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ANALYTICAL & PROBLEM SOLVING SKILLS FOR EMPLOYABILITY OF ENGINEERING GRADUATES IN INDIA – AN EMPLOYERS' PERSPECTIVE

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ABSTRACT

As 'Make in India' is gaining momentum, apart from the presence of existing MNCs, many more MNCs are expected to come to India for manufacturing products and services, by leveraging the talent pool and other resources. Potential employment opportunities for engineering graduates across branches of engineering are very promising. Under this context of opportunities and challenges of low percentage of employable engineering graduates in India, is a concern not only for the Institutions and their survival, but also a concern for the nation as a whole. Government is cognizant to the issue and is focusing on 'Skill development'. This research paper is a portion from the research work of the first author relevant to factors relating to analytical and problem solving skill expectations from employers' perception. It is also included within the scope of the work to identify the gap as evaluated by the employers, thus would result in beneficial improvements and approaches to the employability of mechanical engineering graduates at the institutional level.

Keywords: Make in India**,** Skill Development**,** Employability, Engineering Graduates, Analytical Skills, Problem Solving Skills, Educational Quality

I INTRODUCTION

Employment opportunities in India, particularly in engineering industrial environment have grown phenomenally in last few decades due to globalized market scenario. Presence of MNCs (Multi-National Companies) in India across all Industry verticals has exponentially increased since 2000s, by tapping the local talent pools in global product development. This scenario provided the opportunity for Indian Industries' growth also at the same scale, as MNCs preferred to develop local sources in product development for cost competitiveness. This trend of strong Industrial growth component of GDP during 2016-2020 is predicted to be 10.2% as per forecasts by dun &brad street [1]. One benefit of the industrial growth resulted in higher net income of individuals and employment opportunities across all levels. Exponential growth of educational industry in India during last few decades is not an exception and engineering education can be considered as one of the verticals of the educational industry in producing engineering graduates.

On one hand, the industrial growth resulted in business & economy, but has thrown the challenges on the industries like, getting the products 'faster to the market', 'least in cost', 'high in quality', 'globally competitive', 'mobility & cultural differences' etc.,. These challenges faced by the industries have resulted in time constraints in training the fresh graduates hired from the

institutionsin preparing them for the actual job. Hence, their expectations from the educational institutions are that, the produce of educational institutions is 'Job ready'. The gap between expectations from the industry and the availability from the institutions results in gap, leaving considerable percentage of 'un-employable' engineering graduates. This phenomenon on 'un-employable graduates' is of varying percentage across the globe, but in India more particularly with engineering graduates, the 'un-employable' engineering graduates are reported to be around 80% as cited from literature surveys by Ramanan et. al, in their work [2 to 4, 6 to 10].

The factors involved in the employability issues, the respondents surveyed and other relevant details relating to this research work with a focus on employability of mechanical engineering graduates are detailed in [2]. The focus of [2] was also to bring-out in detail the research out-puts relating to 'Soft Skills' in employability. This paper brings out the details of research work relating to the factor 'Problem Solving and Analytical Skills' on employability of mechanical engineering graduates, as perceived by the employers.

II OBJECTIVES OF THIS RESEARCH

This explorative research brings-outemployers' perception on 'problem solving and analytical skills', an employability factor in mechanical engineering graduates, its importance and the assessment of current skill level of the students. The skill dealt in this work is one of the few easy to equip skills at the institutional levels as identified by [3] and are Critical to Quality [CTQ] in addressing employability defect and they are interconnected as seen in Fig.1

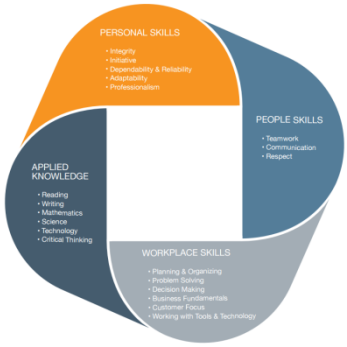

Fig.1 Interconnections of Employability Skills [4]

III RESEARCH METHODOLOGY

Samples, Size, Distribution and Approach

As reported in [2] the samples were drawn from all four regions of India, covering all the industrial segments and cross functions of engineering like design, manufacturing etc. The respondents are technologists and technology managers involved in the hiring process and have a direct knowledge on the needs of mechanical engineering job role of fresh engineering graduates [2]. The multi-stage sampling includes both judgmental and snowball sampling approach in data collection. Total sample of 352 represents the afore said characteristics.

