A Meta-Analysis of Correlation Between Big Five Personality Traits and TVET Skills Acquisition

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Abstract- Personality assessments play a crucial role in the successful completion of academic studies and the acquisition of technical abilities. Aligning personality traits with learning capabilities can enhance course outcomes, reduce dropout rates, and significantly improve returns on investment. This study examines the correlation between TVET learning skills and the Big Five Inventory (BFI) personality traits. It aims to enhance youth employability in the skilled workforce and increase ROI through personalized course offerings. Using the Chi-Square method (χ^2), we analyzed the correlation between TVET trades and BFI Personality Traits over three years of data collected from one of Pakistan's largest TVET training providers. Our findings indicate that two BFI Personality Traits, Openness to Experience and Extroversion, demonstrate a strong correlation with TVET trades. This research successfully links TVET skills with personality traits, offering potential benefits for enhancing TVET course recommendations, predicting dropout rates, and providing career counseling. This correlation opens avenues for further research into various dimensions of TVET education, promising practical applications in optimizing educational outcomes and career development strategies

Index Terms- TVET Digitization, Chi-Square Analysis, BFI Personality Traits, Digital Skills

I. INTRODUCTION

Researchers are increasingly focusing on human personality to understand cognition, behavior, and emotional patterns. Understanding human personality dimensions can facilitate connections with career choices, learning styles, skills development, and educational outcomes [1]. Personality exerts a significant influence on learning, affecting preferences for learning styles, motivation levels, cognitive processes, interpersonal interactions, and adaptation strategies. Traits such as extraversion, conscientiousness, openness to experience, agreeableness, and neuroticism play specific roles in shaping how individuals approach educational settings and handle challenges. Recognizing these dynamics enables educators to better address the diverse needs of learners, while individuals can leverage self-awareness of their traits to optimize their learning strategies effectively. According to findings from the study [2], these personality traits impact how students perceive learning outcomes and their attitudes toward discussing classmates' assignments and receiving feedback from peers. Moreover, the research identifies three distinct student types: the 'proactive emphatic leader', 'speculative leader', and 'passive follower'.

The Big Five Inventory (BFI) is a psychological assessment tool designed to evaluate individuals across five core personality traits [3]: Openness to experience, Conscientiousness, Extroversion, Agreeableness, and Neuroticism, commonly known as OCEAN. We utilized a 50-item questionnaire sourced from the International Personality Item Pool (IPP @ http://ipip.ori.org) as it provides a manageable number of questions suitable for understanding and response among Technical and Vocational Education and Training (TVET) trainees. Research spanning four decades [4] exploring the relationship between the Big Five personality traits and second language acquisition concludes that Openness and Conscientiousness show significant correlations with proficiency in second language learning. Case studies [5], [6] highlight the critical roles of learning styles and trainee aptitude in academic performance, affirming that Openness strongly correlates with GPA, while Conscientiousness and Agreeableness positively influence learning styles conducive to academic achievement. A comprehensive literature review [7] suggests that Augmented Reality (AR) can enhance effective learning practices. This study seeks to expand understanding of OCEAN personality traits by incorporating Neuroticism and exploring their interaction with AR technologies in educational contexts.

The TVET sector plays a pivotal role in youth development by bridging skills gaps and imparting essential lifelong learning and survival skills [8], [9]. Our previous research [10], [11], [12] highlighted the inadequate ICT integration within Pakistan's TVET sector. In light of sustainable development goals set by UNESCO [13] for 2030, including Goals 4, 5, 8, and 17, TVET has received significant attention and support from the Pakistani government, international donors, and funding agencies. Despite this, the TVET sector in Pakistan lags in digital infrastructure compared to school and higher education systems, necessitating the adoption of scientific digital methodologies to enhance educational quality. The BFI has been effectively employed in TVET studies, such as a research [14] examining transitions from schools to Vocational Education and Training (VET) in Germany. This study identified Conscientiousness as the most influential personality trait across various indicators. Another vocational study [15] emphasized the strong associations between Agreeableness, Openness, and TVET trainees. However, there is a notable absence of similar studies and datasets specific to the TVET context in Pakistan, highlighting a research gap that needs to be addressed.

