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Low Employability of Graduate Engineers – Ascertaining Role of Industry by leveraging Total Interpretive Structural Modelling.

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***Abstract*—**The objective of this study is to conceptualize a Total Interpretive Structural Model (TISM) of factors leading to low employability of graduate engineers, at entry level, in context to Indian IT Industry. The paper focuses on factors emerging due to lack or low participation of IT Industry in overall academic activities contributing to low employability. Authors have developed Total Interpretive Structural Model (TISM) to understand the interplay of industry induced factors, leading to low employability of graduate engineers. Factors considered are limited to the role of IT industry in academia. Qualitative Semi Structured interviews & survey inputs gathered from academic experts including Senior Faculties, Heads of the Departments, Principals and Training and Placement officers from 10 engineering colleges in Maharashtra (India), are considered to arrive at factors highlighting the wanting contribution of IT industry. Total interpretive structural model has been developed for the factors leading to low employability. This model provides a hierarchical structure to the identified factors at four different levels based on their driving power and dependence. The model also portrays factor's interplay with the help of direct and transitive linkages. Based on the research authors recommend key initiatives at fundamental factors which can have a cascading impact on other dependent factors. This research has implications for IT Industry, academia and academic governing authorities. The study provides an indicative list of strategic factors and the synergistic effect created by their interplay. The relationships amongst these factors are being modeled providing an insight, in terms of cause and effect relationship, prioritizing the areas to be addressed on priority. The proposed model, examining the factors of low employability due to IT industry's wanting role in academic context is a fresh approach & pioneering one. To the best of authors' knowledge, this is the first study that analyzes the factors of low employability of graduate engineers using TISM approach, focusing on IT industry and not on academia, as being done historically.

Keywords—Total Interpretive Structure Modeling Employability; Factors; IT Industry

I. INTRODUCTION

THERE are Multiple studies & researches which have aptly amplified the problem of unemployable or low employable undergraduate engineers passing out in India every year. Majority of studies are focused on exploring the causes leading to poor or low employability from the prospective of academic context. In this paper authors have tried to explore the reasons from industry perspective which contribute towards the problem of low employability, specific to IT Industry. Growth of Indian IT Industry has led to growth of engineering education industry in India. IT Industry is the major beneficiary of the output of these engineering colleges. IT industry can and should take more responsibility of ensuring sustained support to the academia for improving the quality of education imparted to engineering students. As observed Industry has been majorly playing the role of beneficiary then that of a partner. Industry's role towards improving employability is found to be limited or often driven by short-term business interest, demand of skilled manpower is defined basis their business model and its context, thus limiting their interests in upskilling graduate engineers, as per their need rather than investing in fundamental education. Expectations from the academic institutes in terms of producing employable engineers are also not clearly defined by the industry, as employability levels of a passing out engineers are often defined by the Industry with respect to their business model.

India can be one of the fastest growing economy over the coming decade. India features at the top slot of the global list with its predicted annual growth rate of 7.72 percent for the coming decade, (Dasgupta 2017). Economic growth of India faces the challenge of a very low supply of quality skilled workforce. In the context of the growth and favorable circumstances, it is observed that India is struggling to produce engineers, who are relevant and employable by the industry. Number of undergraduate engineers passing out in India is very high, approximately 1.5 million/year, which is more than US and China, but the quality of the passing out engineers is been highly criticized by the Industry. There are various surveys published, concluding that 65% to 85% of engineering graduates students from India as unemployable. Most Indian industry suffer from the major constraint of skill shortage. Lack of skilled manpower is reported as key challenge for growth by the IT Sector, which is one of the top exporting sectors. IT sector witnessed Year on year 15% hike in salaries, from 2003 to 2006 mainly because of unavailability of qualified & skilled talent pool. (Blom& Saeki, 2011).

