

The Significant Contextual Predictors of Industrial Academic Collaboration in Engineering

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Abstract:

In a Modern Economy, transforming academics into competitive advantages is pivotal. The present work discusses the impact and challenges of academia-industry collaboration on academic output and campus placement preparation. This study explores the contextual predictors related to core placement and industrial-academic collaboration requirements among undergraduate students in Engineering. Industrial-academic training and placement intent are defined as the core competence and the students undergo these trainings to develop the skills in order to get placement in the core domains of RTL Verification using System Verilog, SOC-ASIC physical design, Embedded system design, IoT and Artificial intelligence for Cyber security. Overall, 509 students have been included as participants and they are students of second year, third year, and final year engineering from the Department of Electronics and Communication Engineering of Kalasalingam Academy of Research and Education. This work examines the Collaborative Success in Learning New Application, Teaching Research Level Collaboration, and Preparation for First Campus Placement. The statistical Analysis of Regression has been utilized to address the relationships. Skill training from industry and participation in domain-specific activities are more strongly intended for engineering undergraduate students during their course. The analysis pertains that both are significant parameters. However, the level of significance is more in Collaborative Success in Learning New Application (CSLNA) compared to Teaching Research Level Collaboration (TRLN) for the confidence level in Preparation for First Campus Placement (PFNP).

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Motivational intellectual collaborator is the key where the students' motivation to join the intent is a pivotal issue and

that is the significance quality of engineering education community.

Keywords: Collaborative Success in Learning New Application, Teaching Research Level Collaboration, Preparation for First Campus Placement, Industry-Academic Collaboration, Regression, Anova, Tukey.

1. Introduction

Academia and industry collaboration is pivotal for knowledge sharing. Industry benefits from quality products and innovation (Bishop et al., 2011). The intellectual and economic benefits increase with collaboration (Arza et al., 2015). It is part of the nation's economy and a highly dependent factor for innovation and growth. The academia-Industry collaboration reflects the strategies of mutual sustainability and transformation in many contexts and hence, it is considered as a critical factor in extending the knowledge resource to multiword opportunities. The creation and dissemination of content knowledge are essential for commercializing science and technology in order to craft the innovation reach the grassroots levels (Chen et al., 2017). It has also mentioned a similar idea where it provides importance to society in leading the collaboration (Cohen et al., 2002).

The strategies have been carried out for commercial success collaboration, educational values, and scientific temper (Perkmann et al., 2013). The enhancement of innovation at the academic level is possible with collaboration (Lin et al., 2016).

Freedom is required in academic collaboration and it needs to be in multidimensional academics and research by maintaining the quality (Laursen et al., 2014). The Regeneration of economic activity and the creation of knowledge as an instrument have been growing acceptance for the collaboration. The collaboration gets explored for short-term and long-term benefits (Bruneet al., 2010). Certain studies have focused on the institutional and

individual factors for the engagement with industry from academia (D'Este et al., 2007). The vision, mission, prior experience, affiliations, and quality of research are significant drivers. The conflicts and the method are essential parameters to resolve using integration skills for the study (Bruneel et al., 2010). There are several connecting dots available for the relationships due to collaboration for the academic and industry. The motivational factors mainly play a role with collaborative experiences to ensure the outcome.

2. Related Works

A. Motivational Intellectual Collaborator

In specific works, collaboration can be defined as a term with the significance of expectation of profit and it includes the connotations to the concept that one size does not fit all (Etzkowitz et al., 2000), (Lee et al., 2000). This term is considered in the context of academics as the intellectual quantity. It gives evidence with a study in this direction (Ankrah et al., 2013). The study describes the economic outcomes as benefits. Therefore, the knowledge exchange can be described as the motivational intellectual driver and it contributes immensely in the growth related to projects in scientific study and other research-oriented studies that benefit with projects along with publications as well as intellectual property is guaranteed for scientific discoveries with problems related to the industry. The data show that some of these research outcomes are beneficial in terms of funds from suitable resources (De Fuentes et al., 2012). It has also shown that the studies have offered some revelations of academic talk with industry on the aspects of the research component and there is very little to be done with commercialization of knowledge. Further, the prime factor is the motivator in intellectual gains as a benefactor and it is less on economic aspects (D'Este et al., 2011). The works proposed with similar academic engagement to the industry are strictly intellectual factors, and the contributions are significant (Abreu et al., 2009).