Survey Design

Self-Administered research questionnaire covers the factors as detailed in [2 & 3] takes into accounts the attributes as reported in NBA (National Board of Accreditation), Washington Accord, literatures and the opinions expressed during initial survey [3] that are perceived to have an impact on the factors and purpose related to applying theoretical knowledge to practice. This paper restricts the discussions to analytical and problem solving skills towards employability as in [2, 3].

Survey Instrument

As detailed in [3] the research survey questionnaire structured has two components 1) rating on the importance of the factorstowards employability needs 2) ranking on the skills of the fresh engineering undergraduates related to the factor. Both of these components are of importance in understanding the expectation and availability as perceived by employer, thus helpful in quantifying gap and solution development. The dependent and Independent variables are as in Table 1. The independent variables have been elaborated with examples for clarity of questions in the questionnaire and a simplified one is as in Table 2 and for dependent variable [3].

Table 1. Dependent and Independent Variable

Independent Variable	Dependent Variable
Fundamental Knowledge on Maths, Science & Engineering	Analytical & Problem Solving Skill
Approach to Solving Engineering Problems	
Innovation & New Ideas	
Root-Cause Analysis	
Selection of Technology	
Decision Making	
Data Analytics	

Table2. Simplified Questionnaire Related to analytical and problem solving skills

Question Code	Simplified Question from the description of survey questionnaire	Pl. rate the importance of the Need	Pl. rank the skill of fresh graduate
		Strong Agree - 5 Agree - 4 Neither agree nor Disagree - 3 Disagree - 2 Strong Disagree - 1	Good - 5 Above Ave - 4 Average - 3 Below Ave - 2 Bad - 1
APS	Analytical & problem solving skills, importance & availability, for employability		
APS-1	Fundamental knowledge on Maths, science & Engineering, its importance & availability		
APS-2	Knowledge in approach to solve engineering Problems – importance & capability		
APS-3	Innovation and New Ideas, ability to think out-of-box – Importance and ability		
APS-4	Knowledge on Root-Cause Analysis in problem solving - its importance& awareness		
APS-5	Analytical knowledge in selecting Technology for cost effective, faster, reliable solutions – Importance and ability		
APS-6	Ability in Decision making – Importance and ability		
APS-7	Application of data analytics with domain / technology toarrive at conclusions in problem solving – Importance & ability		

As detailed in [2] the questionnaire was color coded to distinguish the scores for rating of importance and ranking of skills availability as perceived. The ratings and rankings are received on Likert scales as shown in Table 2.

Research Hypothesis

Following research hypothesis (null-hypothesis) were developed for the research questions related to the analytical and problem solving skills.

Haps-a –Analytical and problem solving skill gap amongst mechanical graduates is not significantly different across regions.

Haps-b– Analytical and problem solving skill gap amongst mechanical graduates is not significantly differentacross industry segments.

Haps-1a–Fundamental knowledge gap is not significantly different across regions.

Haps-1b– Fundamental knowledge gap is not different across industry segments

Haps-1c–Fundamental knowledge gap is not influencing on analytical and problem solving skills

Haps-2a– Knowledge gap in approach to solve engineering Problems is not significantly different across regions

Haps-2b–Knowledge gap in approach to solve engineering Problems is not different across industry segments

Haps-2c–Knowledge gap in approach to solve engineering Problems does not have an influence on analytical and problem solving skills

Haps-3a– Innovation – Gap in ability to think differently is not significantly different across regions

Haps-3b– Innovation – Gap in ability to think differently is not different across industry segments

Haps-3c–Innovation – Gap in ability to think differently does not have an influence on analytical and problem solving skills

Haps-4a– Knowledge gap in root cause analysis is not significantly different across regions

Haps-4b– Knowledge gap in root cause analysis is not significantly different across industry segments

Haps-4c–Knowledge gap in root cause analysis does not have an influence on analytical and problem solving skills

Haps-5a–Analytical knowledge gap isnot perceived significantly different by respondents across regions

Haps-5b–Analytical knowledge gap is not perceived different across industry segments

