	Stress Level (1-7)	Alertness Level (1-9)	Sleep Hours	Caffeine Consumption (mg)	…	Remarks

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