The research extension with incentives is a significant factor in the collaboration process (D'Este et al., 2011). The financial involvement of academia-industry tie-ups results in an academic research boost (Glaser et al., 2005). The field-testing prime factors like academic researchers are essential as the motivational factors for academics to keep sustainable collaborative relationships with secured funds (Lee et al., 2005). The case is that funding acts as a stimulus of creativity and networking for the utilization of knowledge. It is an opportunity where research outputs are tested practically and they are fundamental in gaining knowledge as well as insights for research and industry problems. There are cases where joint academic-Industry supervision of research thesis and publication is contended. It is a joint work with special access to equipment, data, and technology equipped in the industry. The technology

and knowledge act as scales of deliverables for collaboration. Results are bound with one another, and these are related or expressed with acquiring, supplementing, and scientific with financial support along with training and career opportunities for the students. The collaboration outcomes include a network for knowledge creation and sharing with utilization as well as validation of commercialization of research results with skill updation of academics from exposure to business practices (Cohen et al., 2002). There is a factor of academic takeaway which acts as the motivational contributor.

The collaboration will be directly proportional to the motivation provided initially, and the outcome is projected at the post collaboration (Arza et al., 2010). In the proposed model, intellectual models with the collaboration of teaching and research sharing with industry and academic collaboration are verified for their significance.

B. Experienced based Motivational Intellectual Collaborator

It suggests that the collaborative experiences are always carried over to future collaborations in academia and it is the most exceptional case (Bercovitz et al., 2007). The collaborative experience counts the industry's engagement by academia, and whenever the previous engagements and the sizes are considered pivotal for future engagements. The ability to predict the collaboration gets experienced with academic participation. The motivational factors in the collaboration work as the reference point for the firm selection especially for future collaborations and engagements. The collaborative experiences act as a bridge of engagement between collaborative and motivational factors and they are essential as well as the measured collaboration extends with benefits anticipated from academics and industry.

The importance of economic, institutional, and social contest for academia-industrial collaboration is confirmed for studies (Ankrah et al., 2015). In some works, there is an insight into the positive influence of experience with collaborations on academia's outcomes -industry tie-ups (Bhullar et al., 2017). A collaborative scheme ~~is follows~~ defines on past engagements and future anticipation with high tackling of complexities. Sometimes, the outcome can be predicted when a study relevant to collaborative experience is reflected, especially from industry-academia tie-ups, including pre-empt problems. Apart from the institutionalization of the system, collaborative experience plays a significant role and acts as a stimulus. It is the mediator in translating the motivational factors into collaboration outcomes.

C. Outcome in teaching and research based Motivational Intellectual Collaborator towards employable training satisfaction.

It is essential to judge the broadened horizons' significance and supplement intellectual capacities from academic to industry experience. It is possible with incentive mechanisms with engaging industry. The factors like exposure factors in the academic pedagogy are directly related to teaching and research quality of the system in terms of collaboration. Academic research is tested with a serving point of view. In both these cases, industry participation and involvement are essential for exploring the opportunities. Therefore, teaching and research performances are collaboratively checked for its significance.

The impact of the collaboration outcomes can be observable and hence, it needs to look at the overall effect of the academics and research components from academic and industry points of view. Qualitative and quantitative improvements are necessary. It follows with the collaborations in teaching and research.

In some works, it is envisaged that the addition of teaching and research collaborations within the classroom leads to redesigning the curriculum and developing the student competencies towards employable opportunities (Perkmann et al., 2009). Subsequently, rich experiences of theoretical knowledge and practical knowledge are obtained and the world of academia and industry is converged. As a result, the present paper needs to focus on the research questions of the significance and relationships of the parameters like collaborative success in learning new applications, teaching research-level collaboration, and preparing for first-campus placement.

3. Methodology

The critical requirements of techno learning and skill up-gradation are needed. Consequently, the innovation and induced competitiveness to the system of collaboration are given between academia and industry. The outcome typically projected is that low employable opportunities are created for the students from engineering or the students' satisfaction level gets deteriorated in facing their first campus placement. These factors have not been considered by many as needed or significant parameters because of the stakeholders' educational misadventures.

