**Analysis on Predictors of Mental Health in Tech Industry**

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**Abstract**

It is widely known that mental illnesses among employees has been common in the United States. We first analyzed how workers in the technology industry view mental health issues in their workplaces. By factor selections with regression and Random Forest, we then examined what factors can affect the occurrence of mental illness or certain viewpoints of the employees about mental health issues. Based on the results of our factor selections and the research articles about mental illness in the workplaces, we finally suggested possible approaches for IT companies in order to create better working environments for their employees.

**A. Introduction**

According to the National Institute of Mental Health (NIMH), about a third of adults in the United States have suffered from various kinds of mental health disorders or illness. Also, patients with mental illness in general have been considered as those who need to receive special treatments from the societies, more than those who suffer from physical illness. Then, this different attitude toward mental illness from the societies, provoked a particularly negative impression of the patients with mental illness, thus leading to perceivable discrimination from others in many social environments, such as discrimination from the companies.

Technology industry is highly known for growing business fields in many countries in the world, but it is also notorious for the heavy workloads for workers who are mainly in charge of dealing with technological skills, such as engineering, software development, and customer management. Based on this known fact, we can surely assume that there will be many employees who have suffered from at least a mental illness, which can largely affect the quality of their work in their workplaces. Therefore, for the entire paper we are going to examine the association between the outbreak of mental illness and the several factors such as personal information, employees’ attitude toward having mental illness, and their working environments. We then investigate which factors are strongly related to the actual/potential possession of mental illness or certain viewpoints of the employees toward the mental health issues, by using different kinds of methods in the area of machine-learning. Based on the result, for the final section of the paper, we present different types of approaches for the employers in the IT industry to create a working environment where their employees are no longer concerned about the potential discrimination from either their colleagues or the supervisors.

Through a sociological lens toward the stigmatization of employees in terms of mental health issues, we interpret the results of our analysis from the earlier sections of the paper. Therefore, the paper will be a great resource to build certain standards of what would be much better strategies for the employees to highly improve the quality of their work, even for the employees who felt mental illness interfered with their work.

**B. Data**

The dataset of ‘Mental Illness in Tech Industry’ is a survey conducted by the non-profit organization in the United States, Open Souring Mental Illness (OSMI). Since 2014, OSMI’s database has provided public data about the responses to mental illness from the workers who represented themselves as those primarily engaged in the fields of technology business. We used the data set published in 2014, since this obtained the largest number of the respondents compared to the rest of data that OSMI conducted later. The data is anonymized with 1,260 respondents from the survey in 2014. The main statistical software that we used is R. While we originally planned to use all of the information given in the data, we found that there are many empty values in the particular category on the dataset, thus deciding to fill the missing values with either the median of each category or the response with the highest frequency. Furthermore, in the dataset, there were some responses in the column of sex that cannot easily be distinguishable, such as male, cis-male, cis-female, androgyne, queer, and so on. Then, we reassigned the column of sex/gender to have only three factors of categories: Male, Female, and Others. Finally, since the paper focuses on the analysis of mental illness in the technology industry, we included only those who are mainly in charge of technology services, which shows a better pattern in the mental illness in the technology field of business. Using the filtered 1,031 data from the raw set, we now begin to analyze the first characteristic of the workers with mental illness in terms of the personal information. Then, we also examine how employees in the technology industry view mental health issues in their workplaces. Table 1 provides the factors we considered for the general analysis of the dataset by OSMI.

Table 1. Factors in the dataset

|  |  |  |
| --- | --- | --- |
| Variable | Level | Type |
| Age | Personal  information | Continuous |
| Gender | Categorical |
| Family history of mental illness |
| Medical history of treatments for mental illness |
| Whether they feel interference on their works due to mental illness |
| Easiness in Taking a medical leave for a mental illness | Employees’ perspective toward mental illness |
| Expectation on negative results by discussing mental illnesses with employers |
| Willingness to discuss mental illness with co-workers |
| Willingness to discuss mental illness with supervisors |
| Willingness to talk about mental illness to the potential employers during job interview |
| Experience in negative result for co-workers with mental illness in the workplace |
| Employers’ provision of mental health issue benefits | The Working environment |
| Employers’ provision of mental health care options |
| Employers’ discussion of mental health as a part of wellness program |
| Employers’ provision of resources to mental health issues and treatment |
| Protection of anonymity in utilizing mental health treatment resources provided by employers |
| Personal opinion to the employers’ consideration of mental illness as serious as physical health issues |

**C. General Analysis of Data**

***1. Personal History/Information***

***a. Gender***

Investigating the factors in relation to personal history/information of the employees, we first found that male workers in the technology industry consists of about 72% of the entire respondents who answered they have mental issues. This highly reflects the reality of technology field of business, in which a majority of the workers are primarily male. One interesting result in this factor of gender is that people who represent themselves as ‘others’ consist of about 2.3% of the entire respondents who suffer from mental illness while working in a technology industry. This could be interpreted as the individuals’ concern due to a slightly negative impression to the non-traditional category of gender, such as LGBTQ+ society in the U.S.