We are driven by three primary motivations for this research. Firstly, Pakistan's demographic profile is predominantly youthful,

with 63% of the population aged between 15 and 35, highlighting a pressing need to create job opportunities for this demographic amidst a significant skills shortage. Secondly, the ongoing skills deficit is identified as a critical factor contributing to the challenges faced in infrastructure development projects within the country [16], [17], [18]. Addressing this shortage is crucial for enhancing the effectiveness and success of such projects. Thirdly, despite substantial national (public and private sectors) and international funding from organizations like USAID, DFID, British Council, JICA, and the World Bank aimed at supporting skilled labor production through Technical and Vocational Education and Training (TVET), the employability rate of TVET graduates remains disappointingly low at just 38% [19]. This low employability not only hampers individual economic prospects but also poses barriers to achieving inclusive and sustainable economic growth on a broader scale.

In this study, we investigated the correlation between BFI personality traits and TVET trades through the following hypotheses:

1. **Null Hypothesis (H0):** There is no relationship between TVET trainees and BFI personality traits in the TVET trades.
2. **Alternative Hypothesis (H1):** There is a significant relationship between TVET trainees and BFI personality traits in the TVET trades.

These hypotheses serve as the foundation for exploring how personality traits influence vocational education outcomes, providing insights into the intersection of individual characteristics and skill development in technical and vocational fields. We have used Chi-square (χ^2) to determine whether there is a significant association between categorical variables of BFI Personality Traits and TVET Trades. Identifying correlations between Big Five Inventory (BFI) personality traits and Technical and Vocational Education and Training (TVET) trades is crucial for enhancing educational approaches and career counseling in vocational settings. Understanding how traits like Conscientiousness, Openness to experience, and Agreeableness relate to success in specific trades allows educators to tailor teaching methods and curriculum designs accordingly. This knowledge not only improves student engagement and satisfaction but also informs policymakers and program developers on optimizing TVET programs. By integrating personality assessments into admission processes and curriculum planning, institutions can better support students in choosing and excelling in careers that align with their strengths and preferences. Moreover, research in this area advances academic knowledge in educational psychology and vocational education, paving the way for future innovations in enhancing learning and career outcomes in vocational contexts.

The remainder of the paper is organized as follows: Section II provides a Literature Review, Section III outlines the Materials and Methods used in this study, Section IV presents the Results and Discussion drawn from our analysis, and Section V discusses the Conclusion and Future Directions for further research and application of findings. Each section contributes to a comprehensive understanding of the study's objectives, methodologies, outcomes, and avenues for future exploration.

II. LITERATURE REVIEW

Chi-square tests are utilized in various fields including psychology, sociology, biology, and business to examine relationships between variables that are measured on a nominal or ordinal scale. The test calculates a chi-square statistic based on the differences between observed and expected frequencies in a contingency table. If the calculated chi-square value exceeds a critical value from the chi-square distribution table, it indicates that the variables are associated or dependent.

The literature review reveals that BFI OCEAN personality traits play a significant role in academic learning, with Openness to experience highlighted prominently [20]. Additionally, research [21] focusing on factors influencing TVET found that mismatched trainee interests and course offerings led to poor performance and a high dropout rate of 29%. This underscores the importance of aligning trainee aptitude and interests with course selection to enhance success rates. In Malaysia, a TVET study [22] employing Chi-Square analysis identified positive correlations between professionalism dimensions and generic skills, while another study [23] found no gender-related relationship in 360-degree teaching evaluations using the same statistical method. The TVET Teachers model [24], employing Chi-Square analysis, revealed a robust correlation between the type of teaching assessment method and its accuracy, considering gender differences. This finding underscores the significance of evaluating teaching methods concerning their effectiveness in educational settings, highlighting potential gender-related implications in the assessment process within TVET. Furthermore, a TVET study in Kenya [25] using Chi-Square analysis emphasized trainers' comprehension of Competency-Based Education and Training (CBET) goals.

Notably, there is a lack of prior personality studies within the TVET sector specific to Pakistan. This study aims to fill this gap by establishing the first national dataset of TVET personality traits, which can serve as a valuable resource for enhancing research across various dimensions. The resulting TVET personality dataset is expected to benefit academia, researchers, TVET training providers, policymakers, donor agencies, and trainees alike, aiming to improve the overall effectiveness of TVET programs in Pakistan.

