An Industrial Training Management System for Engineering Students:- A Systematic Literature Review

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Abstract--- Graduate students with sufficient non-technical skills are currently in demand in the industry, however this does not meet employers' expectations. So, employers and lecturers are paying close attention to an Industrial Training Management System (ITMS) that aims to turn an engineering student into a work-ready engineer. This is because ITMS is a viable alternative to researchers' proposal to extend the duration of industrial training in order to increase students'non-technical skills to an adequate degree. An effectiveness ofITMSare based on structured industrial training program, also known as competency-based training program, that emphasize adult learning; the ability to improve engineering students' skills to an adequate level in a short period of time; the ability to measure trainers' and students' competency; student recruitment or placement without any skills mismatch; suitable reporting documentation, such as a log book, a report book, and presentation slides incorporate into Eight-Disciplines (8D) methodology; and student rewards or recognition.The purpose of this paper is to analyze the existing literature about ITMS for graduate engineers through a systematic literaturereviewand paper analyses literature through electronic databases mainly from Scopus and Web of Science. This paper summarizes the gaps in items that applied in current ITMS in the engineering field inside the industries. Based on that, conclusion and recommendation willbe given for further improvement to design a comprehensive ITMS.

Keywords--- Structured, Internship, Industrial, Training.

I. Introduction

EAC (2012) and MOHE (2012) both emphasized the relevance and necessity of industrial training, recommending that industrial training at higher education institutions be increased to at least 6 months. The recommendation to increase the training duration, however, may overstress or overburden engineering students, given the hefty course structure set for engineering programs in general(Yee C.F., 2015). A better approach would be to improve industrial training by making it more "well-structured." It is therefore critical to determine the most effective method for incorporating necessary skills such as technical knowledge, soft skills, and good engineering qualities into current industrial training in higher learning institutions within a realistic time. In this context, industrial training program benefit to employers and students if and only if a robust Industrial Training management System (ITMS) is introduced.Otherwise, This could be a disadvantage for undergraduates because employers who use interns solely for manpower may take advantage of students(Rostami et al., 2015). An efficient ITMS should encompass structured training modules, competent trainers, effective assessment methods, adult learning principles, competency-based training (CBT), industrial familiar documentation, and appreciation (Johan and Turan,

2016).According to the literature, the current framework has to be improved, primarily by employers within industries, because companies define the performance level of internship students and not universities.Furthermore, a significant number of lecturers have extensive technical knowledge but limited industrial experience (Johan, 2015). In this case, comprehensive ITMS from industries and employers are required in order to stimulate full engagement of employer-student during the industrial training program.

II. Literature Review

This research article explores into the role of industries and employers in internship programs. The training providers for interns are still the employers, despite the fact that universities initiate the internship program.As a result, the goal of hiring interns should be to meet both university and industry requirements. This is advantageous to both students and employers.All constructs from the pre-industrial training phase, the industrial training phase, and the post-industrial training phase must be examined in this perspective(Johan and Turan, 2016).

Pre-Industrial Training Phase

In the industry, the human resource (HR) department serves as a portal for students to be placed in industrial training programs. It's essential that companies disclose HR email address, their website, the nature of their product, and a list of internship students' job descriptions. This will provide students with a broad overview of the company and assist them in making the best option possible when it comes to applying to the proper working environment for their academic background(Ooi, 2017). One of the most popular questions asked by interviewers of graduate engineers is on their industrial training experience (Inceoglu et al., 2019).So, avoiding skill mismatch is highly important and it is HR's job to assign students to the proper departments and tasks. Because the majority of students are unaware of current career changes that are relevant to their academic institution's course due to technological advancement (Mohd Kamaruzaman et al., 2019). Furthermore, ITMS should priorities the wellbeing of students by offering personal protective equipment (PPE), personal accident insurance (PAI), medical leave, and a monthly allowance. This demonstrates that companies are concerned about the safety and well-being of interns(Allais, 2012).