In Maharashtra there are 374 engineering colleges which provide undergraduate level engineering education in various engineering domains (AICTE, 2017). A very small percentage of these students get placed through campus placements. As per industry standards only, approximately 17 % students are found as employable. 83% percent of fresher engineers are found even unfit for basic entry level engineering jobs in the industry (Aspiring minds, 2017). A national level study quotes that 67% of the employers in India experience difficulties in scouting the right talent. The same percentage stands at 34% globally, highlighting the deficiency of employable engineers. The same study also observes that 64% of the employers observe that they are somewhat or partially satisfied with the quality or performance of engineering graduates in India (Blom&Saike, 2011). Keeping in view the growth of Indian economy in context to IT Industry, and the contribution of Indian labour in world IT market, there is an urgent need to explore measures to enhance the skills and competencies of graduate engineers who intend to gain employment with IT industry. Availability of skilled manpower remains as fundamental constraints to for Indian IT industry, however seldom studies are conducted to identify the contribution made by the industry towards producing employable engineers. It needs to be recognized that industry too need to play a significant role in developing employable engineers as its going to be the primary beneficiary of the skilled manpower.

II. Literature review

Uniform interpretation of skills and its application in industry, is an important step towards building shared understanding between industry and academia (Chris Collet, Damian Hine, Karen du Plessis, (2015)). Each Stakeholder is using different meanings of skill & its application, which is the biggest challenge and needs to be resolved (Pellegrino and Hilton, 2012). At national level, the relationship between educational institutes and labour market is very contextual (Tomlinson, 2012). It is further observed that industry gives a lesser consideration to basic knowledge of subjects as compared to operational level skills which are often contextual and dynamic (Holmes, 2001). In work context metamorphosis of a fresh graduate engineer to skilled employee is a process of development, of a shared understanding of skills and their application. Employers have not articulated their requirement clearly to higher education sector (Rosenberg et al., 2012), & that industry owns the onus of training graduates for each sector (Holmes, 2001; Harvey, 2001, 2005). Entry level job statistics do not take into consideration the right-fit perspective, some graduates may accept lower level job due to financial pressures, these scenarios also need to be considered in the study of employability and the study should not just be restricted to whether passing out student has secured a job or not. (Lorraine Dacre Pool, Peter Sewell, 2007). Employers deploy a minimum cut off GPA while hiring graduate, this reflects a measure for discipline knowledge giving low preference to practical technical skills NACE (2013). Remedying lack of technical skills is easier than training students for soft skills is observed by employers in skills mix report (Saflund 2007) and (Rosenberg et al. 2012) . Employers participation in design and delivery of sandwich courses, coupled with structured work experience displays a clear positive effect on the ability of graduates to secure employment. The high relevance of sandwich courses graduates to labour market is well established in the study, but there is no evidence that the importance given by academia to the teaching, learning and assessment of employability skill in academic context has significant effect on students at graduate levels. (Mason et. al2009). Redesigning the curriculum with more opportunities of industry projects and industry trainings will lead to better understanding of employability requirements of the employer & will enhance employability of graduates (Varwandkar Ajit, 2013). Perception of employability varies significantly between students and their employers. Students with prior work experience have better understanding of employability as comparted to students with no work experience. Skill enrichment and its application through well-defined industry exposure will enable availability of engineers with relevant employability skills.(Chithra. R 2013).Considering the socio economic prospective, if young, able bodied youth is not engaged appropriately in gainful employment, it may result in economic crisis impacting social fabric of our community, jeopardizing the law and order situations in extreme case.

As IT sector has been the biggest employer of the entry level engineers it's important to understand the entry level criteria for the same. It is important to establish the definition of employable entry level engineer for IT Industry as a whole, as many a times employability is seen in context to a particular hiring organization, which may be recruiting for a very specific skill or attribute in students. Considering the quality of the engineers produced by engineering colleges in rural, semi Urban and Urban regions today, it's important to understand, as to why industry is not ready to accept majority of passing out engineers as employment ready and what needs to be done to address this issue. Industry's role in terms of clearly communicating its expectation to academic suppliers, also needs to be critically judged. Industry being the consumer of the skilled manpower produced by academia, need to play a bigger role in contributing to the teaching learning process, with focus on education and not limiting their views to the skills required with respect to their business model, which are dynamic and contextual to the prevailing business opportunity.

III. Research Methodology

Qualitative Semi Structured interviews & survey inputs, with academic experts including Principals, Senior Faculties, Head of the Departments and Training and Placement officers from 10 engineering colleges in Maharashtra are considered to arrive at the eight factors indicating the wanting role of IT industry in academic context. The authors have further leveraged TISM for interpreting and explaining the complex relationships amongst the factors identified.