III. MATERIALS AND METHODS

This section delineates the approach and procedures undertaken to gather, analyze, and interpret data to explore our hypothesis comprehensively. The research methodology employed in this study is illustrated in Figure 1, which outlines three main phases: data collection, model development, and result evaluation. The data collection phase involves gathering, cleaning, and preparing data for model development. Subsequently, the model development section details the application of the Chi-Square method for knowledge extraction. The results and evaluation section presents the findings of the model, including their interpretation and significance. Furthermore, these results are compared with existing literature to contextualize their

implications. Additionally, the study examines the hypotheses formulated within the results and evaluation section. All three section details have been elaborated accordingly. This structured approach not only ensures methodological rigor but also underscores the study's significance in contributing new insights to the field.
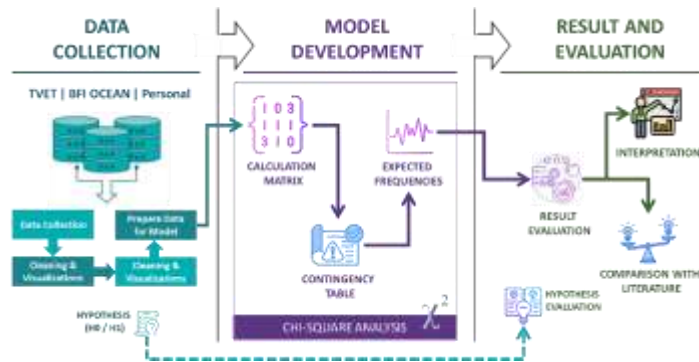

Figure 1: Research Methodology

This research is based on data obtained from trainees enrolled in the Punjab Vocational Training Council (PVTC) in Pakistan. PVTC [26] operates as an autonomous body established by the Punjab Government, offering vocational skills training through its network of 348 Vocational Training Institutes (VTIs) across the province of Punjab. Before commencing this research, formal approval was obtained for data collection from the VTIs, as well as for research publication from PVTC. Initially, data from 1,075 trainees were collected across 8 VTIs spanning 17 different TVET trades. Following preprocessing and cleanup procedures, 747 cleaned datasets were utilized for the study. Detailed information regarding the seventeen trades and the corresponding number of records collected is provided in Table 1. Data collection and analysis were conducted using the Orange Data Mining tool, Python language, Tableau, a customized web-based application, and Microsoft Excel.

Data collection for this study encompasses TVET trainees' personal information, their chosen TVET trades, and their scores on the Big Five Inventory (BFI) personality traits. The BFI data includes individual scores on the dimensions of Openness to Experience (O), Conscientiousness (C), Extroversion (E), Agreeableness (A), and Neuroticism (N), collectively known as OCEAN traits. For model preparation, the dataset includes variables such as Profile Code, Trade, Gender, Age, Score_O, Score_C, Score_E, Score_A, and Score_N. The dataset "D" reflects a gender distribution where 64% of trainees are male and 36% are female. Analysis of the data reveals that TVET trainees range in age from 14 to 35 years, with the majority falling between 15 and 21 years old. Among female TVET trainees, the highest proportion falls within the 15 to 21-year age bracket, with an extended distribution up to 24 years. Additionally, it has been noted that female trainees typically commence their TVET education approximately two years later than their male counterparts.

Figure 4 presents the boxplot results for each OCEAN personality dimension among the trainees in dataset "D." Each OCEAN score ranges from 0 to 40. The boxplots for the BFI personality dimensions display distinct ranges: Score_E represents Extroversion, Score_A represents Agreeableness, Score_C represents Conscientiousness, Score_N represents Neuroticism, and Score_O represents Openness to Experience. Several outliers are visible in the boxplots depicting BFI scores for OCEAN traits. The majority of Score_E values fall within the range of 18 to 26, while Score_A typically ranges from 24 to 34, and Score_C ranges from 26 to 36. Score_N values are distributed between 14 and 25, whereas Score_O values span from 24 to 32. This visualization highlights the distribution and variability of OCEAN personality scores among the trainees in dataset "D."

