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Need Assessment of CDIO Curriculum in Ethiopia Particularly in Mechanical Engineering Education

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Abstract:- In Ethiopia, most of engineering graduates are unemployed. It is known that Unemployment is the main causes for under development of a country. Ethiopia is one of the last listed countries by development. To generate a job creating society the curriculum used in the country should be checked whether it let the graduate to create a job or not. That will let to go through curriculum amendment. These days the best and widly spreading curriculum type is the one that is called CDIO. The CDIO approach uses active learning tools like group projects and problem-based learning to better equip engineering students with technical knowledge as well as communication and professional skills. Furthermore, the CDIO Initiative provides resources to member university instructors in order to help them improve their teaching skills. Finally, the survey seems to have collected responses from a relatively diverse range of departments, including mechanical engineering, electromechanical engineering, manufacturing, and thermal engineering. This suggests that the survey has been conducted in an inclusive manner, with respondents from different academic departments having equal opportunities to participate.

Key terms: - CDIO, curriculum, respondents, Mechanical engineering, job crafting

INTRODUCTION

In Ethiopian mechanical engineering education, the undergraduate courses are delivered by lecturers supported by tutorials that would be ended with different assessment types, assignments, tests, and final examinations. Of courses, there are some courses that need laboratory work, software labs, and workshop technologies. Even though the beginning is very good, the ending is not satisfactory with today's sophisticated technology because the student will be asked for the laboratory report and it would be assessed rather than to be implemented and operated.

In today's undergraduate mechanical engineering education, there appears to be an unresolvable conflict between two expanding needs. On the one hand, there is the ever-growing body of technical knowledge that graduating students are expected to possess. On the other hand, there is an increasing realization that young engineers need a diverse set of personal, interpersonal, and system-building knowledge and abilities in order to work in real-world engineering teams and generate real-world products and systems.

Ethiopia is one of the last listed countries by development. According to world bank report, Ethiopia's real GDP growth slowed to 6.1% in 2021/22. (1) The majority of the growth was driven by industry, particularly construction and services. Unemployment will have its own contribution here for the development of the country.

Unemployment refers to the proportion of the labor force that is unemployed but available for and seeking work. Ethiopia's unemployment rate in 2021 was 3.69%, up 0.46% from 2020. Ethiopia's 2020 unemployment rate was 3.24%, a 0.91% increase from 2019. Ethiopia's unemployment rate in 2019 was 2.33%, up 0.01% from 2018. (2)

- Ethiopia unemployment rate for 2021 was 3.69%, a 0.46% increase from 2020.
- Ethiopia unemployment rate for 2020 was 3.24%, a 0.91% increase from 2019.
- Ethiopia unemployment rate for 2019 was 2.33%, a 0.01% increase from 2018.
- Ethiopia unemployment rate for 2018 was 2.32%, a 0.02% increase from 2017.

. This will let the researcher to go through curriculum amendment. Those days the best and idly spreading curriculum type is the one that is called CDIO. So that there is a need to asses the validity and appropriates of CDIO curriculum type in Ethiopia so as to reduce unemployment rate as well as to add engineering educational quality.

The National Academy of Engineering in the United States named 14 "grand challenges" for engineers to overcome in the twenty-first century. "Sustaining life on Earth," "Living secure from threats," "Promoting healthy living," and "Living and learning with joy" are some of the issues. (3) According to Al-Atabi (4), a program that prepares students to handle major issues should include research experience, an integrated curriculum, entrepreneurship training, a global perspective, and service learning.

To better equip engineering students with technical knowledge as well as communication and professional skills, the CDIO approach employs active learning tools such as group projects and problem-based learning. Furthermore, the CDIO Initiative provides resources for member university instructors to improve their teaching abilities.

Engineering education programs throughout much of the 20th century offered students plentiful hands-on practices. Accomplished and experienced engineers taught courses that focused on solving tangible problems. In due course of time, due to rapid advancement in science and technology, engineering education drifted towards the teaching of engineering science. Teaching engineering practice was increasingly de-emphasized. As a result, industries in recent years have found that graduating students, while technically adept, lack many abilities required in real-world engineering situations.