Haps-5c–Analytical knowledge gapdoes not have an influence on analytical and problem solving skills

Haps-6a– Gap in the ability to make decisions scientifically, is not significantly different across regions

Haps-6b–Gap in the ability to make decisions scientifically, is not significantly different across industry segments

Haps-6c– Gap in the ability to make decisions scientifically, does not have an influence on analytical and problem solving skills

Haps-7a– Gap in the ability to make decisions scientifically, is not significantly different across regions

Haps-7b–Gap in the ability to make decisions scientifically, is not significantly different across industry segments

Haps-7c– Gap in the ability to make decisions scientifically, does not have an influence on analytical and problem solving skills

IV RESEARCH FINDINGS

Data collected from the respondents are used in commuting the gap as perceived by the respondents. Data analysis with statistical tools was carried-out using the multipurpose commercial statistical algorithm Minitab version 17 [13].

Test for Reliability and Consistency of the Construct

As brought-out in [2], before rolling-out the questionnaire for larger audience, a pilot survey was conducted to test the reliability and consistency. An overall Cronbach Alpha value of 0.92 for importance of needs, 0.96 for ranking of skills was predicted indicating high correlation and consistency of the questionnaire.

Gap in Analytical and Problem Solving Skills

The perceived opinion and view of the individual respondents as the representative of the employer has been used in computing the gap between expectation vs availability with fresh mechanical engineering graduates. Fig. 2 explains the gap with the means of the dependent and independent variables, through interval plot, related to analytical and problem solving skills for this research paper by plotting importance vs availability perceptions of employers.

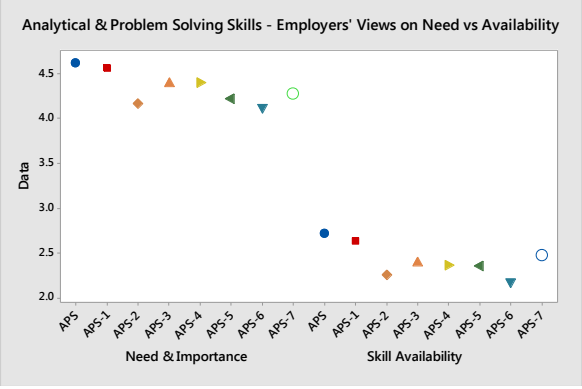

Fig. 2 Interval Plot – Expectations vs Availability for Variables Related to Analytical & Problem Solving

As could be seen from Fig 2, the need or importance for the analytical and problem solving skills in employability is perceived by the employers at a mean of 4.61, while the skills availability as predicted by the employers with the fresh graduates are at 2.72, both of them are measured with 1 to 5 scale as captured in Table 2. These factors can be interpreted with the need and importance vs the skill availability related to problem solving skills, impacting the applied knowledge needs of employability as captured in Fig [1].

Analysis of this gap for various independent variables considered for analytical and problem solving skills in employability, brought-out some interesting and surprising facts that all the factors are not at the same levels of the gap. As could be observed from Fig.3, there are factors like APS-1, APS-2 and APS-7, the data of gap below Quartile Q1, explains that the gap is ranging between (1 to -2). This observation implies, that the gap in expectations vs knowledge availability with the student community as perceived by 25% of the employers', is either very low as 1 as or more than their expectations (as the gap is spreading to -1 and -2). This could be due to the fact the regulators, educational institutions etc., are cognizant of the issue and the theoretical syllabus are constantly been upgraded resulting in this trend. This observation correlates with couple of observations as found in some of the literatures surveyed that the theoretical knowledge meets the employers expectations. It could be observed from Fig 3, all the factors above quartile Q2, (50the percentile and above) reports the gap is between 2 to 4, while between inter-quartile range of Q1-Q2 & Q2-Q3 accounts for a gap of 1. This brings out the fact from the research findings that considerable portion of the employers feel, the mechanical engineering students have issues not on theoretical knowledge, but in applying theory to practice.