A. Total Interpretive Structure Modelling (TISM)

TISM is an approach that is used to develop a hierarchical structure of inter-related factors. It is a stepwise method which enforces individual comparisons of all factors to first establish the contextual relationships. The established relationships amongst the factors are further interpreted by developing reachability matrix and establishing direct and transitive relationships. TISM deploys systematic iteration of graph theory leading to development of diagraph, which helps in establishing hierarchical relationship amongst the factors and better interpretation. Finally, development of interpretation matrix and TISM simplifies the relationships amongst factors by elucidating the driving and dependencies.

B. Why Total Interpretive Structure Modelling (TISM)

Low employability of graduate engineers is a complex problem. There are multiple factors which contribute to it. Knowledge of these factors is tacit and is restricted to the SMEs from the academia. These factors further interact with each other to develop a synergistic impact. There is also an in-built relationship amongst these factors which needs to be decoded. TISM provides an approach which ensure relative study of each factor with all remaining ones. It helps us to establish how each factor is influencing or enhancing the effect of other factors. Dependencies and driving power of factors are also calculated by using graph theory. TISM helps us to segregate the factors at different hierarchal levels highlighting the strategic priority factors which are fundamental in nature and have cascading effect on other factors. Finally, TISM enables us to model the overall dynamics of the context along with clear relationship between the factors enabling strategic decision making.

C. Application of TISM Framework

1) Step I - Identification and definition of Factors

Subject Matter Experts (SMEs) from academics, from 10 engineering colleges from Maharashtra shared their inputs through semi-structured qualitative interviews and surveys. Following eight fundamental factors are identified through the interaction:

No Clear Definition of Employability by Industry – (E1) Lack of clarity regarding entry level employability, makes it difficult for academia to focus on skills and competencies valued by industry. The employer's requirement varies across different business models (Service Industry, Product based organizations, Domain focused IT services organizations etc.)

Low Internship Opportunities for Students (E2) – SMEs expressed grave concerns regarding lack of value adding internship opportunities for students. Internships provides a real-life industry experience to students. This enables them to understand the requirements of industry more clearly. Lot of experiential learnings happen in internship process.

Low Industry Working Experience of Faculty (E3) – Very few faculties of engineering college have considerable experience of working in Industry. Faculties with work experience in industry are able contextualize the academic concept with real-life implementation of the same. By virtue of their work experience, these faculties also have good insight of skills, competencies & attributes valued by the industry.

Low Opportunity of Professional Development for Faculty in Industry (E4) – Industry provides very low opportunities for the faculties for professional development. This restrict faculties exposure to the latest technologies and business context. Professional developments of faculties in industrial environment will enable seasoned teachers to relate the academic concepts with on the ground deployment of the same, making learning more holistic & relevant.

Lack of Industry Participation in Evaluation System (E5) – Evaluation system deployed by majority of engineering colleges is orthodox and traditional in nature. Industry experts do not rigorously participate in the same. Practical deployment of concepts learnt doesn't get evaluated completed. As observed multiple instances in industry a strong theoretical understanding doesn't ensure good practical implementation.

Low Industry Participation in Defining Curriculum (E6) – Curriculum taught to engineering students need to be relevant to industry. As per SMEs there is always a considerable gap observed in the technologies being used by Industry and the content of curriculum deployed. This gap can only be bridged by consistent effort from industry's end by participation in various processed of curriculum design and re-imagination of courses. Industry participation in consistently keeping the curriculum updated will ensure that students learnings are industry relevant, making them more employable.

Lack of Reliable Platform for Continuous Interaction of Academia and Industry (E7) – SMEs define this as one of the most important factors. Many issues and requirements (of both industry and academia) can be effectively handled through this platform. Free-flow of content & talent can be enabled through this platform to minimize the classic industry-academia gap.

Low Investment by Industry in Developing Required Infrastructure (E8) - Industry investment in educational institute is low and is restricted to institutes of repute. This investment is required to create virtual channels and simulated environments to provide learning opportunities to students and faculties. With appropriate infrastructure and security mechanisms in place, industry will be able to provide real-life problem statements to academia which would be a precious learning opportunity for students and an extended intellectual resource access for industry.

2) Step II – Determination of Contextual Relationship

In this step of research, the contextual relationship between the different factors is defined basis howFactor E1 will influence and enhance Factors from E2 to E8 Factors when compared individually.