Figure 1. Gender in the technology industry

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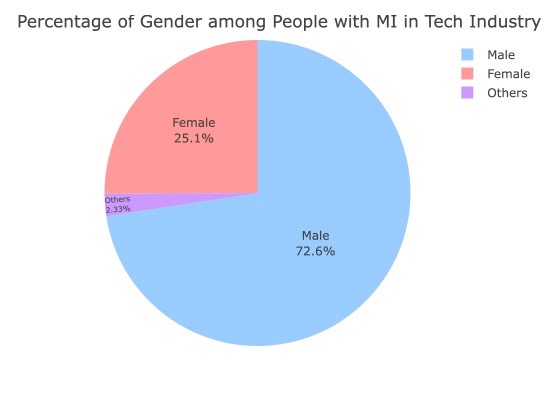


Figure 2. Gender among people with Mental illness in tech industry

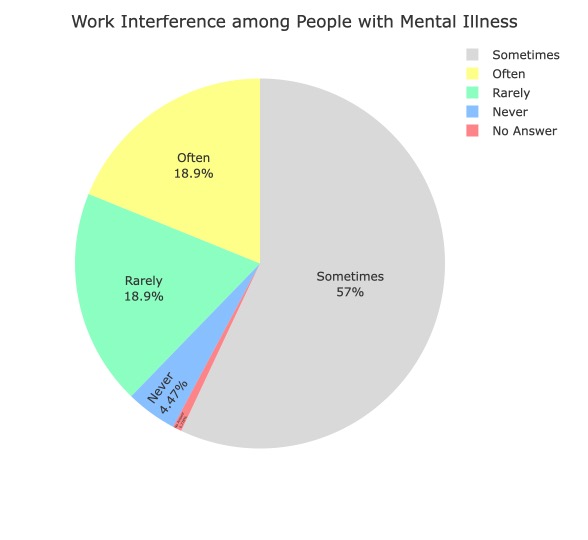
***b. Age***

For the factor of age among people with mental illness, it is figured out that the average age of the workers with mental illness was about 32, which is slightly older than the average is 31 in the overall technology industry. Also, those who have sought treatment for mental health issues were mainly distributed in the age between 20-35, which seems quite young compared to the result of the entire distribution of age, as shown in Figure 3 below.

***c. Work Interference***

About 75% of the respondents of the dataset answered that they had experienced that their work was interfered with by mental illness before. This indicates that mental illness would highly affect the quality of their work.

Figure 3. Distribution of Age

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Figure 4. Feeling of Interference during work due to mental illness

***2. Employees’ Perspective toward mental illness in the workplace***

To compare the results of each plot, we divided the entire group of people by two groups: one who have sought treatment for mental illness and the other who have not.

***a. How easy to take a medical leave for mental illness***

In the question of “how easy is it for you to take a medical leave for a mental illness,” the employees who have sought treatment for mental illness answered to be somewhat or very difficult to request the leave from their supervisors, more than those who have not. One point to look at is that both groups did not know about this advantage, where we can predict that they have never asked for a medical leave from their employers.

***b. Expectation on negative results by discussing mental illnesses with employers***

For the question of “do you think that discussing a mental health issue with your employer would have negative consequences?” employees who have sought treatment tend to agree with the question more than those who have not.

Figure 5. Negative Results by Discussing mental illness with Employers

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***c. Willingness to discuss mental illness with co-workers/supervisors***

In the question of “Are you willing to discuss a mental health issue with your co-workers,” both groups responded to share their health conditions with their co-workers. However, for the question of discussing mental issues with supervisors, employees who have sought treatment for mental illness tend to hide their illness from their supervisors, although both groups did not show considerable differences in the responses to this question.