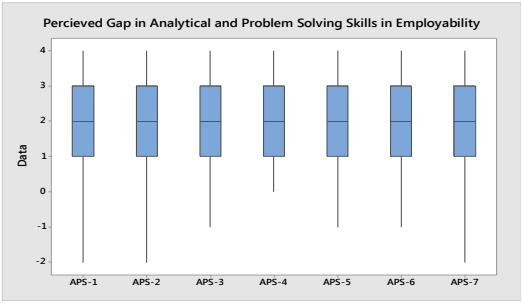

Fig.3. Gap in Analytical & Problem Solving Skills

Further analysis for the gap on the dependent varaiable to know whether the application of analytical and problem solving skills into practice as percieved by the employers is captured in Fig. 4

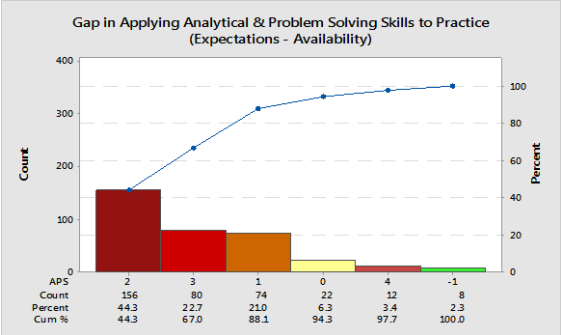

Fig.4. Gap in Applying Theoretical Knowledge to Practice using Analytical & Problem Solving Skills

As could be seen from Fig. 4,majority of the employers as high as 91.5% feel the gap in employing mechanical engineering graduates is applying theoretical knowledge to practice in utilising the analytical and problem solving skills. This is a major cause of worry from the employability. A smallest percentage of (6.3%) repondents feel there is no gap, while 2.3% of employers feel that the knowledge on application of analytical and problem solving skills to practice is more than their expectations. This brings-out the fact, though there might be some of the indpenedent variables as seen in Fig. 3 would be more than their expectations, but overall the dis-satisfaction (gap) of applying analytical and problem solving skills by mechanical engineering graduates is high with employers and a concern in employability. This prompted for sanity checksonone of the indepenednt variables namely APS-1and is reported in Fig. 5, before further analysis. The sanity check revealed that larger percentage as high as 91.2% of

respondents feel the gap, while ~1% found the skill is above their expectations and 8% found there is no gap, which trends with that of dependent variable.

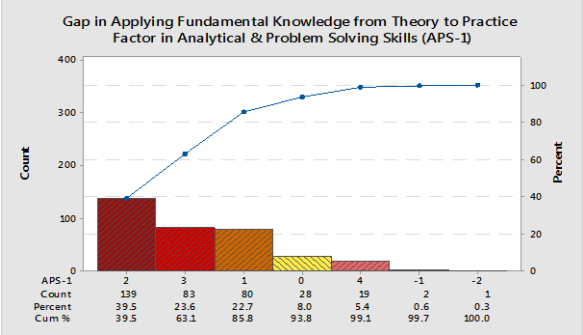

Fig. 5 Gap in Applying Fundamental Knowledge

At the first instance, data was analysed to confirm whether the trend is the same across Industries segments and the regional locations of India through Anova. Hypothesis testing (Haps-a & Haps-b) using one way Anova, for analyzing the gap for the knowledge in applying analytical and problem solving skills across regions of India and industries segment is same, found $p > 0.05$ [Table -3] with 95% confidence interval, thus null-hypothesis for Haps-a & Haps-b are accepted. This statistically concludes there is no difference on the trends of the gap related to analytical and problem solving skills either by industry segment or by regions of India. However, the independent variable APS-3 on the skills relating to skills in applying innovation and new ideas is found to be significant regions of India ($p < 0.05$).

Anova and Regression Analysis

To test the hypothesis as stated earlier for the statistical significance for the importance of individual factors, one way Anova and simple linear regression have been performed. The details of the hypothesized codes of questions with relevant statistical tools applied and the p values are as posted in Table 3.

As found in ANOVA, null hypothesis Haps-3a has to be rejected as the p value is < 0.05, this implies that the employers by regions of India differ in percieving the gap in the skills relating to innovation and new ideas using analytical and problem solving skills to apply theoretical knowledge in practice. However, there is no significant difference for the same skill by industry segment. Interval plot for the gap percieved by the employers towards Innovation and new ideas [Fig. 6] brings-out North and West regions of India, the gap is high compared to other regions and their percived view is the same with the mean of 2.14 and 2.23 respectively. However, eastern and southern regions of india percieves this gap with mechanical engineering students is low with the mean of 1.7 and 1.8. It could also be observed that the spread of the gap amongst the respondents in the eastern regions of India is very wider, when compared to other regions as found from interval plot [Fig.6].