The fall in significant value adds industry and rightly points towards the gap existing (Saha et al., 2015). The research question should focus on whether the CSLNA-Collaborative Success in Learning New Application and Teaching Research Level Collaboration are significant factors concerning employable training satisfaction or the student's confidence in appearing for first campus placement reflects as a positive outlook.

Some issues addressed by (Dahlman et al., 2005) like Government Centric inputs and Academics as 27% and 3 %, respectively. Mostly, the collaboration is not

measured anywhere in other universities as a significant factor.

National Knowledge Commission (2009) has reported that Research and Development are weak by concerning academic and manufacturing industries' collaboration. Lack of healthy cooperation between private industry and academia is a factor. There are no developed mechanisms available to structure the collaboration and to stimulate the significant academia and industry tie-ups as per the Ministry of Science and Technology report quoted during 2013. By considering the weakness, it is needed to verify how academia and industry collaboration exists through proper analysis methodology matters.

The Research Questions are based on the Questionnaire as follows

Table1, Survey Questionnaire for Academia-Industry Collaboration

S:N	Category	Questionnaire
1	CSLNA-Collaborative Success in Learning New Application	Rate the collaborative success (share and learn with industry support) in terms of learning new technology like Blockchain Technology
		Rate the collaborative success in terms of learning new application in Artificial Intelligence
		Rate the collaborative success in terms of learning new application in Embedded System
		Rate the collaborative success in terms of learning new application in RTL and System Verilog
		Rate the collaborative success in terms of learning new application in Soc and Physical Design
2	TRLC-Teaching Research Level Collaboration	Rate the teaching level under collaboration [from industry]
		Rate the teaching level under collaboration [from academic]
		Rate the research level under collaboration[from industry]
		Rate the research level under collaboration[from academic]
		Rate the overall performance level under collaboration [self-assessment]
3	PFCP-Preparation for First Campus Placement	Rate your Preparation for First Campus Placement Interview

The above questionnaire have been framed for CSLNA and TRLC. This paper focuses on checking whether it is achievable and it can be a part of the Predictor model to address the stakeholder's confidence level. The paper explores the option of regression and other statistical tools to check the significance of the predictors of collaboration between academia and industry. Here, CSLNA and PFCP are dependent Influences whereas TRLC and PFCP are independent Influences.

4. Experimental Analysis

The Data which are collected in the form of a survey include 509 students. It comprises students of the second year, third year, fourth-year engineering. Figure 1 shows that 80.6% of respondents are males, and 19.4% are females.

From figure 2, it is clear that 61.9% respondents are from second year, 15.2 % respondents from third year and 22.5% from final year. The second year respondents have been given specific information from the industry collaborator meeting about the collaboration, and that has been depicted as the increased participation in the survey. For the study, Regression Analysis, a statistical technique has been used to model and the relationship between two or more variables has been investigated. The regression determines significant factors, identifies non-significant factors for the omission, and shows dependent and independent influences.

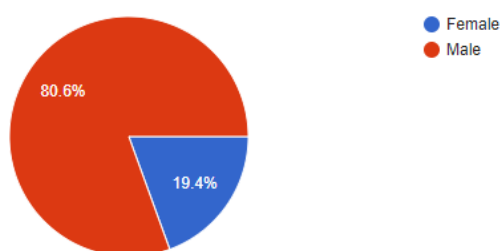


Fig 1. Gender Response

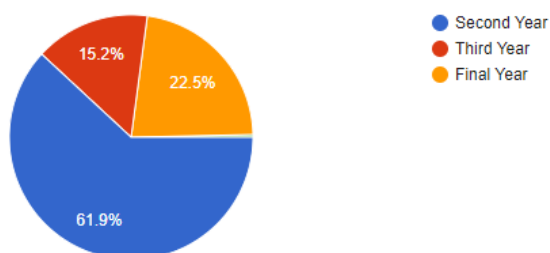


Fig 2. Student Response

The statistical model illustrated in the proposed study is demonstrated for prediction. Regression is used here for testing with the tool Minitab. Run chart and Normality Testing usually accomplish continuous improvement using the data that do not cause any special causes, as the data with the special causes can lead to incorrect interpretations in the analysis as well as the improvement phase of continuous improvement. A run chart is a tool that will help to identify special causes. Run chart plots all the individual observations versus the subgroup number and draws the horizontal reference line at the median. When the subgroup size is more significant than one, the Run chart also plots the means or medians of the subgroups and connects with the line.