Industrial Training Phase

Usually,experience staff in companies will be nominated as a trainer but need to ensure they are competent to train the interns. Assigning trainer is important process because only experienced trainers or those designated as subject matter experts are capable of properly transferring skills as they are good in applying training function, which is based on the competences required to support students in specialized employment; and other non-technical skills (Padmini, 2012).

Next, structured ITMS consist of four important construct which are classroom training, on-job-training, continues guidance and assessment. The contents of the Table 1 were tabulated based on preliminary study conducted in 3 main industries those practicing structured industrial training approach. However, all of them have different way of conducting the classroom training (Kamsah, 2004), on-job-training (Musid et al., 2019) and continues guidance(J. Larson, W. Barnard, J. Chandler, M. O'Donnell, W. Savenye, 2020). Except assessment method remain same which enforce presentation, report book writing and log book writing because its requested by universities (Osma and Sayginer, 2010). Employers are really interested in assessing interns' performance when they're under their supervision because trainees will be a valuable asset to their organization in the near future (Padmini, 2012). Therefore, it's advisable to use industrial based assessment form and document which familiar to employers and its gave early exposure to the students about industrial based report preparation techniques such as 8D,P5 and A3 (Osma and Sayginer, 2010).

Table 1:Secondary Document Review of Industrial Training Phase

Construct	Employer A	Employer B	Employer C
Classroom Training	Introduction and Induction Training (familiar with company structure, safety, rules, discipline) Objectives and learning outcomes Department introduction Project introduction	Exposure to various aspects of industry practices and ethics	Leadership / Soft skills development (Classroom training, work assignments & meetings)
On-Job-training	Project assignment briefing - Project on Improvement (Yield, Low Yield Trigger, Productivity improvement) Working at the actual work	Opportunity to experience and resolve day-to-day challenges Problem solving skills	Functional skills development (Projects relevant to field of study)

	station (admin and/or production area)		
Continues guidance	Buddy with Engineer Weekly meeting Project / assignment group meeting to follow up the progress	Expert will mentor the Intern throughout the internship. Interns will be fully involved in the workings of Business Units / Departments	Interpersonal Skills development (Community projects, company events, interns team building)
Assessment	Presentation to department / management Project Outcome (Before & After) – submit to Manager/Engineer Soft Skills and knowledge	Presented with assignments relevant to their studies. Human Resources department will provide a Letter of Reference and Certificate of Completion upon successful conclusion of the internship program.	Internship Report upon completion Internship Presentation Manager's evaluation on attendance, disciplines and projects accomplishment

Post-Industrial Training Phase

A post-industrial training is not end of the program. In actual the career begins after industrial training. The industries-students relationship should continue after the industrial training till job placement in the same industry after graduation. Internship students must be given a job offer or job assurance based on their performance during the industrial training period. Such that, ITMS will only achieve its goal if graduate engineers are hired within 1 to 6 months of course completion (Fenta et al., 2019). Employers should provide an intern with a certificate and/or testimonial as a sign of appreciation, and supporting credentials should detail the intern's ethics and performance during their time in the industry ("NCSC Annual Review," 2019).

III. Research Methodology

The structure of an industrial training management system at the employer level is the topic of this research. Since the terms "industrial training" and "internship" are interchangeable, the articles picked for the literature review must be error-free and cover both terms simultaneously. As a result, the VOSviewer software version 1.6.17 was chosen in this study to reduce error and increase accuracy. The software can convert article names, keywords, and abstracts from Web-of-Science (WoS) and Scopus into ris, csv, and txt format, and then into bibliometric maps, network visualization, overlay visualization, and density visualization. (Eck and Waltman, 2016). The initial data was gathered using the keywords structured, internship, industrial, and training from WoS and Scopus. The information was gathered as of September 30, 2021, and was limited to the engineering field. At the first stage, 1020 Scopus and 486 WoS documents were extracted, with only 309 and 235 articles being shortlisted, respectively.