To confirm the signifcance of independent variable APS-3 in combination with other variables by the industry segment and regions of India, a general linear model under Anova with multiple responses and factors, has been performed and found to have p value of 0.158 for regions of India and 0.122 by the segments of Industry. Hence it is concluded that under the combined effect of all factors, there is no significant difference found for APS-3 by the regions of India.

Hypothesis	Statistical Tool	p Value	Details
Haps-a	One Way Anova	0.756	Regions of India
Haps-1a		0.702	
Haps-2a		0.674	
Haps-3a		0.013	
Haps-4a		0.913	
Haps-5a		0.863	
Haps-6a		0.973	
Haps-7a		0.146	
Haps-b		0.439	Industry Segments
Haps-1b		0.778	
Haps-2b		0.101	
Haps-3b		0.096	
Haps-4b		0.657	
Haps-5b		0.174	
Haps-6b		0.151	
Haps-7b		0.118	
Haps-1c	Linear Regression	0.000	Relation of Independent variables with dependent variable
Haps-2c		0.028	
Haps-3c		0.017	
Haps-4c		0.000	
Haps-5c		0.059	
Haps-6c		0.276	
Haps-7c		0.617	

Table 3.Hypothesis Testing and P Value

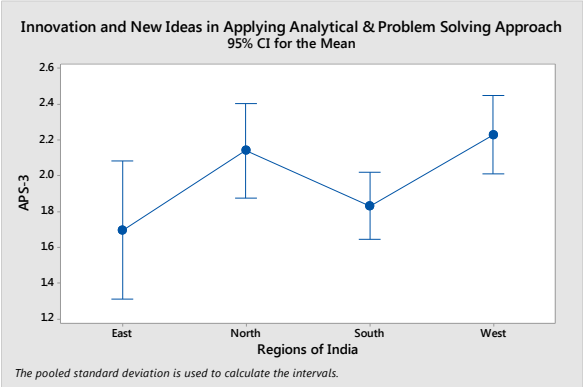

Fig. 6 Gap in Application Knowledge to Practice Using Analytical and Problem Solving Skills with Innovation and New Ideas by Regions of India – As Percieved by Employers

The linear regression performed for finding out the relationship between dependent and indpenedent variables is indicative of statistical significance for all the factors (p values are < 0.05), except for (Haps-6c& Haps-7c) as its p values is > 0.05. The fits and residuals are indicative of decent fit as seen in the histogram of residual in Fig. 7. The R-Sq value of 53.48% and R-Sq(adj) of 52.53% and R-Sq (pred) 51.22% and their closeness explains the fit of the perceptions measured and the corresponding regression equation is as follows

APS = 0.3400 + 0.4562*APS-1 - 0.0910*APS-2 + 0.1073*APS-3 + 0.2336*APS-4 + 0.1151*APS-5 – 0.0514*APS-6 +0.0247*APS-7

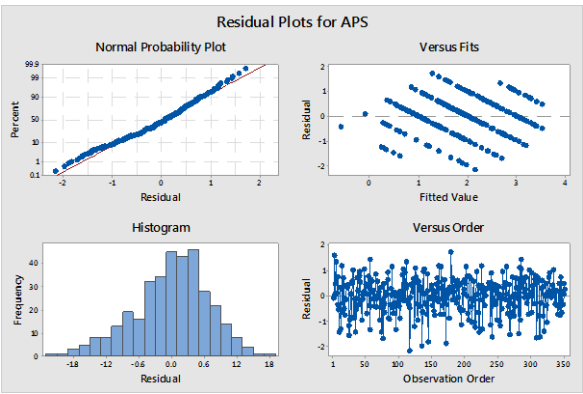

Fig. 7.Residual Plots

VI APPROACH TO SOLUTION IN REDUCING GAP

Predictive Modeling& Sensitivity Analysis

To decide whether to drop the last two terms (APS-6 & APS-7) in the transfer function developed based on the statistical significance (p value of 0.276 & 0.617 in Table 2) under the context of R-Sq values are around 52%, sensitivity analysis has been performed through Monte-Carlo simulation usingDevize [14], by considering and ignoring them. The mean and standard deviations of the variables as derived from the survey responses are used for the independent variables. The simulation model for the sensitivity simulation is as seen in Fig.8