3) Step III – Interpretation of Contextual Relationship

SMEs opinions are collected to establish whether Factor E1will influence or enhance Factor E2 or not. If the contextual relationship mentions Yes "in what way factor E1 influence or enhance factor E2, will be recorded. This interpretation of relationship of factors ensures recording of in-depth tacit knowledge of SMEs about the factors.

4) Step IV – Interpretive Logic for Pair-wise Comparison

An interpretive logic base is created recording pair-wise comparison of eight identified factors. Sample of interpretive logic base comparison is presented in table below.

TABLE 1
Logic base comparison of factors

Element	Releation	Element	Y/N/NA	Explanation
E3	will influence or enhance	E1	Y	Faculty with Industry can better understand employability requirements because of the work
E3	will influence or enhance	E2	Y	Faculty with industry experince can create more avenues for internship
E3	will Influence or enhance	E3	NA	
E3	will Influence or enhance	E4	Y	Faculty with industry experience can create more avenues for faculty development
E3	will Influence or enhance	E5	Y	Faculty with industry experience can influence evalution system
E3	will Influence or enhance	E6	Y	Faculty with industry experience can mobilize industry participation in syllabus defintion
E3	will Influnence or enhance	E7	N	
E3	will influence or enhance	E8	Y	Faculty with industry experience can mobilize industry investment

5) Step V - Developing Reachability Matrix

Reachability Matrix is developed from responses recorded in interpretive logic knowledge base by making entry of 1 for every record of "Y" and 0 for "N".

Transitivity of the relationship are also examined and recorded.

TABLE 2
Reachability Matrix

Elements	E1	E2	E3	E4	E5	E6	E7	E8	Driving Power
E1	1	1	0	0	0	0	0	0	2
E2	1	1	0	0	0	0	0	0	2
E3	1	1	1	1	1	1	0	1	7
E4	1*	0	0	1*	0	0	0	0	2
E5	1	0	0	0	1	1	0	0	3
E6	1	0	0	0	1	1	0	0	3
E7	1*	1*	0	1*	1	1	1	1	7
E8	0	1	0	1	0	0	0	1	3
Dependence	7	5	1	4	4	4	1	3	

*Transitive relationship

6) Step VI Partitioning of Reachability Matrix

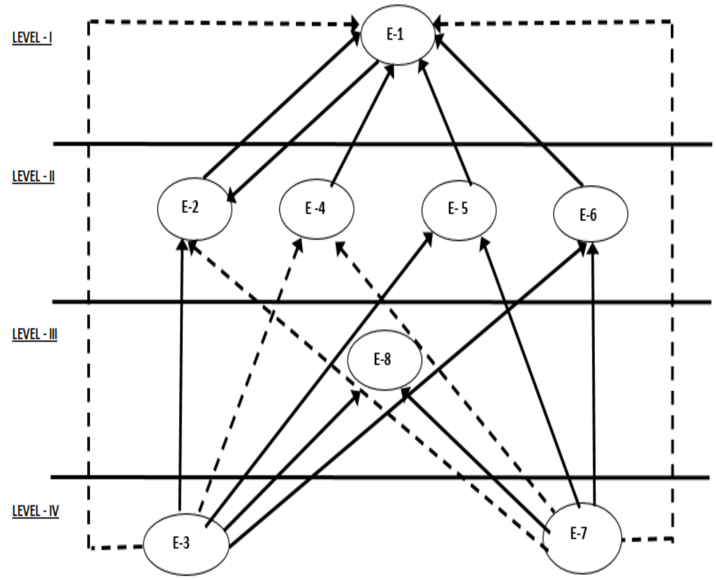
Level wise partitioning of reachability matrix is done till level for all factors are identified. This level help in identifying the hierarchy of factors and is leveraged in development of diagraph and TISM. Table 3 Illustrates the level partitioning done for the factors of interest in the current study.