Figure 6. Employees' willingness to discuss mental illness with their co-workers

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***e. Willingness to talk about mental illness to the potential employers during job interview***

In the question of “Would you bring up a mental health issue with a potential employer in an interview,” most of employees in both groups answered to not mention their mental illness or conditions during an interview of recruitment. This explicitly showed that most of the job applicants generally viewed mental illness as a deficit of themselves, which negatively impacts the results of their employment in the future.

***f. Experience in negative result for co-workers with mental illness in the workplace***

For the question of “Have you ever heard of or observed negative consequences for co-workers with mental health conditions in the workplace,” a majority of the workers in both groups indicated they had not experienced it before, but the group of employees who sought treatment for mental illness, showed they had experienced negative consequences more than those who have not.

***3. The Working Environment***

***a. Employers’ provision of mental health issue benefits/care options to their employees***

For the question of “Does your employer provide mental health issue benefits,” a majority of employees received benefits from their employers, especially among the group of people who sought treatment.

Also, for the question of “Do you know options of mental health care which your employer provides,” the workers who sought treatment for mental health issues knew the care options offered from their employers, more than those who have not. Workers without mental illness were not likely to notice the available care options from their companies.

***b. Employers’ discussion of mental health as a part of wellness program***

For the question of “Has your employer ever discussed mental health as part of an employee wellness program,” a large amount of people in both groups indicated that they had not experienced such a situation in their workplace. This illustrated that the mental health care was yet to be considered as a main wellness program.

***c. Employers’ provision of resources to mental health issues and treatment***

For the question of “Does your employer provide resources to learn more about mental health issues and how to seek help,” a majority of people in both groups answered that they have neither known nor experienced such resources provided by their employers. Workers who have sought treatment for mental illness were likely to view this situation while working in their workplaces, more than those who have not.

Figure 7. Employers' Provision of Mental Healthcare Resources

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***d. Protection of anonymity in utilizing mental health treatment resources provided by employers***

For the question of “Is your anonymity protected if you choose to take advantage of mental health or substance abuse treatment resources,” most of the workers in both groups did not know the protection of their anonymity when using the resources in their workplace. However, the employees who have sought treatment knew their anonymity was protected, more than those who have not. This illustrated that those employees had utilized the resources that their employers have provided.

***e. Personal opinion to the employers’ consideration of mental illness as serious as physical health issues***

Lastly, for the question of “Do you feel that your employer takes mental health as seriously as physical health,” a large number of people in both groups showed that they did not know about this issue. One result to focus on is that while nearly same amount of people in both groups have seen their employees considering mental health as seriously as physical health, those who have sought treatment did not experience this situation much more frequently than those who had not. This showed that there were still some employers in the workplaces who did not perceive treatment of mental health as important as the one of physical health.

**D. Predictors of Mental Illness**

**among Employees in Tech Industry**

In this section, we will analyze the predictors of the employees’ having mental health issues in their workplaces. Our first task is to find out which factors are most relevant to the likelihood of having mental illness in their workplaces by using a technique of logistic regression. Following the idea of logistic regression, we will also use a concept of a stepwise regression model to select the variables that have most to do with the employees’ medical history of mental illness. Lastly, we will examine those factors by utilizing the Random Forest model, and then we will compare each result of different methods of factor selection in order to ultimately sort out the top five important factors. Therefore, this section will perform as a foothold to the next section of the paper, where we will discuss the possible approaches for the employers in the tech industry to create a better environment free of the concerns about having mental illness.

**1. Logistic Regression**

**a. Method Explanation**

Logistic Regression is widely used to model a binary dependent variable with respect to either continuous or categorical variables, both of which are well-defined as the attributes for the dependent variable. Since our dependent variable, the medical history of treatments for mental illness, has a response of either “Yes” or “No” for the entire data, an idea of using logistic regression will match what we aim to do for the entire paper - analyzing the predictors of mental illness in the technology industry.

**b. Association Selection**

**I**n this part of the section, we will begin to look at some variables, each of which is relatively associated with our target variable, the workers’ medical history of treatments for mental illness. Some of the variables that we have looked at carefully showed a response of “Don’t Know” as the most frequent one, which could not be considered as not quite related to the target variable for the classification model. So, we will drop those variables for our analysis and predictive models as well. Therefore, the factors that we are going to focus on are the following:

- All factors in the personal level

- All factors in the level of Employees’ Perspective toward mental illness in the workplaces except the medical leave

- Employers’ provision of mental health care options, Employers’ discussion of mental health as a part of wellness program, Employers’ provision of resources to mental health issues and treatment, and Personal opinion to the employers’ consideration of mental illness as serious as physical health issues, in the level of the working environment.