Sensitivity of the model by including terms (APS with 7Xs) and model excluding terms (APS with 5Xs) are simulated with 50000 trials, predicted 1.897 and 1.953 for the means and 0.5789 and 0.5755 for the standard deviation respectively. An analysis of this data through paired-t test, statistically concludes that there is no significant difference by including or excluding the variable APS 6 & APS 7 (p 0.539). However, the mean gap predicted in model with all the 7 independent variables are lower when compared from practical significance, as we are focused in bringing down gap to zero, this model is used in further optimization studies. The predictive model from 50000 respondents is captured in Fig. 9. In the existing scenario, if we target the gap to range between 0 and 2.5, it is predicted that 42.52% will fall beyond the upper specification limits.

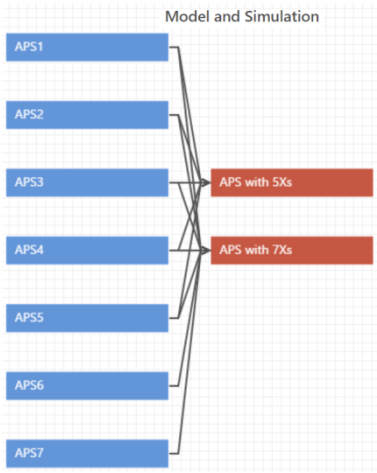

Fig. 8 Sensitivity Simulation Model

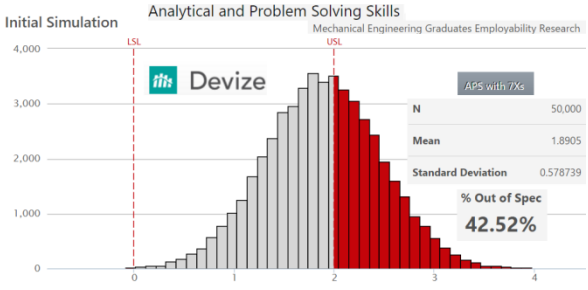

Fig.9. Analytical and Problem Solving Skill Gap – Predictive Model (Existing)

The gap from the expectations and availability of the skills as perceived by the employers can be addressed in two stages:

First Stage – Reducing the variation

In the first stage the focus has to be reducing the variation on dependent variable by controlling the variations in the independent variables. This could be achieved with ease by leveraging the best practices within the institutions. Table 4 shows the benefit of controlling the variation of the independent variable from the existing to the proposed, by keeping the mean as in existing.

One could visualize by controlling the input variations on the dependent variables, improvement as high as 37% (from 42% to 5%) can be achieved [Figs 9 &10].

Table 4 – Mean and Standard Deviations of Independent Variables

	Existing		Proposed	
Xs	Mean	St. Dev	Mean	St. Dev
APS-1	1.929	1.010	1.929	0.065
APS-2	1.903	1.045	1.903	0.298
APS-3	2.000	1.190	2.000	0.286
APS-4	2.026	1.142	2.026	0.137
APS-5	1.855	1.092	1.855	0.241
APS-6	1.949	0.963	1.949	0.249
APS-7	1.796	0.994	1.796	0.279

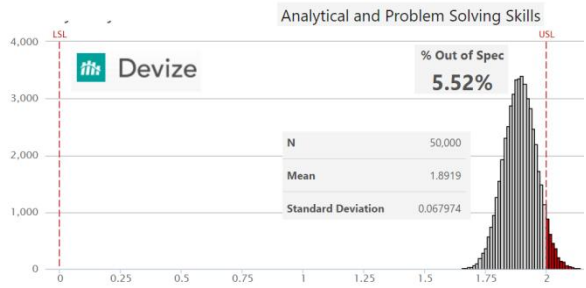

Fig.10. Analytical and Problem Solving Skill Gap – Predictive Model (Proposed)

Second Stage – Shifting the Mean

In the second stage the focus has to be in shifting the mean to zero by focussing on the strengths and weakness of individual institutions relevant to the independent variables to shift the gap from the mean of 1.89 [Fig 10] to zero. This can be achieved in multi-stage or in single stage depending on the time, effort, commitment to the cause by the management of the institutions.