There appears to be an irreconcilable conflict between two growing needs in undergraduate engineering education today. On the one hand, there is the ever-expanding body of technical knowledge that graduating students are expected to possess. On the other hand, there is a growing recognition that young engineers must have a diverse set of personal, interpersonal, and system-building knowledge and skills in order to function in real engineering teams and create real products and systems. (5)

Innovative solutions that do not overburden students and lectures are required to resolve this conflict. To address the increasing gap between scientific and practical engineering demand and to meet the global requirements of professional Engineers, the CDIO curriculum was introduced. (6). The CDIO initiative promotes fundamental engineering education within the context of the product-system lifecycle, which can be thought of as having four metaphases: conceiving-designing-operating-implementing (7). This is typically accomplished through the use of active, hands-on, and project-based educational approaches in order to achieve integrated learning, in which disciplinary knowledge and CDIO skills are acquired concurrently. The CDIO initiative's philosophy is outlined by the 12 standards and syllabus it uses.

BACKGROUND OF THE RESPONDENT

With a reasonable distribution across gender, age, education level, and department, the information provided for the respondent's history appears to be fairly inclusive. Male respondents made up 60.3% of the total respondents in the study, while female respondents made up 39.7%. This shows that both male and female respondents had an equal opportunity to participate in the survey, which was conducted in a gender-inclusive manner.

With 91.3% of respondents being undergraduates, it appears that the poll is largely aimed at this educational level. This implies that the poll may not be totally representative of the entire student body because it only focused on a specific segment of the student population. It is important to note, nevertheless, that the poll was still able to obtain responses from graduate students (5.5%) and students who were on duty or teaching (3.2%), which lends the survey some further inclusivity.

According to the survey's respondents' age distribution, a substantial portion, or 84.9%, of the respondents are between the ages of 18 and 26. This could imply that the poll is targeted at a specific age group that enrolls in undergraduate classes and could not be completely representative of the general population. Yet, the poll was still able to elicit replies from participants between the ages of 26 and 30 (11.1%) and participants over the age of 30 (4%).

Finally, the survey seems to have collected responses from a relatively diverse range of departments, including mechanical engineering, electromechanical engineering, manufacturing, and thermal engineering. This suggests that the survey has been conducted in an inclusive manner, with respondents from different academic departments having equal opportunities to participate.

When it comes to data analysis, it's crucial to make sure that the survey results are reviewed thoroughly, taking into account the various demographic characteristics of the respondents. As a result, any potential biases in the survey findings will be more easily detected, and the data analysis will correctly reflect the opinions and experiences of all respondents.

With a reasonable distribution across gender, age, education level, and department, the information provided for the respondent's history appears to be fairly inclusive overall. Yet, it's crucial to remember that the survey might have concentrated on a specific segment of the student body. As a result, data analysis should be done inclusively to account for any potential biases.

FUNDAMENTAL KNOWLEDGE AND REASONING OF THE STUDENTS

A variety of knowledge domains and skill sets that are essential for success in the engineering sector are covered in the data that was provided for the evaluation of fundamental engineering knowledge and reasoning in the context of CDIO curriculum development.

Beginning with mathematics and statistics, the survey reveals that a sizable portion of participants (45.2%) believe they have average mathematical knowledge, with a smaller portion of participants ranking their skills as either very high (11.1%) or very low (4%). This implies that there is a great range of mathematical and statistical ability, and that curriculum creation should take the demands of pupils with high levels of mathematical proficiency into mind.

Regarding natural science, the poll reveals that the majority of participants assess their skills as high (44.4%) or average (44.4%), while only a very tiny proportion of participants rate their skills as very low (0.8%) or very high (10.31%). This shows that while students generally have solid natural scientific backgrounds, there is always space for growth.

According to the survey, most respondents rate their abilities in terms of core engineering fundamental knowledge as average (54.8%) or high (31.7%), with lesser numbers of respondents evaluating their abilities as very low (1.6%), low (5.5%), or very high (6.4%). This implies that while most students have a solid understanding of fundamental engineering principles, there is still potential for growth in several areas.