For the study, the samples have been collected randomly from the Department of Electronics and Communication Engineering especially from the second year to final year

students enrolled in the Undergraduate program in Engineering, i.e., Bachelor of Technology of Kalasalingam Academy of Research and Education.

The steps include data collection for Linear regression, ANOVA, and Multiple Regression for experimenting the data's significance. The data are processed for the Regression, the run-chart, and boxplot. It facilitates the terms and the outliers are removed subsequently. The Data samples (509) are tested using linear Regression, and Multiple Regression, and Annova. Experimental work has been done using the statistical tool Minitab. Here, CSLNA and TRLC are checked using the Stat, Quality tools, and Run chart mechanisms and the clusters indicate the sampling or measuring problems where Mixtures indicate mixed data from two populations, and oscillations refer to data that vary up and down rapidly and trends refer to the trending of the data. The p-value is expected with the value 0.005 for clusters, mixtures, trends, and oscillations to support no special causes present in the sample data. If the p-value is not supporting, then the F value can be utilized.

The experimental study gives the significance of the CSLNA and TRLC as a predictor of the confidence level in PFCP. Here, the model has been utilized for the analysis of CSLNA components or between PFCP and CSLNA. The fit is the predicted value of the response variable PFCP for a given value of the predictor variable CSLNA. The content includes the residual, which is the difference between an actual observation, and the fitted value, which is the difference between an individual data point and the predicted value. It is expected to identify the relationship between CSLNA and PFCP when Industry-Academia Collaboration takes place. It identifies and creates an action plan, if the CSLNA positively correlates with the increase in PFCP. Also, the focus is to generate a regression equation that can predict the PFCP.

The Minitab Tool is utilized in the regression analysis as well for one way and Annova. The selected includes the Stat, Regression, and Fitted Plot Line. In response, the data entered are the PFCP, and for predictor, CSLNA. Hence, a positive correlation is obtained between CSLNA and PFCP. The steps are repeated for TRLC. It means that the CSLNA increases, the PFCP also increases, and it results in an R-Square adjusted value, which is greater than 65%, to categorize the model as the significant model. This is also checked for TRLC.

5. Results and Discussions

A.Fitted Line Plot Regression

The sampled 509 are used for Linear Regression (Fitted Line Plot) for confidence level in PFCP versus CSLNA and TRLC, as shown in Figures 3 and 5. Figure 4 and Figure 6 depict the residual plots of the analysis. Here, R square adjusted value is 81.4% for CSLNA and 80.2% for TRLC.

It means that there is a good correlation between CSLNA and PFCP, and the regression equation is obtained