Table 1: Dataset D

S #	TRADE NAME	# OF RECORDS
01	Auto Electrician	16
02	Auto Mechanic	28
03	Beautician (Women/Men) Level 2	61
04	Clinical Assistant	151
05	Computer Application & Office Professional	107
06	Computer Application for Business	25
07	Computer Hardware & Network Professional	45
08	Computer Operator Level 2	30
09	Dress Making	37
10	Fashion Designing	25
11	HVACR Level-2	23
12	Industrial Electrician	44
13	Industrial Garments Stitching	21
14	Motorcycle Mechanic	19
15	Plumber	13
16	Refrigeration & Air Conditioning	90
17	Repair & Maintenance of Electrical Appliances	12
TOTAL >>		**747**

The Chi-square test is a statistical method [27] designed to compare observed and expected outcomes. Its primary objective is to ascertain whether the disparity between observed and expected results is attributable to chance or a genuine association between the variables under investigation. This makes the chi-square test an indispensable tool for elucidating and interpreting relationships between two categorical variables.
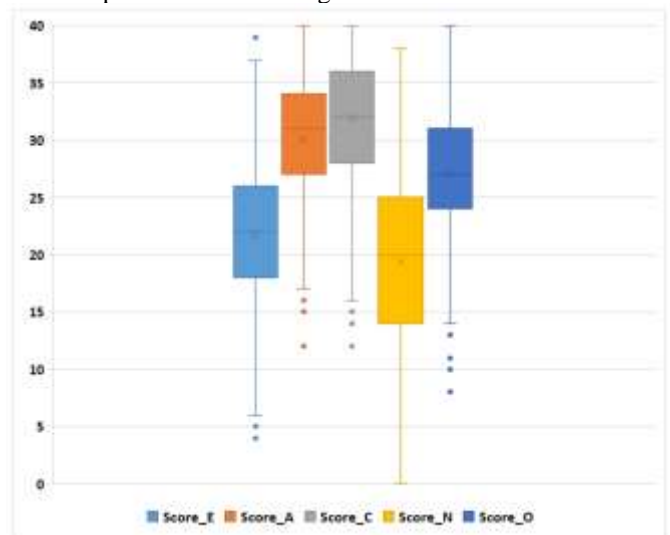

Figure 2: Dataset D OCEAN Score Boxplot

In this research, we chose to utilize the Chi-Square Test due to its demonstrated efficacy over algorithms such as FCBF or Relief, especially in the realm of educational data mining [28], [29]. Moreover, it has been successfully employed in numerous previous studies within the TVET context [22], [23], [24], [25]. Given that the OCEAN personality scores are numerical values, we transformed them into categorical variables to explore correlations between each OCEAN personality dimension and TVET trades. To achieve this, we determined the BFI score range for each OCEAN personality trait and categorized it into three priorities: Low (L), Medium (M), and High (H). Table 2 illustrates the matrix used to categorize the dataset presented in Table 2. In Table 3, beneath the heading of each OCEAN personality trait, there is a row indicating the minimum and maximum score range for that trait. Subsequently, we calculated the difference between the minimum and maximum scores in the following row, which was then divided into three equal parts. These calculations allowed us to establish the score ranges corresponding to the Low, Medium, and High categories for each OCEAN trait. These labeled data categories were subsequently utilized in the Chi-Square analysis model to assess the hypotheses formulated in our study.

Table 2: BFI OCEAN Score Calculation Matrix

DESCRIPTION	O [0 – 40]	C [0 – 40]	E [0 – 40]	A [0 – 40]	N [0 – 40]
Min – Max Score Range	8 – 40	12 – 40	4 – 39	12 – 40	1 – 38
Score Difference	32	28	35	28	37
Divided / 3	11	9	12	9	12
L	< = 19	< = 21	< = 16	< = 21	< = 13
M	< = 29	< = 31	< = 27	< = 31	< = 26
H	< = 40	< = 40	< = 39	< = 40	< = 38

To evaluate Pearson's Chi-Square test results, we have used the P-value, Expected Frequencies, and Degree of Freedom. The formula of Chi-Square [30] is shown in EQ-1: -

$$x^2 = \sum \frac{(O - E)^2}{E} \qquad \text{EQ - 1}$$

Where,

O: Observed frequency
E: Expected frequency
∑: Summation
χ2: Chi-Square Value

To assess the dependency between two variables using the Chi-Square test, a contingency table is essential. A contingency table [31], also known as a cross-tabulation or crosstab, is a two-way table used for this purpose. Table 4 displays the contingency table for the BFI OCEAN personality traits. Each OCEAN personality