The survey shows that, when it comes to advanced engineering fundamental knowledge, methods, and tools, a sizable portion of respondents rate their abilities as either low (37.3%) or average (42%), with smaller portions of respondents rating their abilities as either very low (3.2%), high (14.3%), or very high (3.2%). This implies that there is opportunity for advancement in terms of advanced engineering knowledge and abilities, and that curriculum development should concentrate on giving students the instruments and strategies they need to excel in this field.

Finally, the survey shows that most respondents rank their understanding of social science and humanities as low (61.1%) or very low (9.5%), whereas lesser numbers of respondents rate their knowledge as average (24.6%), high (4%), or very high (0.8%). This argues that additional social science and humanities content should be included in curriculum development to provide students a more comprehensive understanding of engineering and its place in society.

Overall, the data provided for the evaluation of fundamental knowledge of engineering and reasoning in the context of CDIO curriculum development is comprehensive and suggests that there is room for improvement in various areas. Curriculum development should take into account the needs of students with varying levels of proficiency in mathematics, natural science, core engineering concepts, advanced engineering knowledge and skills, and social science and humanities. By doing so, we can help students develop the knowledge and skills they need to succeed in the field of engineering and make meaningful contributions to society.

PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES

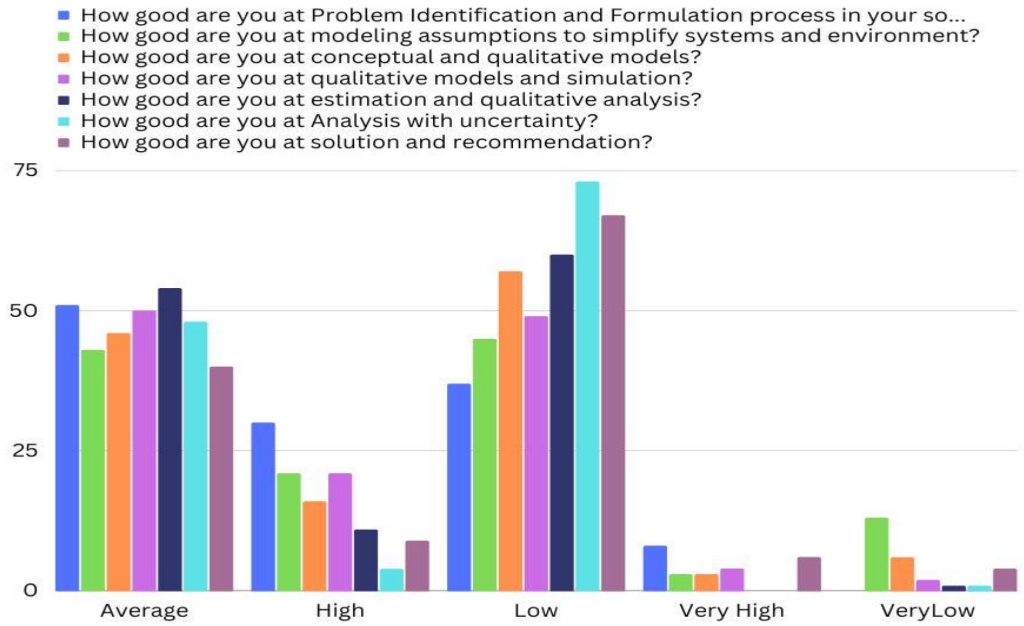

FIGURE 1:- RESPONDENT'S PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES

The survey's findings on analytical thinking and problem-solving skills in Ethiopian society can offer important insights into how the nation's engineering education is doing right now. We can assess the pupils' abilities for problem-solving and analytical thinking based on their responses to the survey questions.

The majority of respondents (40.5%) ranked their competence in problem formulation and identification as average, while 29.4% rated it as low, suggesting that there may be space for progress in this area. Similarly, a sizable portion of respondents (46%) ranked their skill as low or very low in the area of modelling assumptions to simplify systems and the environment, suggesting that students may need more instruction and training in this area.