Second stage accomplishment depends on many factors like simple change to reporting formats in the lab experiments to little involved solutions like changes in curriculum. Ramanan et.al [15] has brought out the six sigma approach in developing solutions to the issue at the institutional level. One of the approaches in solution development is the application of QFD (Quality function deployment) as captured in Fig. 11, relevant for the analytical and problem solving skills. One advantage of QFD is that, it will bring-out the relation between the few of the independent variables proposed to be introduced and its impact on many of the dependent variable.

Suggested solutions are after studying the existing practices in institutions, reviewing good number syllabus of the Government & Deemed Universities and consulting with academic experts on the ease of implementation at institutional level etc. For example it has been observed that in most of the engineering curriculum across India&with most of the universities, engineering statistics as a theoretical subject is available and taught. However, it was found to have a gap of missing link of statistics lab. Hence, if statistics lab is introduced in the first year of engineering studies, it will also help in meeting other four customer expectations [Fig 11]. The benefit of QFD flowing-up from Xs can be helpful in identifying few of the critical Xs to deliver a major impact on customer expectations. Experience of the first author in conducting the program on 'Practical statistics for Practicing Engineers' spanning for 16 hours of lecture session with hands on is found to have an impact on practical application knowledge improved by 30%, however due to confidentiality with industries the data could not be shared in public domain. This data proves the importance of the statistical knowledge to other four dependent variables [3]. This also confirms the inter-relations of dependent variables [Fig.1].

Some of the suggested solutions from QFDare:

- Statistics lab in first year of engineering – Data for the statistics lab is suggested to be drawn from the first year Physics, Chemistry and work–shop practical. The experience from the statistics lab has to be carried out in all other labs in further studies while documenting lab reports.
- Statistics lab should facilitate students' presentation in groups as a cluster and be

encouraged to discuss and debate the variation within and between the group.

- The lecturer at the end of the semester for respective lab shall consolidate and present to the class on the variation within the group and between various groups. Comparison with previous years and presenting the trends shall be highly impactful for practical application of theory into practice.
- Introduction of DFMEA in design lab and PFMEA in manufacturing lab for understanding the risks and mitigation approaches.
- Variation in CAD lab – Study the variation impacts to components, sub-assemblies to system using approaches like Monte Carlo simulations
- Virtual lab simulations to practical problem and developing solution through group activity.
- Introduction of known defect into simple products and giving that as an exercise for rectification in the lab.

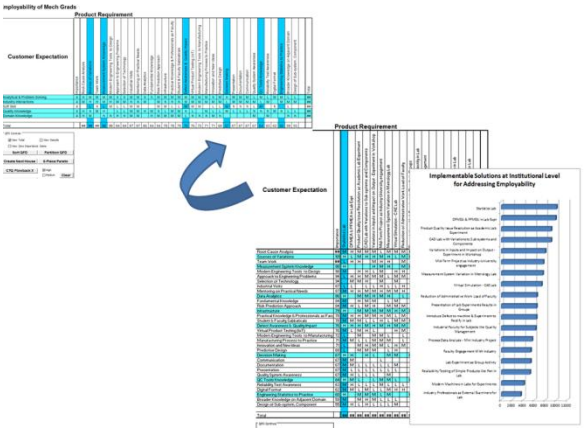

Fig.11 Two Stage QFD Flow-Up (from X to Y)

VII RESULTS AND CONCLUSSION

The following conclusions can be arrived from this research work.

- Analytical and problem solving skill gap is across regions of India and not specific to a region.
- Analytical and problem solving skill gap is across industries segments and not specific to industry segments.
- Application knowledge to practice with fundamentals or concepts, solution to engineering problems, innovative ideas, root-cause analysis, and selection of technology, analytical approach and decision making are significant factors in enhancing the employability of mechanical engineering graduates.
- Above independent variables are significantly contributing in reducing the gap on the 'analytical and problem solving skills' for applying theory into practice.
- Regression model developed can be adopted by the engineering educational institutions for improving analytical and problem solving skills.
- Predictive model approach developed and as presented in this work can be embraced by institutions to reduce the analytical and problem solving skill gap by reducing the variations on the independent variables as demonstrated in this work through predictive modelling
- The approach presented in this work can be used by the institutions in resolving issues on employability with various other branches of engineering with suitable modifications.
- The recommendations as suggested in this work, if implemented shall facilitate in reducing the skill gap to a very large extent from the institutional level.