$$\text{Confidence level in PFCP} = 0.6576 + 0.8458 \text{ CSLNA} \quad (1)$$

$$\text{Confidence level in PFCP} = 0.4933 + 0.8502 \text{ TRLC} \quad (2)$$

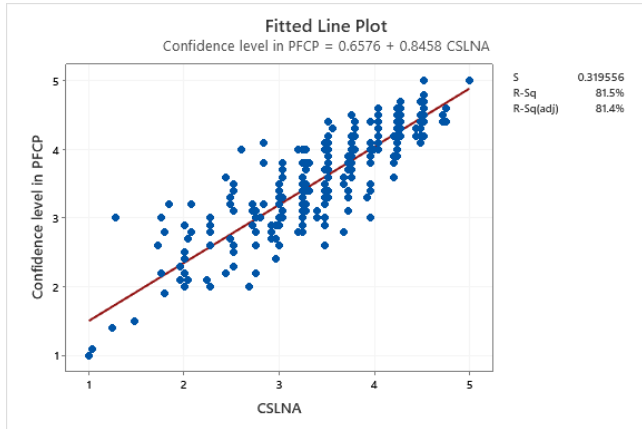


Fig3. Confidence level in PFCP versus CSLNA

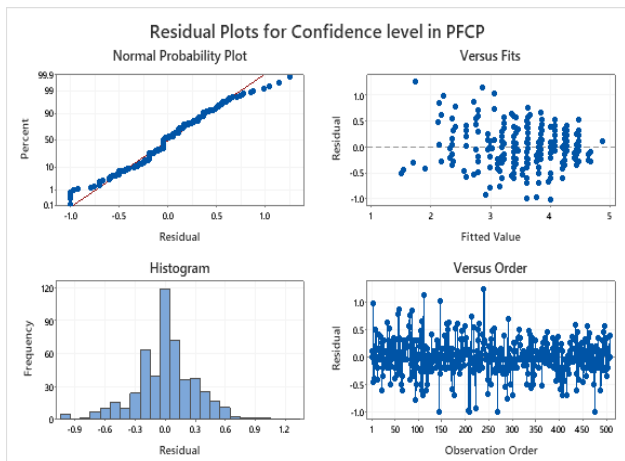


Fig 4. Residual Plots for confidence level in PFCP

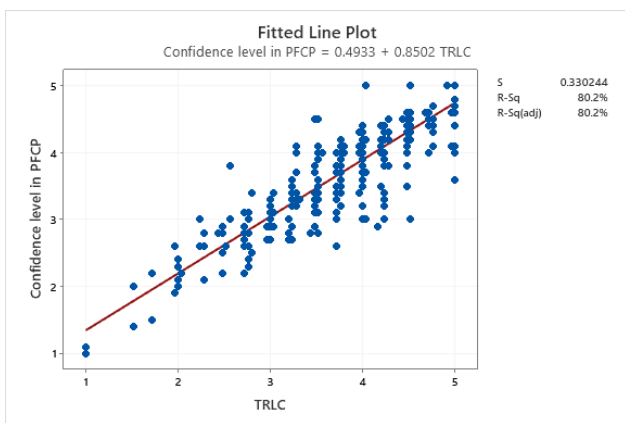


Fig 5. Confidence level in PFCP versus TRLC

Here, both CSLNA and TRLC are significant factors for the Confidence in Placement Interview.

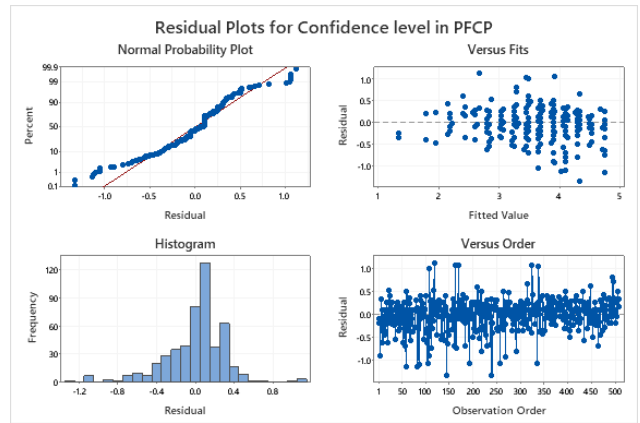


Fig 6. Residual Plots for confidence level in TRLC

B. One-way Analysis of Variance (ANOVA)

The One-way Analysis of Variance (ANOVA) is a procedure for testing the hypothesis that K population means are equal, where $K > 2$. The One-way ANOVA compares the means of the samples or groups to make inferences about the population means. It is a single factor analysis of variance because there is only one independent variable or factor. The independent variable has nominal levels or a few ordered levels. In this study, Tukey is selected for the analysis. Tukey compares all the pairs of groups while controlling the simultaneous confidence level, as shown in figure 7.