Table 2: Systematic Literature Review Methodology

Description	**Conditions / Results**
Objective	Function of 8D-Problem Solving Method as an Industrial training log book to develop non-technical skills among engineering students. Analyze and understand the current framework of industrial training management system and structured internship program.
Source of Data	Scopus
Area of Interest	Non-technical skills development via Structured Industrial Training Management system for graduate engineers
Search field	Structured Internships program for engineering students
Publication years	Web of Science (1887-2021) & Scopus (1970-2021)
Covered Period	30/09/2021
Preliminary Document Selected	Web of Science (486) & Scopus (1020)
Engineering Related Papers screened	Web of Science (235) & Scopus (309)
Documents Analysis	Keywords, title and abstract were analyzed with the aid of VOSviewer

Scopus and Web-of-Science were chosen for the literature study because both websites contain a large number of data collections that are sufficient to conduct a comprehensive literature review (Mascarenhas et al., 2018). Table 2, shows the systematic literature review approach.

IV. Results and Findings

The network visualizations in figures 1 and 2 show the population and reoccurrence of keywords used at least 5 times in research articles found in Web of Science and Scopus, respectively. Since these studies focus on industrial

management systems that emphasize significant constructs must be included in the internship procedure but are often taken for granted.

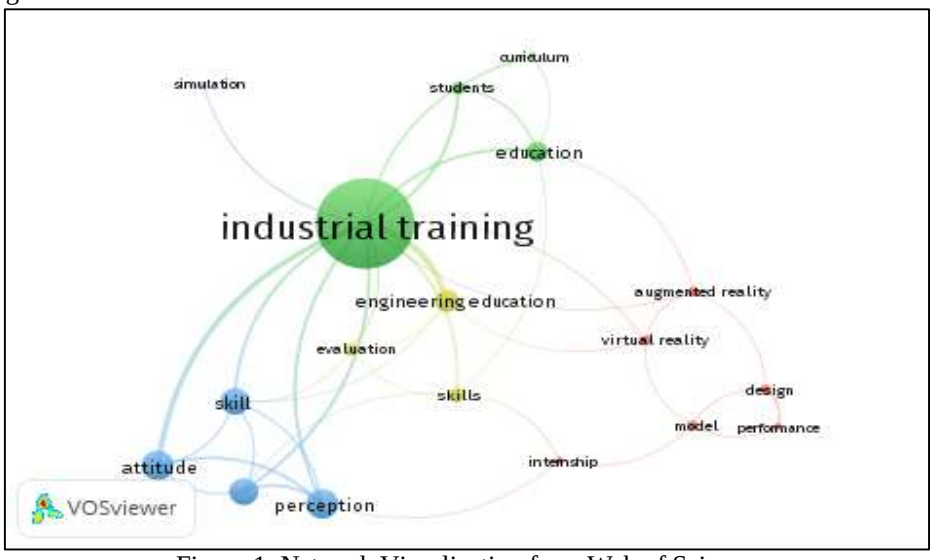

Figure 1: Network Visualization from Web of Science

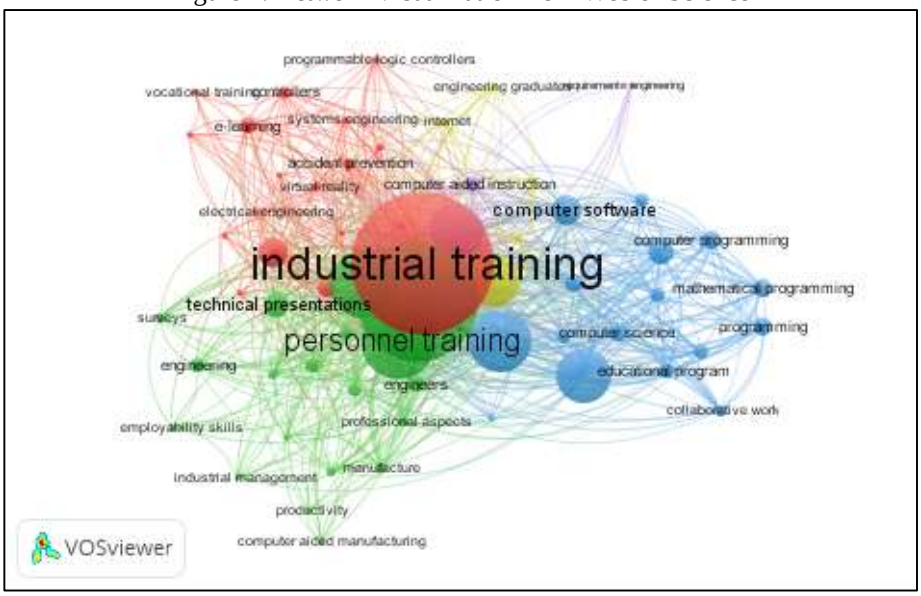

Figure 2: Network Visualization from Scopus

According to bibliometrics studies, industrial training focuses on skill development, technicalpresentation, evaluation and personal development in general. Noticeable that employers take responsibility to design industrial training module to improve the non-technical skills and assign a competent trainer in their organization to train the internship students. Due to the perception that industries will provide the best for trainees, questions about trainer competencyand specifics on training modules are rarely raised(Phang et al., 2013). On the other hand, academic institution providing assessment form to be filled by the employers; by right the assessment form should come from industries since employers hunting for work-ready-engineers. Moreover, students frequently write, present, and receive engineering training, but writing and presentation guidance is typically provided by the academic institution, with little participation from the employer (Norback et al., 2010). The reason for this is because log book writing, report book writing, and presentation are not in the same format as industrial reporting, which employers are unfamiliar with. To address this, universities could adopt document formats that are similar to industrial technical writing formats, such as the Eight-Disciplines (8D) report, Plan-Do-Correct-Act(PDCA), Define-Measure-Analyze-Improve-Control (DMAIC), A3 and 5P which encourage employer participation (Osma and Sayginer, 2010).