In terms of conceptual and qualitative models, 44.5% of respondents assessed their skills as low, which may suggest that pupils need more instruction in this area. The majority of respondents (90.5%), however, ranked their skill as either ordinary or strong in the area of estimating and qualitative analysis, suggesting that students may have a solid foundation in this field.

With only 3.2% of respondents evaluating their competence as high in this area, the poll results also suggest that the capacity to assess problems with uncertainty may be a limitation. Similarly, the majority of respondents (53.2%) ranked their capacity for coming up with answers and recommendations as low, suggesting that more instruction and assistance may be required to increase students' capacity for doing so.

Overall, the survey results suggest that while Ethiopian engineering students may have a good foundation in certain areas, such as estimation and qualitative analysis, there may be room for improvement in other areas, such as problem identification and formulation, modelling assumptions, and conceptual and qualitative models. Additionally, the low ratings for analyzing problems with uncertainty and generating effective solutions and recommendations indicate that students may require more support and training in these areas.

In terms of curriculum development, these results imply that it could be necessary to update and broaden current courses in order to more effectively address the survey-identified areas of weakness. To enhance students' abilities in these areas, courses might be created that concentrate particularly on issue formulation and identification, modeling assumptions, and conceptual and qualitative models. Courses that focus on assessing situations with uncertainty and coming up with workable answers and recommendations might also be created, with a focus on giving students practical, real-world experience in these areas.

Finally, the data survey on analytical thinking and problem-solving skills in Ethiopian society offers insightful data on the country's undergraduate engineering students' strengths and deficiencies. By pinpointing students' weak points, curriculum designers can work to expand and alter current courses to better meet students' requirements and advance their all-around analytical and problem-solving abilities.

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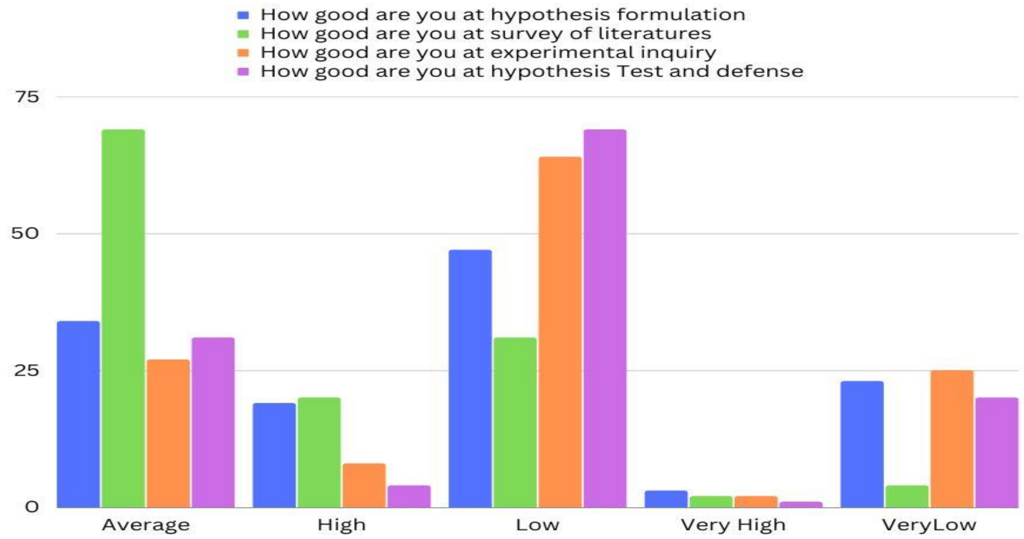

Figure 2:- it determine the extent Experimentation, investigation and knowledge discovery in the respondents' society based on the subject matter you have learned

There is potential for development in the students' capacity to carry out scientific research, according to the data summary on experimentation, investigation, and knowledge discovery in Ethiopian undergraduate engineering education. The majority of respondents indicated low to average levels of proficiency in the creation, testing, and defense of hypotheses.

Only 2.4% of respondents claimed to have very high competence in the formation of hypotheses, compared to 18.3% who reported very low ability, 37.3% who reported poor ability, 27.0% who reported average ability, and 15.0% who reported excellent ability. This shows that the pupils would require additional instruction and direction in developing testable hypotheses.