TABLE 3
Partitioning of Reachability Matrix

Variable	Reachability set	Antecedent set	AS Intersection RS	Level
E1	**1,2,**	**1,2,3,4,5,6,7**	**1,2**	**I**
E2	1,2	1,2,3,7,8	1,2	
E3	1,2,3,4,5,6,8	3	3	
E4	1,4	3,4,7,8	4	
E5	1,5,6	3,5,6,7	5,6	
E6	1,5,6	3,5,6,7	5,6	
E7	1,2,4,5,6,7,8	7	7	
E8	2,4,8	3,8	8	
Iteration 2				
E2	**2**	**2,3,7,8,**	**2**	**II**
E3	2,3,4,5,6,8	3	3	
E4	**4**	**3,4,7,8**	**4**	**II**
E5	**5,6**	**3,5,6,7**	**5,6**	**II**
E6	**5,6,**	**3,5,6,7**	**5,6**	**II**
E7	2,4,5,6,7,8	7	7	
E8	2,4,8	3,7,8	8	
Iteration 3				
E3	3,8	3	3	
E7	7,8	7	7	
E8	**8**	**3,7,8**	**8**	**III**
Iteration 4				
E3	**3,8**	**3**	**3**	**IV**
E7	**7,8**	**7**	**7**	**IV**

7) Step VIIDevelopment of Diagraph

Diagraph is prepared basis the partitioning of the reachability matrix. Hierarchical levels and recorded contextual relationships basis inputs from SME is pictorially represented in Diagraph.



8) Step VIII – DevelopmentInterpretive Matrix

Fig.1 Logic Base Comparison of Factors

		No Clear Defination of Employability by Industry	Low Internship opportunity for students	Low Industry Working Experience of Faculty	Low Opportunity of Professional Development for faculty in Industry	Lack of Industry participation in Evaluation System	Low Industry participation in defining syllabus	Lack of reliable platform for continuous interaction of academia and Industry	Low i Indust requi
		E1	E2	E3	E4	E5	E6	E7	
of ity by	E1		Clear requirements of Industry can guide students on the nature of internships						
ship y for	E2	During internship students can understand employability requirements of Industry better							
ry of	E3	Faculty with Industry can better understand employability requirements because of the work experience	Faculty with industry experince can create more avenues for internship		Faculty with industry experience can create more avenues for faculty development	Faculty with industry experience can influence evalution system	Faculty with industry experience can mobilize industry participation in syllabus defintion		Facu e mo
tunity onal ent for ndustry	E4	With exposure to industry facutly can better understand employability requirements of Industry							
ustry on in System	E5	Traditional evaluation system should be mapped to employability requirement of the industry					Traditional evaluation system should be mapped to employability requirement of the industry		
ry on in llabus	E6	Industry input from employability perspective is required to upgrade syllabus				Industry participation in syllabus developmetn can lead to industry participaton in assessments			
able r of nd	E7	Reliable platform can facilitate the discussion between Industry & Academia to arrive at required skills to enhance employability	Reliable platform can facilitate higher internship opportunties for students		Reliable platform can facilitate in providing higher number of prof. dev opportunities for faculties in Industry	Reliable platform can facilitate Industry paticipation in revamp of evaluation system	Reliable platform can facilitate participation of industry in syllabus development		Relia fac inves i
ment in ure	E8		Industry ready infrastructure at college level can improve internship opportunities		Industry ready infra at college level can increase prof. development opportunities for faculties.				