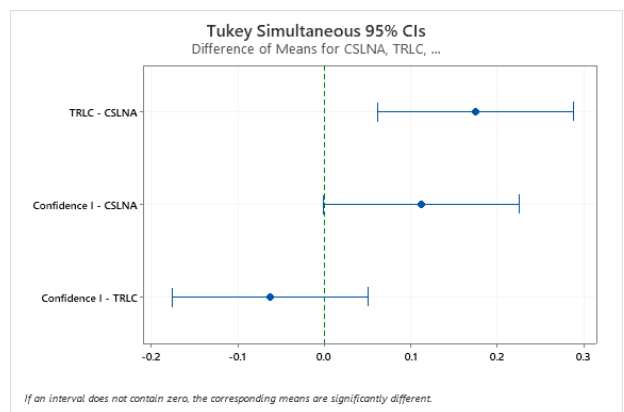


Fig 7. Tukey performed with one way Annova for CSLNA and TRLC

The Tukey result shows that the confidence intervals for the differences between CSLNA and TRLC are from 0.06 to 0.28, and this range does not include zero, which indicates that the difference is statistically significant. The remaining pairs' confidence level is zero, which indicates that the difference is statistically not significant. Here, the confident is 95% and it assures that all confidence intervals contain real differences.

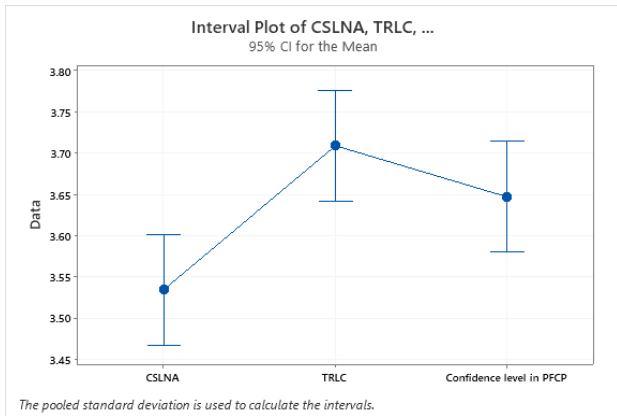


Fig 8. Interval plot of CSLNA and TRLC

As shown in Figure 8, the CSLNA has the lowest mean, and TRLC has the highest mean in the Interval plot. However, from this graph, it is not possible to determine whether any graph is statistically different. To determine the statistical significance as the competence intervals for the differences of the means, Grouping Information using the Tukey Method is gathered and 95% Confidence is presented in Table 2.

Table 2, Grouping Information with Tukey

Factor	N	Mean	Grouping
TRLC	509	3.7086	A
Confidence level in PFCP	509	3.6466	A B
CSLNA	509	3.5341	B

Table 2 illustrates group A contains TRLC and Confidence level in PFCP, and group B contains CSLNA and Confidence level in PFCP. Here, the observation can be made from grouping that the TRLC is significantly different from CSLNA, and TRLC has a significantly higher mean than CSLNA.

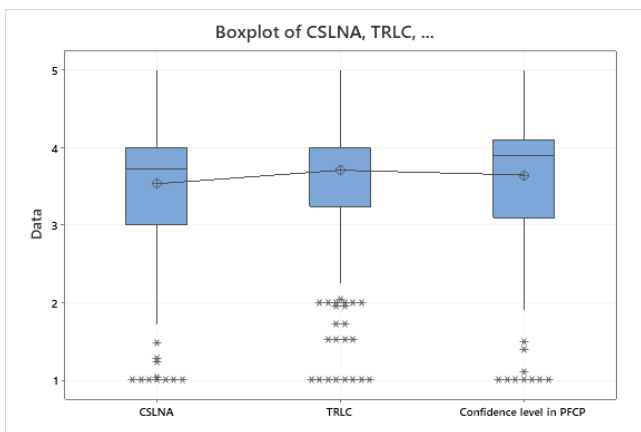


Fig 9. Boxplot of CSLNA and TRLC

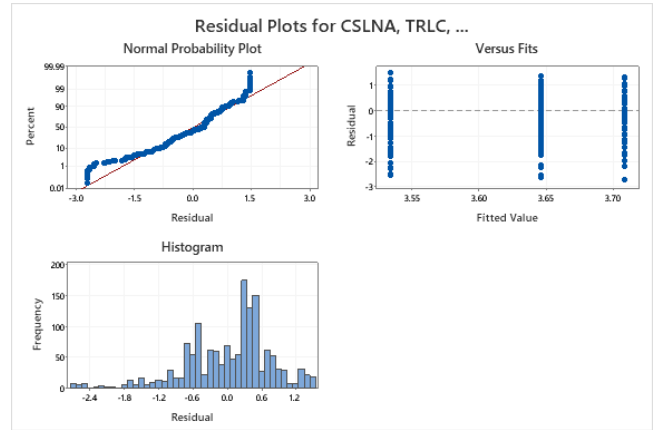


Fig 10. Residual Plots for CSLNA, TRLC for one way-Annova

Here, the P significance value is 0.001, which is less than 0.05 and the null hypothesis of all means is equal which can be rejected. Hence, it can be concluded that some factors have different means.