In the same way, 19.9% of respondents said they had very low ability, 50.8% said they had low ability, 21.4% said they had average ability, 6.3% said they had good ability, and only 1.6% said they had very high ability. This suggests that the students would want additional practical instruction and first-hand experience when planning and carrying out experiments.

15.9% of respondents indicated very poor skill in hypothesis testing and defense, 54.8% indicated low ability, 24.6% indicated average ability, 3.2% indicated strong ability, and just 0.8% indicated very high ability. This shows that in order to successfully test and defend their hypotheses, the students might require more instruction in statistical analysis and critical thinking.

Overall, the statistics point to a possible need to reform Ethiopia's undergraduate engineering education curriculum to place a stronger emphasis on scientific research and experimentation. This would entail including more practical instruction and hands-on experience in critical thinking, statistics, and research methods. The curriculum might also put a stronger emphasis on encouraging students' capacity to create testable hypotheses, plan and carry out experiments, and evaluate and defend their results.

It's crucial to remember that this information is based on self-reported levels of aptitude, which could not accurately represent students' performance. Hence, additional study might be done to evaluate students' actual talents and the success of any curriculum modifications in enhancing their research abilities.

Based on the subjects they have studied, the survey results for system thinking ability show that the majority of respondents have an average degree of system thinking ability in their society. Just a very small fraction of respondents (4.8%) reported having a very low degree of holistic thinking capacity, while the majority (52.4%) had an average level of ability, according to the findings for the question, "How a course you learn helps you in thinking holistically?" Twenty-two percent of those polled said they had a high capacity for holistic thinking. This suggests that while there is definitely space for improvement, the existing curriculum may be somewhat useful in fostering holistic thinking. It is crucial for curriculum designers to pinpoint the courses that can help students build their capacity for holistic thinking and to concentrate on improving those courses.

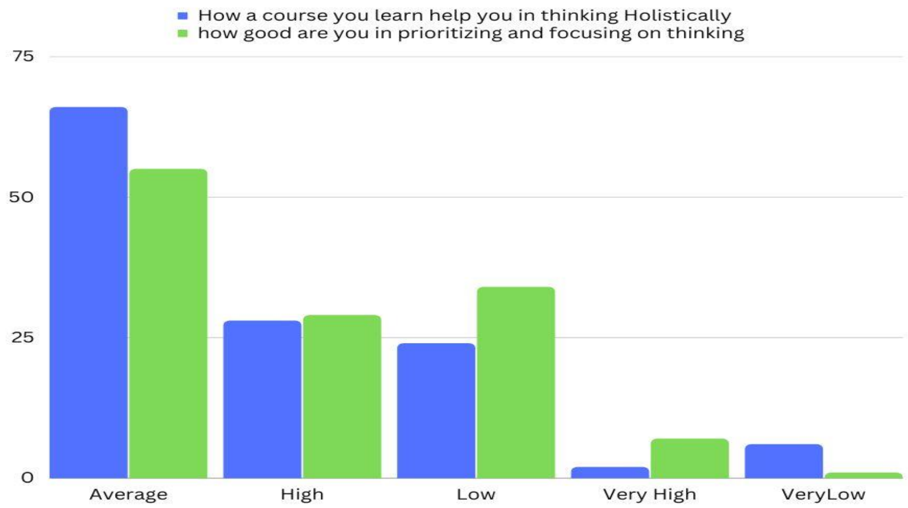

Figure 3:- It determine the extent of thinking ability in respondents' society based on the subject matter they have learned

How adept at setting priorities and concentrating on thought are you? 43.6 percent of respondents said they had an average degree of ability. A sizable portion of respondents (23%) claimed to have a high level of skill, whereas a negligible portion (0.8%) claimed to have a very low level of ability. This finding implies that while there is space for improvement, the curriculum may be successful in encouraging priority and concentration.

Overall, the statistics indicate that, while there is definitely space for improvement, Ethiopia's current CDIO curriculum is effective in encouraging system thinking to some level. The creation of curricula should concentrate on identifying and enhancing those courses that can aid in the development of system thinking skills. Also, it is crucial to make sure that the lessons are delivered in a way that enables students to effectively develop and exercise their system thinking skills.