9) Step IX Development of TISM Model

Fig.2. Interpretive Matrix

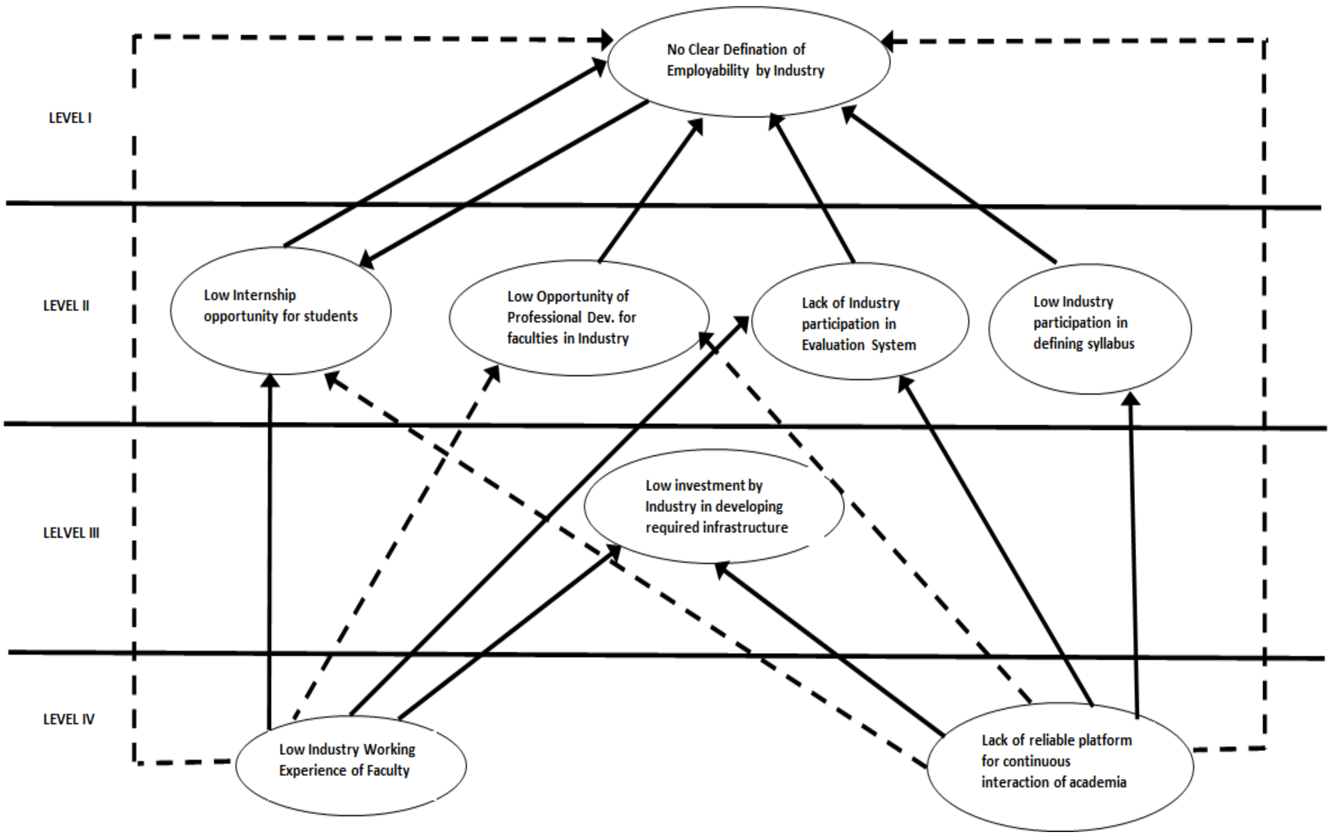


Fig 3 : Total Interpretive Structure Model

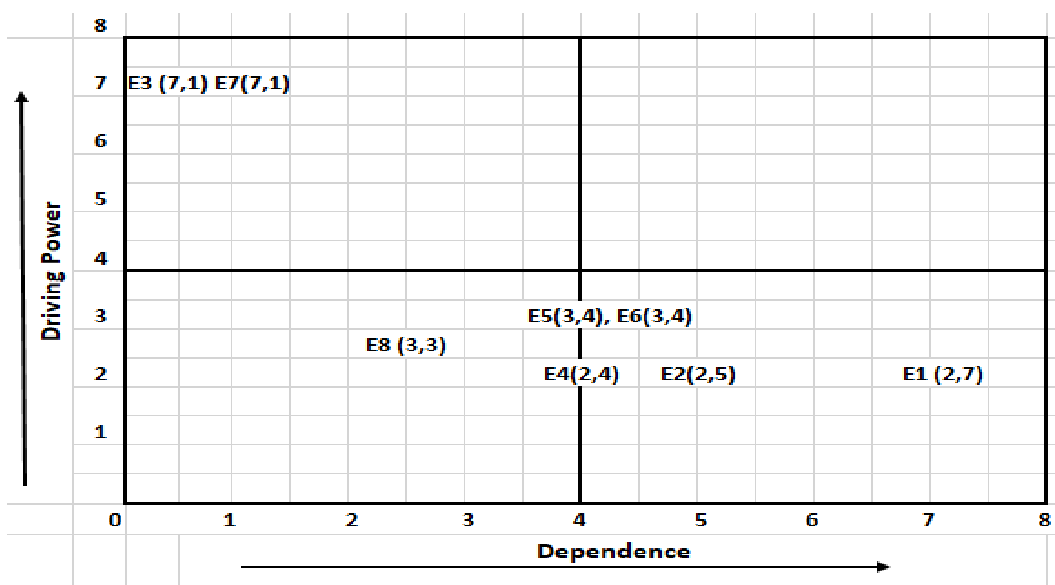


Fig 4: MICMAC Analysis depicting Dependency and Driving Power of Factors.