V. Conclusion

The market includes industries such as small and medium enterprises (SMEs), multinational corporations (MNCs), original equipment manufacturers (OEMs), and contract manufacturers (CM). Some are well-established, such as companies that run structured internship program, have training departments, trainers, and even training facilities. It appears that not all students had the opportunity to complete an internship at a well-known industry. Industrial training, on the other hand, has the same purpose and outcome for all students. By adopting a Framework of structured Industrial Training Management System (ITMS), all industries will be encouraged to strive toward the same goal of an industrial training program while also meeting their vision and mission. Furthermore, ITMS will encourage all sorts of industries and employers to follow comparable methods without compromising the purpose of employers to recruit interns for their organizations.Introducing new frameworks or techniques to industries that are unfamiliar might be challenging (Johan and Turan, 2016). But, ITMS adopts the majority of good manufacturing practices (GMP) from industries, which is more related to industrial culture such as industrial training procedure; training matrix; trainer-trainee competency assessment; log book and report book follow industrial formats. This will promote industry and employer participation in industrial training program. At the same time, the outcomes of this framework will respond to Malaysia's demand for "holistic graduates," as articulated in the Malaysian Education Development Plan(Sirat and Da Wan, 2018).

References

[1] Allais, S., 2012. Will skills save us? Rethinking the relationships between vocational education, skills development policies, and social policy in South Africa. Int. J. Educ. Dev., 32, 632–642. https://doi.org/10.1016/j.ijedudev.2012.01.001

[2] Eck, N.J. Van, Waltman, L., 2016. VOSviewer Manual. Manual 1–28. https://doi.org/10.3402/jac.v8.30072

[3] Fenta, H.M., Asnakew, Z.S., Debele, P.K., Nigatu, S.T., Muhaba, A.M., 2019. Analysis of supply side factors influencing employability of new graduates: A tracer study of Bahir Dar University graduates. J. Teach. Learn. Grad. Employab., 10, 67–85. https://doi.org/10.21153/jtlge2019vol10no2art801

[4] Inceoglu, I., Selenko, E., McDowall, A., Schlachter, S., 2019. (How) Do work placements work? Scrutinizing the quantitative evidence for a theory-driven future research agenda. J. Vocat. Behav., 110, 317–337. https://doi.org/10.1016/j.jvb.2018.09.002