In conclusion, the results of this survey provide valuable insights into the current state of system thinking ability in Ethiopia's engineering education. The findings can be used to guide the development of a more effective CDIO curriculum that promotes holistic thinking, prioritization, and focus on thinking. By improving the curriculum, students can acquire the necessary system thinking skills to succeed in the complex and dynamic world of engineering.

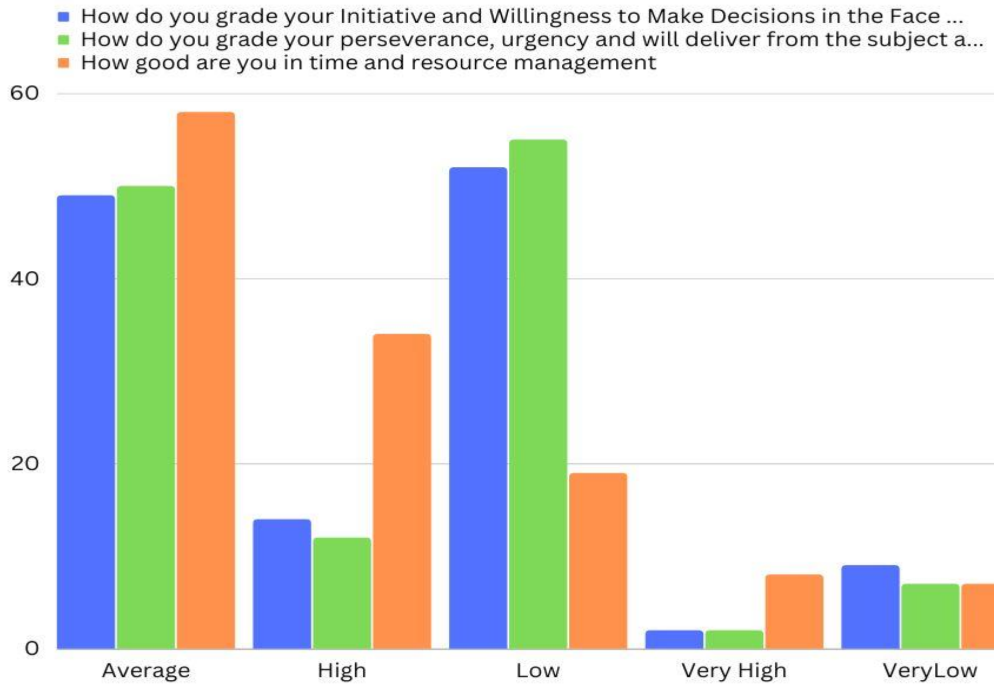

Figure 4:- a chart that determine the extent of Attitude, thought and learning in respondents' society based on the subject matter you have learned

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For assessing the success of the CDIO curriculum creation, data surveys on attitude, thought, and learning in Ethiopian engineering education are essential. This portion investigates the students' level of initiative, tenacity, time and resource management, and readiness to make choices despite ambiguity.

The majority of students (80%) have poor to average skill in making judgments in difficult situations, according to the first statement on initiative and willingness to act in the face of ambiguity. This may be a result of kids not being exposed to real-world situations where they can practice making decisions. As a result, case studies and real-world experiences should be incorporated into the CDIO curriculum to help students learn how to take initiative and make decisions.

According to the second statement on persistence, urgency, and will to succeed, 85% of the students exhibit poor to average skill in this area. This research suggests that experiential learning activities that encourage resilience and motivate students to put greater effort into their work should be included. For instance, giving learners difficult tasks, projects, or competitions could assist them develop their persistence and urgency skills.

The majority of students (61.1%) have average to low skill in managing their time and resources, according to the third statement on time and resource management. This observation is strengthened and reinforced since it implies that Ethiopian engineering students are adept at planning their tasks and resources. To help students gain more complex skills in these areas, the curriculum development could include additional training or courses in project management and financial management.