trait is represented by four columns. The first column lists the trade names, while the subsequent three columns indicate whether the trait score falls into the Low (L), Medium (M), or High (H) category based on BFI calculations. In the context of contingency table analysis, observed frequencies denote the actual number of occurrences observed in the experimental data. These are empirical measurements obtained directly from the data. Conversely, expected frequencies represent the theoretical probabilities of occurrence. Figure 3 presents the Expected Frequency shown for Dataset "D" where expected frequencies are computed by subtracting the expected count from the observed count and dividing by the square root of the expected frequency.
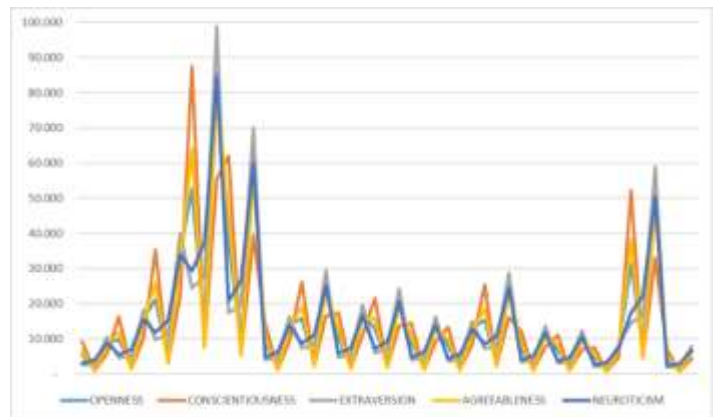

Figure 3: BFI OCEAN Expected Frequencies

IV. RESULTS AND DISCUSSION

The result summary of the P-value, Degree of Freedom, and Chi-Squared test statistics is shown in Table 3. As shown, the target variable "Trade" has been evaluated with all six BFI OCEAN personality traits.

Table 3: Result Summary

Variables	Score_O	Score_C	Score_E	Score_A	Score_N
P-Value	0.0002	4.8474	0.0004	1.7245	1.1812
Degree of freedom	32	32	32	32	32
Chi-squared test statistic	67.32	72.98	65.52	83.57	111.03

The Chi-square probability or p-value assesses the likelihood of a relationship between two variables. A p-value less than 0.05 is typically deemed statistically significant, suggesting a relationship unlikely to occur by chance. Conversely, a p-value greater than 0.05 indicates that any deviation from the null hypothesis is not statistically significant. As depicted in Table 6, the p-values for Score_O and Score_E are less than 0.05, indicating a statistically significant relationship. In contrast, Score_C, Score_A, and Score_N exhibit p-values greater than 0.05, suggesting no statistically significant relationship. Score_O represents Openness

to Experience, and Score_E represents Extroversion, implying a robust relationship with TVET Trades based on the data. Similarly, Score_A (Agreeableness) and Score_N (Neuroticism) have p-values slightly above 0.05, suggesting a potential relationship with TVET Trades that could benefit from further investigation with additional data in future Chi-square tests. However, Score_C (Conscientiousness) shows a notably higher p-value compared to the other personality traits, indicating no substantial relationship with TVET Trades. The degree of freedom for Dataset "D" is 32, representing the number of independent variables that can be estimated. According to the Chi-square distribution table [32], at 32 degrees of freedom, the critical value (α) is 46.1943. As shown in Table 3, all Chi-Square values for the BFI personality traits exceed the alpha significance level, leading to the rejection of the null hypothesis. This implies that significant relationships exist between these traits and TVET Trades.

We have critically compared our study with existing Chi-Square statistics applied to the TVET sector for knowledge extraction. The findings are listed below:

1. The study [23] indicates a Chi-Square value of 1.324 with a significant P-value of <0.001, surpassing the threshold ALPHA (α) of 0.05. This provides substantial evidence suggesting an association between 360-degree teaching evaluation, specifically concerning gender preference.
2. In the study [24], a Chi-Square value of 31.220 and a P-value of <0.001 indicate a significant association between teaching assessment preferences (peer review or self-reflections) and accuracy, despite ALPHA (α) not mentioned in this context.
3. Another study [22] reported a Chi-Square value of 1.324 with a P-value of <0.001, noting positive relationships between the dimensions of professionalism and generic skills, with ALPHA (α) deemed not applicable in this context.
4. This study [33] identified a Chi-Square value of 1.324 and a P-value of <0.001, adhering to an ALPHA (α) of 0.05. It explored environmental awareness and attitudes towards solid waste management among students.
5. Finally, in this study [34], a Chi-Square value of 1.324 and a P-value of <0.001 were reported, though ALPHA (α) was not specified. The major finding indicated that students were satisfied with the current formats and implementations of various training modes.