IV. DISCUSSION & IMPLICATION

The objective of developing hierarchical TIMS model is to clearly identify and establish the relationships amongst the industry driven factors which are contributing to low employability of engineering students. The hierarchy indicates decisive factors which needs to be addressed by policy makers and governing bodies on priority basis.

As evident from the TISM Factor E-7 – Lack of a reliable platform & E3 "Lack of Industry work experience "are key factors having impact on multiple other factors. A reliable platform can be of immense utility as today there is occasional and need based dialogue and exchanges of resources between academia and industry because of, lack of a clear medium which can enable this connect. Industry bodies should take this initiative to create an inclusive virtual & physical connecting platform which can enable the mapping of requirements and available resources from both the ends. There are multiple examples of symbiotic relationships between individual organizations and an educational institute, but these are achieved due to certain driving factors which are business driven need of the industry and specific reasons from educational institute as alumni connect or similar factors. The benefit of such relationships remains limited to one institute or organization. If these benefits are to be provided to all institutes and overall industry, a reliable platform is a must as reach of individual educational institutes are industrial organization is limited.

Similarly factor E-3 "Low Industry working experience of Faculty, is also a very strategic factor to be addressed. It clearly indicates that many of the issues of low employability of engineers can be better handled by the faculties, if they have a good experience of working in Industry. Good talent needs to move from industry to academia, if this gap is to be addressed. Faculties with past industry experience can leverage their experience and connect in the industry to encourage industry participation in multiple initiatives or work areas as discussed. These faculties will also bring in a good understanding of employability requirements as required by the industry.

Basis the TISM modelling and MICMAC analysis we can observe both the fundamental factors E3 & E7 have highest driving power with lowest dependency, making it easy to initiate a corrective action.

Factor E-8 "Low investment by industry in developing required Infrastructure, too plays a very important connecting part in overall context. Physical distance between the academic institute and industry can be minimized, if industry develop specialized facilities (with respect to their business domain) on campus. These extended industrial contexts can provide opportunities to students and faculties to carry on various professional development activities without leaving the campus. Today such investments are less in number and are restricted to premium academic institutes. Through this secured channel industry will be able to access the intellectual resources of students and faculties for business problems, where fresh perspectives are required. Such interactions would be of mutual benefits for industry & academia.

Factor E2 – Low internship opportunities for students & E4- Low professional development opportunities for faculties in industry, point towards wanting role of industry in engaging these two important stakeholders – Faculties & Students. Both students and faculties get to understand industrial context, as well as the ask of industry with respect to employability better while doing internships & faculty development programs respectively. Factor E7 – "Lack of reliable platform for interaction between academia & industry" can play a key role in mapping such developmental offerings from industry with the deserving participants from academia.

Factor E5 - Lack of Industry participation in evaluation system & E6 - Low Industry participation in defining syllabus" can be seen together as major areas of improvement for industry academia interaction. Academic institutes have a lower visibility of the changing technology context as compared to the industry. Industry should ensure that key changes with respect to technology and business domain are appropriately included in the syllabus. Industry should also participate in evaluation system as the traditional evaluation approach do not completely covers the practical execution learnings in real life, industrial scenario. Again both factors E7 and E8 can play an important role in enabling both this requirements of academia.

Factor E1 – "No clear definition of employability by industry" is a highly dependent factor. Employability requirements of the industry varies with respect to the business model of aorganization. Industry should engage more proactively with academia, by leveraging factors identified at level IV, III and II of the TISM.

V. Conclusion

Industry need to play role of a contributing partner with academia to produce highly employable engineers. As of date industry is playing the role of beneficiary, with very low participation from its end in the process of developing competent engineers.

A reliable platform to enable industry & academia interaction on continuous basis is a kay requirement. It will enable various measures required to improve employability.

Industry exposure for the faculties is a must, either by they are having a past work experience in the industry or by providing faculties ample opportunity for professional development in the industry.

Industry should invest in appropriate infrastructure in the college Campus to extend the industry context and provide developmental opportunities to students and faculties.

Future work can focus on the role of governing bodies, professional networks and government authorities in development of an ecosystem which will nurture the talent and make it relevant to the requirement of Industry.

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