Overall, the results show that students could do better in terms of initiative, tenacity, and readiness to make choices in the face of ambiguity. Nonetheless, it appears that students are competent at managing their time and resources. Thus, the creation of the CDIO curriculum should focus on fostering students' resilience and decision-making abilities by adding more hands-on and experiential learning opportunities. By doing this, the CDIO curriculum can provide Ethiopian engineering students the abilities they need to handle problems effectively and lead in their professions.

INTERPERSONAL SKILLS: COLLABORATION, TEAMWORK, AND COMMUNICATION

In accordance with program objectives and with the approval of program stakeholders, Standard 2 of CDIO curriculum development focuses on creating precise, in-depth learning outcomes for discipline knowledge, personal and interpersonal skills, and product, process, and system building abilities. The survey results' interpretation, justification, recommendation, evaluation, and data summary for the interpersonal learning outcomes, which center on one-on-one and group interactions like teamwork, leadership, communication, and communication in foreign languages, will be covered in this section.

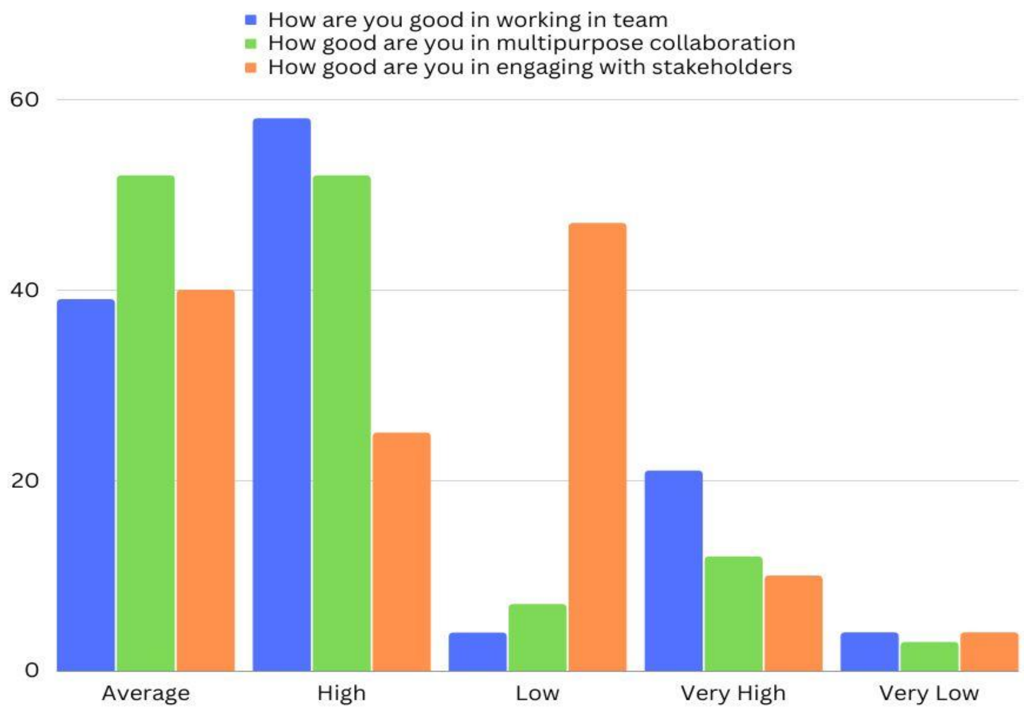

Figure 5:- This chart is to determine the extent of teamwork and collaboration of respondents' in their society based on the subject matter you have learned

The survey's results demonstrate that while just 6.4% of respondents ranked their ability to manage time and resources as very high, 46% of respondents thought it was high and 16.7% thought it was very high. In addition, 41.3% of respondents gave their capacity for multitasking collaboration a high rating, while 9.5% gave it a very high rating. Just 7.9% of respondents, however, gave their capacity to interact with stakeholders a very high rating.

These results indicate that in addition to cooperation and collaboration abilities, there is a need to concentrate on building interpersonal skills related to managing time and resources, as well as engaging with stakeholders. These abilities will aid students in becoming well-rounded engineers who can function well in many settings and with varied stakeholders.