[5] J. Larson, W. Barnard, J. Chandler, M. O'Donnell, W. Savenye, C.E.Z., 2020. Moving Beyond Technical Skills: Fostering the Development of Essential Skills Needed for a Successful Career in Engineering. Geo-Congress 1, 694–701. https://doi.org/10.1061/9780784482810.072

[6] Johan, K., 2015. Perception of Students Towards Lecturers Teaching Engineering Courses with Industry Experience: A Case Study in Malaysia Technical University. Procedia - Soc. Behav. Sci., 195, 925–931. https://doi.org/10.1016/j.sbspro.2015.06.372

[7] Johan, K., Turan, F.M., 2016. Industrial training approach using GPM P5 Standard for Sustainability in Project Management: A framework for sustainability competencies in the 21st century. IOP Conf. Ser. Mater. Sci. Eng., 160, 0–6. https://doi.org/10.1088/1757-899X/160/1/012075

[8] Kamsah, M.Z., 2004. Developing generic skills in classroom environment: Engineering students' perspective.Conference Eng. Educ., (CEE 2004) 14–15.

[9] Mascarenhas, C., Ferreira, J.J., Marques, C., 2018. University-industry cooperation: A systematic literature review and research agenda. Sci. Public Policy 45, 708–718. https://doi.org/10.1093/SCIPOL/SCY003

[10] Mohd Kamaruzaman, F., Hamid, R., Mutalib, A.A., Rasul, M.S., 2019. Comparison of engineering skills with IR 4.0 skills. Int. J. online Biomed. Eng., 15, 15–28. https://doi.org/10.3991/ijoe.v15i10.10879

[11] Musid, N.A., Affandi, H.M., Abas, N.H., Kamal, M.F.M., 2019. The soft skill elements in an on-job training (OJT) (organisation) assessment rubric for construction technology students in Malaysian vocational colleges. J. Tech. Educ. Train., 11, 84–93. https://doi.org/10.30880/jtet.2019.11.03.011

[12] NCSC Annual Review, 2019.Netw. Secur. 2019, 43. https://doi.org/10.1016/s1353-4858(19)30128-x

[13] Norback, J.S., Leeds, E.M., Kulkarni, K., 2010. Integrating an executive panel on communication info an engineering curriculum. IEEE Trans. Prof. Commun., 53, 412–422. https://doi.org/10.1109/TPC.2010.2077413

[14] Ooi, P.C., 2017. Exploring ways to enhance students' internship experience. 2016 IEEE 8th Int. Conf. Eng. Educ. Enhancing Eng. Educ. Through Acad. Collab. ICEED 2016, 107–108.

https://doi.org/10.1109/ICEED.2016.7856052

[15] Osma, A., Sayginer, A.S., 2010. An assessment on problem solving approaches in automotive industry: Illustrative templates, similarities and differences. SAE Tech. Pap. https://doi.org/10.4271/2010-01-0698

[16] Padmini, I., 2012. Education Vs Employability- the Need to Bridge the Skills Gap among the Engineering and Management Graduates in Andhra Pradesh. Int. J. Manag. Bus. Stud., www.ijmbs.com 2, 90–94. https://doi.org/ISSN: 2348-0459

[17] Phang, F.A., Yusof, K.M., Saat, M.M., Yusof, N.M., 2013. Malaysian engineering students' perception on industrial training. Res. Eng. Educ. Symp. REES, 2013, 195–201.

[18] Rostami, A., Sommerville, J., Wong, L.I., Lee, C., 2015. Engineering, Construction and Architectural Management Article information: Eng. Constr. Archit. Manag., 22, 91–107. https://doi.org/http://dx.doi.org/10.1108/09699981111098711 Downloaded

[19] Sirat, M., Da Wan, C., 2018. (Re)positioning humanities in the Malaysian higher education landscape. Kemanusiaan, 25, 191–206. https://doi.org/10.21315/kajh2018.25.s1.10

[20] Yee C.F., H.Y.K., 2015. A Preliminary Case Study on Improving Engineering Students' Competency through Industrial Training in a Private University Chong. PerTanika J. Soc. Sci. Hum., 23,103–110.