VIII SCOPE FOR FURTHER RESEARCH

Individual institutions can use this approach in identifying the gap, analyse their strengths in each of the independent variables to find the opportunity for improvement in reducing the variation thus bringing down the gap.

Individual institutions can bench mark within themselves for continuous improvement by reducing the gap between customer expectations and the skills of the students produced from the institution.

Individual institutions can use this approach by capturing the best practices from the institutions which are performing at a higher level when

compared to them as a bench mark as a quality system approach for continuous improvement.

IX REFERENCES

[1]. India's Macro-Economic Outlook 2020, http://www.dnb.co.in/India2020economyoutlook/Macro_Economic_Outlook2020.asp

[2]. L. Ramanan, M. Kumar, K.P.V. Ramanakumar, *"Approach Towards Reducing Soft Skill Gap of Engineering Graduates in India from Employers' Perspective of Employability"*, International Journal of Engineering Research-Online, Vol.6, Issue 3, pp 504-512, 2015

[3]. L. Ramanan, M. Kumar, K.P.V. Ramanakumar, *"Significant Factors as Low Hanging Fruits in Addressing Employability Defect of Mechanical Engineering Graduates"*, International Journal of Science and Research, Vol.4, Issue 10, pp1382-1389, 2015

[4]. "Common Employability Skills – A Foundation for Success in the Work Place", National Network of Business and Industry Associations, http://www.nationalnetwork.org/wp-content/uploads/2015/03/Common_Employability_Skills-03-30-15.pdf

[5]. Andreas Blom and Hiroshi Saeiki, "*Employability and Skills of Newly Graduated Engineers in India"*, Policy Research Working Paper 5640,(2011), pp 2-3

[6]. L. Ramanan, K.P.V. Ramanakumar, *"Gap in Learning vs Application of by Students and its Impact on Quality Employability of Engineering Students – Case Study in Quality Dimension",* Proceedings of the National Conference on Quality Enrichment – A Pinnacle for Higher Educational Institutions. ISBN: 978-93-8570-51-6, pp 1-4, 2015

[7]. L Ramanan, M. Kumar, K.P.V. Ramanakumar, "Knowledge Gap and Its Impact on Product and Process Quality", Proceedings of the International Conference on Mechanical and Manufacturing Engineering, India, pp – 31, 2015

[8]. L Ramanan, M. Kumar, K.P.V. Ramanakumar, "Knowledge Gap and Its Impact on Product and Process Quality", Journal of Applied Mechanics and Materials, Vols 813-814, pp 1176-1182, 2015

[9]. L. Ramanan, M. Kumar, K.P.V. Ramanakumar, "Six Sigma Methodology for Addressing the Employability of Engineering Graduates", International Journal of Modern Education Forum (IJMEF), Vol 3, Issue 2, pp. 59-64, 2014.

[10]. L. Ramanan, M. Kumar, K.P.V. Ramanakumar, "Six Sigma – DMAIC Frame Work for Enhancing Quality in Engineering Educational Institutions" International Journal of Business Management Invention, Vol 3, Issue 1, pp 36-40, 2014

[11]. L. Ramanan, K.P.V. Ramanakumar, "Six Sigma – As a Measurement Metric in Measuring Quality of Higher Education", International Journal of Business Management Invention, Vol 3, Issue 1, pp 28-30, 2014

[12]. L. Ramanan, M. Kumar, K.P.V Ramanakumar, "Quality Waves and its Impact in Educational Quality for Attaining and Sustaining Institutional Excellence", International Journal of Business and Management Invention, Vol 3, Issue 5, pp 33-38, 2014

[13]. http://www.Minitab.com

[14]. www.minitab.com/en-us/products/devize

[15]. L. Ramanan, M.Kumar, K.P.V.Ramanakumar, "Six Sigma Approach to Employability Issues of Engineering Graduates in India", Quality Approaches in Higher Education, American Society for Quality [Under review]

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