Next, we will draw several mosaic plots of each factor and the treatment history, so we identify the association between these two variables. First, we will look into the plots of variables in the level of personal information versus a variable of the medical history of treatments for mental illness.

***i) Treatment vs Personal Information***

From the figure below, we can find out the large impacts of the factors - age, family history of mental illness, and gender - into an individual’s seeking medical treatment for mental illness. Also, the p-value stated in the Figure 8 below, which is a very small number, indicates those variables are considered to be significant factors into the target variable.

To interpret the mosaic plot, we first look into the size of the boxes, which is related to the counts of the combination of the selected features in the plot. For the feature at the horizontal axis, we can compare the proportion of the features, by looking at the width of the rectangles in each feature. In addition, for the variables at the vertical axes, we can notice the proportion of the combination of the features by comparing the height of the rectangles relevant to the combination of selected features in the plot. For example, when comparing the groups of people with whether the person has sought treatment for mental illness, we can easily figure out that the rectangle for the feature ‘sought treatment’ is wider than the rectangle of ‘not sought treatment.’ For another example of the interpretation of the mosaic plot, we can see that in the column of ‘sought treatment’ and in the row of ‘having family history of mental illness,’ the box of ‘age < 32’ has a higher proportion than the one of ‘age > 32.’

Figure 8. Mosaic plot: Personal information vs Dependent variable

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***ii) Treatment vs Employees’ Perspective toward Mental illness in the workplaces***

Figure 10. Mosaic plot: Provision of healthcare option for the employees versus Dependent variable

Unlike the earlier part of personal information, we will consider how an individual factor influences the medical history of mental illness. Among the variables with respect to the employees’ perspective toward mental illness in the workplaces, those four variables below are figured out to be important factors:

- Employees’ willingness to discuss their mental illness with co-workers,

- Their willingness to bring up their mental illness during job interview,

- Their anticipation of negative results by discussing mental issues with their employers, and

- Their experience in observing the negative consequence of co-workers who suffer from mental illness.

Figure 9. Mosaic plot: Negative Results by discussing mental illness with the employers versus Dependent variable

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***iii) Treatment vs The Working Environment***

Among the variables in the category of the working environments, those two variables below are figured out to be important factors:

- Employees’ provision of mental healthcare options, and

- Employers’ provision of resources to mental health issues and treatment

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**c. Factor Selection / Comparison**

First, the baseline logistic model that we used on all the variables in the dataset showed that the important variables in this model are age, gender, family history, feeling of work interference due to mental illness, healthcare option for mental illness, and the workers’ willingness to discuss with co-workers. However, the logistic model with the variables that have been selected in the section (b) above, showed similar results with the baseline but also included more variables, such as employers’ provision of resources to mental health issues and their observation of negative results of co-workers with mental illness. Table 2 below summarized the results of both regression models by listing the important factors in each model.

Table 2. Selected factors in the logistic models

|  |  |
| --- | --- |
| Baseline Model | Factor Selection Model |
| - All Personal information  - Employer’s Provision of Healthcare option for Mental illness | |
| x | - Provision of resources to mental health issues  - The observation of negative results of co-workers with mental illness  - Employees’ willingness to bring up their mental illness during job interview  - Employees’ anticipation of negative results by discussing mental issues with their employers |

Also, Table 3 below indicates the five selected factors in order of the most important value, when it comes to the logistic model with the selected factors thinking altogether.

Table 3. Top 5 important factors in the logistic model with factor selection by mosaic plot

|  |
| --- |
| Top 5 Important Factors |
| 1. Feeling of Work Interference due to mental illness |
| 2. Family history of mental illness |
| 3. Willingness to discuss with co-workers about mental illness |
| 4. Provision of Healthcare option for mental illness |
| 5. Gender / Talk mental illness during job interview (Tie) |

**2. Stepwise Regression**

**a. Method Explanation**

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Description automatically generatedStepwise regression builds the model from a set of candidate predictor variables by repeatedly entering and removing predictors until there are no more variables to be put into the model. Therefore, stepwise regression is useful to create the final model with the highly selected variables, which enables us to figure out what important factors influence the likelihood of the occurrence of the dependent variable. In this project, we will use the method of stepwise regression to figure out which factors are highly related to the individuals’ medical history of mental illness.