C. Multiple Regression Analysis

Multiple linear regression is a statistical technique to model the relationship between one dependent variable and two or more independent variables by fitting the data set into a linear equation. The difference between simple linear regression and multiple linear regression is that the simple linear regression has only one predictor. Multiple linear regression has two or more predictors. Multiple Regression Analysis is done for 509 Samples and the residual plots are plotted in Figure 11. Regression Equation is given by

$$\begin{aligned} \text{Confidence level in PFCP} &= 0.0195 + 0.5084 \text{ CSLNA} \\ &+ 0.4935 \text{ TRLC} \end{aligned} \quad (3)$$

Here, R-Sq (adj) value is 95.53%. However, from Table 3, the p-value is 0.00 for both CSLNA and TRLC. It shows arithmetic underflow. Hence, the variances with F value considered with CSLNA and TRLC are 1739.74 and 1596.73.

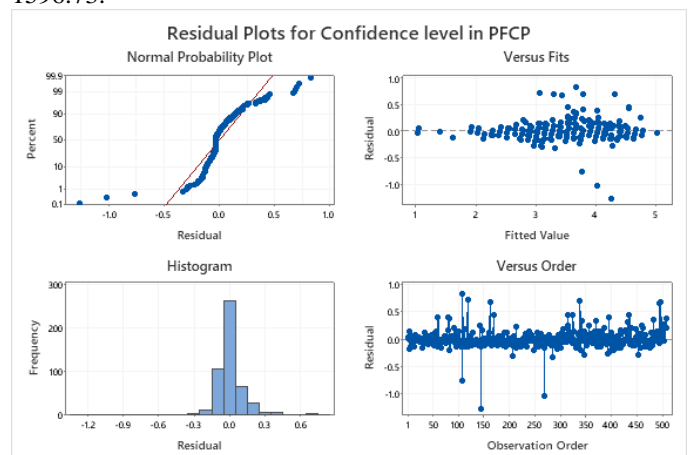


Fig 11. Residual Plots from the multiple regression analysis of CSLA and TRLC.

Table 3, Analysis of Variance

S:No	Source	F Value	P Value
1	CSLNA	1739.74	0.00
2	TRLC	1596.73	0.00

Table 4, Improvements for past 1 year

S:No	Survey Questions and Response Parameter from 509 Students	Number of Students Responded
1	Focused on new Streams of learning	414
2	Scientific Projects like mini-project or community Service projects or EPICS	229
3	Awareness of new research areas in their domain	291
4	Do you know the about how to apply for the patents	150
5	Have you tried to get fund for mini projects or projects in UG	124

From Table 4, it can be noted that 81.4% response has been obtained from students who have focused on learning new streams, 44.9% response from students who have focused on scientific projects like mini-project or community service project or IEEE EPICS, 57.2% of respondents concentrate on awareness of new research areas in their domain, 29.5% response is obtained in the Patent application process and 24.4 % response for applying funding for various projects.

Conclusion

The main objective of the proposed work is to perform a Statistical analysis of the intent for motivational intellectual collaboration within academia and industry. Regression and one-way Anova tests have been conducted for 509 students from Under Graduate Engineering and the questionnaire model designed is more suitable to address the students' confidence level for attending placement when they consider the performance from the course and the respective teaching as well as research inputs. The analysis result concludes that the CSLNA and TRLC are the predictors of the confidence level in PFCP. Besides, TRLC is significantly different from CSLNA. However, the level of significance is more for CSLNA compared to TRLC for the confidence level in PFCP. This model can be used for similar study with industry academic collaboration in other academic institutions. As a result, motivational intellectual collaborator is the key where the students' motivation to join the intent is a pivotal issue and it attracts the attention of the engineering education community.

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