As demonstrated in the above list, existing TVET literature utilizing Chi-Square analysis has consistently emphasized the teaching-learning environment, professionalism alongside skills, and the correlation between environmental awareness and attitudes. Interestingly, none of these studies have explored the correlation between personality traits and skills. In comparison, our study aims to fill this gap by examining the relationship between personality traits and skills.

V. CONCLUSION AND FUTURE DIRECTIONS

In this study, we appraised the correlation between TVET learning skills and BFI personality using Chi-Square analysis. In conclusion of our results, we reject the null hypothesis as we have identified a robust relationship between two BFI personality traits, Openness to Experience and Extroversion, and TVET Trades. Additionally, there is an indication that BFI Personality Traits such as Agreeableness and Neuroticism may also be associated with TVET Trades, pending further data for Chi-Square analysis. Exploring the significant relationship between BFI personality traits and TVET Trades can have substantial implications in various domains such as Dropout Predictions, Career Guidance, on-the-job training Assessments, Exam Assessments, and Course Recommendations. However, it is important to acknowledge that potential limitations, including the need for more data, should be addressed to refine and validate our hypotheses further.

Comparing our study with existing TVET literature utilizing Chi-Square analysis reveals a predominant focus on the teaching-learning environment, professionalism with skills, and correlations with environmental awareness. None of these studies, however, have explored the correlation between personality traits and skills. Based on this comparison, we can conclude the following:

1. This study represents a pioneering effort in Pakistan's TVET sector, being the first to correlate skills with human personality using Chi-Square analysis.
2. Unlike previous literature that typically examines single variables, our study compares all five personality dimensions of the BFI with TVET trades through Chi-Square analysis, offering a comprehensive perspective.
3. Our findings hold significant implications for critical aspects of the TVET training cycle, including dropout predictions, career guidance, on-the-job training assessments, exam assessments, and course recommendations.
4. Given our generalized approach to data collection, applicable across developing countries, our methodology for gathering and assessing personality data can be readily adopted.
5. The dissemination of this research is poised to benefit TVET training providers, policymakers, international funding agencies, researchers, and academics alike, aiming to enhance the effectiveness of TVET programs and maximize returns on investment.

This study not only fills a gap in the existing literature but also provides valuable insights into the intersection of personality traits and skills within the TVET sector, offering potential avenues for further research and practical applications. The significance of this study lies in its potential to be shared with TVET training providers, TVET policy makers, international funding agencies, researchers, and academia to improve TVET Programme performance and ROI.

Table 4: BFI OCEAN Contingency Table

BFI OCEAN Score ➜	Score_O			Score_C			Score_E			Score_A			Score_N		
Trade Name ⬇ | BFI Score ➜	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M
Auto Electrician	8	0	8	10	0	6	1	2	13	4	0	12	2	2	12
Auto Mechanic	10	2	16	16	4	8	2	10	16	13	1	14	7	6	15
Beautician (Women/Men) Level 2	27	8	26	39	3	19	16	9	36	32	3	26	7	25	29
Clinical Assistant	54	13	84	96	3	52	16	30	105	70	6	75	26	35	90
Computer Application & Office Professional	39	12	56	61	3	43	20	24	63	55	2	50	27	24	56
Computer Application for Business	8	0	17	16	0	9	2	2	21	20	0	5	3	1	21
Computer Hardware & Network Professional	10	2	33	22	6	17	14	4	27	20	0	25	11	7	27
Computer Operator Level 2	11	1	18	24	0	6	7	3	20	9	0	21	0	11	19
Dress Making	10	2	25	19	6	12	5	9	23	12	1	24	4	20	13
Fashion Designing	16	0	9	12	1	12	6	3	16	8	0	17	0	14	11
HVACR Level-2	7	2	14	5	3	15	0	4	19	10	4	9	5	5	13
Industrial Electrician	16	2	26	30	1	13	7	7	30	16	3	25	12	9	23
Industrial Garments Stitching	10	0	11	15	1	5	10	0	11	7	0	14	5	4	12
Motorcycle Mechanic	1	5	13	4	4	11	0	7	12	4	2	13	1	9	9
Plumber	0	3	10	5	1	7	1	3	9	1	3	9	2	0	11
Refrigeration & Air Conditioning	32	6	52	52	3	35	12	18	60	29	12	49	24	13	53
Repair & Maintenance of Electrical Appliances	1	4	7	7	0	5	2	2	8	7	0	5	9	0	3

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