Figure 9. Plot of Top 5 important factors in Random Forest

**b. Factor Selection**

Building the stepwise regression model for figuring out predictors of mental illness among employees in the technology industry, we consequently found out that the result of factor selections through stepwise regression are highly similar with the one by logistic regression. This is because stepwise regression uses the same methodology with the logistic regression model. One important thing to focus on in this model is, that only six factors are selected to be the most important factors, which increases the accuracy of the impacts of each factor on the dependent variable. Table 4 below shows the result of factor selections by stepwise regression, listing the most important five factors.

Table 4. Top 5 important factors in stepwise regression

|  |
| --- |
| Top 5 Important Factors |
| 1. Gender |
| 2. Family History of Mental illness |
| 3. Feeling of Work Interference due to mental illness |
| 4. Provision of Healthcare option for mental illness |
| 5. Willingness to Discuss with co-workers about mental illness |
| 6. Protection of Anonymity in utilizing the mental care resources offered by employers |

**3. Machine Learning – Random Forest**

**a. Method Explanation**

Random Forest method can be used to rank the importance of variables in different types of problems, such as regression or classification, by creating different numbers of decision trees to self-learn the dataset and through permutation. For this section, we are also going to use Random Forest for investigating the significant attributes that are highly related to the target variable of mental illness in the technology industry.

**b. Factor Selection**

For this part, we plotted the variable importance so that anyone can know what factors highly signify the employees’ seeking treatment for mental illness while working in the technology industry. First, we set the classification of random forest, created 500 trees as default values, and we set six variables for each split of the trees. Figure 11 below indicates the most important five factors selected by Random forest model.

As described in Table 5 below, the following variables in the table below are considered to be important in predicting the employees’ medical history of mental illness.

Table 5. Top 5 important factors in Random Forest

|  |
| --- |
| Top 5 Important Factors |
| 1. Feeling of Work interference due to mental illness |
| 2. Family history of mental illness |
| 3. How easy to take a medical leave for mental illness |
| 4. Provision of Healthcare option for mental illness |
| 5.Experience in negative result for co-workers with mental illness in the workplace |

**4. Discussion of Results**

So far, we have discovered what factors are highly associated with the employees’ medical history of mental illness while working in the technology industry. We implemented two methods of regression, and a Random Forest to select out the important variables among the total 16 factors of the dataset. We first noticed that the factors in the level of personal information, such as family history of mental illness or feeling of work interference due to mental illness, are highly related with the target variable in all three predictive models. Then, we figured out that employees’ perspective toward mental illness in their workplace is also important to predict their medical history of mental illness. For example, a variable of employees’ willingness to discuss with co-workers about mental illness, is relevant to the dependent variable in all three models. Finally, the working environments also played significantly in predicting whether employees have sought the treatments for mental health issues while working in the technology industry. We found out that these two variables are considered to be important factors for the factor selection in all three models – the employers’ provision of either healthcare option or resources for mental illness. Table 6 below describes the important factors that are shown commonly in all three techniques of factors selections that we have just built.

Table 6. Important factors selected commonly in All models

|  |
| --- |
| Important Factors Selected Commonly in All Models |
| 1. Family history of mental illness |
| 2. Feeling of work interference due to mental illness |
| 3. Provision of healthcare option for mental illness provided by their employers |
| 4. Provision of medical resources from employers |
| 5. Willingness to discuss with co-workers about mental illness |

**E. Approaches for Employers in IT companies to Improve the Working Environment**

In the previous section, we have deeply examined about what factors have been considerably related to the employees’ seeking treatments for mental illness while working in the technology industry. We also figured out the most significant factors in all levels of independent variables that we had listed in the section of B – personal level, employees’ perspective toward mental illness, and the working environments.

Although the factors in the level of personal information, such as the family history of mental illness and the work interference, are highly related to the dependent variable among all factors, these types of variables generally vary by the background of individuals’ lifetime and their living environment, which cannot be easily solved by the generalized suggestions which do not consider each individual’s personal/medical situations.

Furthermore, according to the article “Work-Life Balance and Burnout as Predictors of Job Satisfaction in the It-ITES Industry,” the technology industry is well-known for its heavy workloads on the employees, some of whom stay overnight in the workplace (Kanwar et al., 1-12). This also leads to increasing rates of the number of employees who are diagnosed with mental illness, due to a lesser degree of job satisfaction. This means that the working environments and the employees’ viewpoints can be more related with the employees’ mental illness (Kanwar et al., 1-12).

Therefore, we will focus more on the areas of both employee’s viewpoint on mental health issues and their working environments. Based on the results from the section D and the articles as well, we will suggest the three possible approaches for employers in the United States who are engaged in the technology industry to improve the working environments in which no employees are concerned about their medical history of mental illness.

**1. Eliminate Social Stigma and Discrimination from Co-workers and Supervisors**

When it comes to thinking of the mental illness in the workplaces, most people who have suffered from mental illness will be concerned about the stigma and discrimination from the societies due to their medical history of mental health issues. According to the article “Perceived and Measured Stigma Among Workers with Serious Mental Illness,” the authors claimed that there is a strong belief in the main stereotype about workers with mental illness: persons with mental illness are regarded as “less capable members of the workforce” (Baldwin and Marcus, 388). They also stated that employers are not likely to acknowledge the workers with mental illness in the workplace, due to the limited productivity (Baldwin and Marcus, 388). This consequently leads people with mental illness not to report their treatments of mental illness to the employers, due to the observable stigma and discrimination from the co-workers and the supervisors as well. Furthermore, according to the article “Systematic review of beliefs, behaviors and influencing factors associated with disclosure of a mental health problem in the workplace,” the authors Brohan, et al. maintained that the reason of some employees who are not likely to disclose their mental illness is the lower rates of emotional support from the co-workers and the supervisors (Brohan et al., 8).

Putting all together, the objective of our first two suggestions for employers to improve a working environment is essentially based on how to eliminate the social stigma and discrimination from the co-workers and the supervisors. Since one of the significant factors that we have figured out in the earlier sections is employees’ willingness to discuss their mental illness with co-workers, we now suggest one way for the solution to this topic, in terms of attracting more emotional support from the surroundings in the workplaces.

***- Hold a regular seminar for all workers of how to respect co-workers with mental illness***

***- Provide educational resources about mental illness and its treatment to all employees***

These two suggestions for improving the working environments will also lead to changing the employees’ perspective toward mental illness. According to the article “Mental Health in the Workplace: Introduction, Executive Summaries,” the author International Labor Office in Geneva, Switzerland (ILO) mentioned the current example of what the employers in the U.S. have executed for managing mental health in the workplace (25). Employers in the U.S. generally held the education session for their employees to educate more about the mental health promotion and mental illness prevention as well (ILO, 25). This also means that in order to attract emotional support for the issue of mental illness, the co-workers’ knowledge about mental illness should be preceded to understand the impacts of mental illness into the functional productivity. Therefore, these two ways - holding lectures of the mental illness for employers and providing the healthcare resources for mental illness – will promote the clean working environment free of stigma and discrimination from the societies.

**2. Provide More Healthcare option for mental health issues as benefits for Employees**

As figured out in the earlier section of D, one factor that explains how employees know about their employer’s provision of healthcare options for mental illness, is highly associated with whether employees have sought treatment for mental illness. Also, according to ILO, a large number of employers in the U.S. understand the importance of the presence of healthcare for mental illness, by developing some care programs supportive of work/family/life issues that their employees may have (ILO, 25). Also, Google, one of the popular IT companies in the U.S., currently offers a counseling service for their employees, as one of their healthcare programs, in order to take out their emotional burden of any issues that those individuals have suffered from (Google). Therefore, the greater amount of healthcare options provided by employers, the better working environment without concern about mental illness.

**F. Conclusion**

In this paper, we have analyzed the predictors of mental illness in the technology industry. Through the factor selection by the different methods of regression and Random Forest, we figured out that not only personal information of the employees but also their perspective toward mental illness and the working environments also performed important roles in the employees’ medical history of mental illness. Among all the 16 factors in the dataset, we have selected the following five variables as the one explaining the medical history of mental illness among the employees engaged in the technology industry: family history of mental illness, feeling of work interference due to mental illness, employers’ provision of healthcare option for mental illness, employers’ provision of medical resources for mental illness, and employees’ willingness to discuss with co-workers about mental illness. Furthermore, based on the results of factor selection, we also suggested three possible approaches for the employers to create a better working environment without concern about social discrimination due to mental illness. Despite the many findings in this paper, we also faced limitations on the analysis of the results: that is, the data that we have worked on does not contain much direct information about the technology industry. Therefore, for future research, considering the specific information that are directly associated with the technology industry, such as the job titles of each respondent, would strengthen more insightful analysis on the predictors of mental illness in the world of technology companies.

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