To accomplish this, it is suggested that the CDIO curriculum give students additional chances to participate in project-based learning, which would enable them to practice time and resource management, interact with stakeholders, and develop teamwork and collaboration skills. The curriculum may also contain specialized courses or modules that emphasize intercultural competency, leadership, and communication skills, as well as possibilities for language study.

In terms of evaluation, the survey findings can be used as a starting point to judge how well the CDIO program promotes the growth of interpersonal skills. Participants in the program, such as students, teachers, and business partners, should be involved in validating and evaluating the learning objectives for interpersonal skills.

In conclusion, the survey results show that while students rate their ability to work in a team and collaborate on multiple purposes as relatively high, there is room for improvement in managing time and resources and engaging with stakeholders. The CDIO curriculum can address these gaps by providing more opportunities for project-based learning, including specific courses or modules that focus on communication skills, leadership, and intercultural competence, and involving program stakeholders in validating and assessing the learning outcomes related to interpersonal skills.

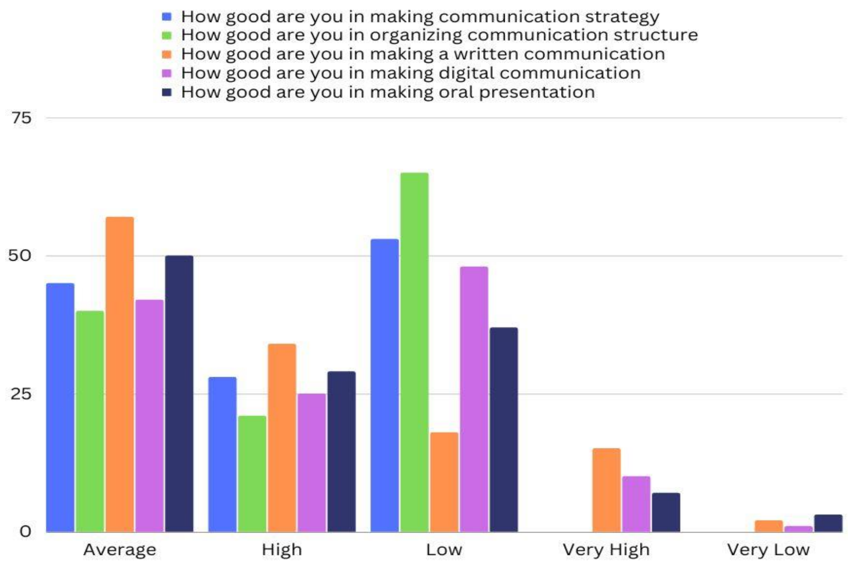

Figure 6:- This section determine the extent of communication of the society based on the subject matter they have learned

Standard 2 of CDIO curriculum creation focuses on precise, in-depth learning outcomes for disciplinary knowledge and personal and interpersonal skills that are in line with program objectives and approved by program stakeholders. Engineering students must master the interpersonal skill of communication if they are to succeed in their future careers as engineers.

According to the data collected, a low percentage of respondents feel confident in their ability to create a communication strategy, with only 22.2% indicating a high level of proficiency. Similarly, only 11.9% of respondents felt very high in their ability to write effectively, while 27% had a high level of proficiency, 45.2% had an average level, and 14.3% had a low level. In the case of digital communication, 38.1% of respondents had a low level of proficiency, 33.3% had an average level, 19.8% had a high level, and only 0.8% had a very low level. For oral presentations, 29.4% of respondents indicated a low level of proficiency, 39.7% had an average level, 23% had a high level, and only 2.4% had a very low level.

These findings indicate that Ethiopia's engineering curriculum needs to include more instruction in communication skills. Engineers must be able to communicate complicated technical knowledge to a range of audiences, so effective communication is a key ability. Engineering programs in Ethiopia can fill this gap in their curricula by teaching communication skills. This can involve instruction in technical writing, public speaking, and electronic communication. To further strengthen their communication abilities, teachers should encourage students to take part in extracurricular activities like debating clubs, public speaking competitions, and engineering communication contests.

In conclusion, the data analysis highlights the need for the inclusion of communication skills training in the engineering curriculum in Ethiopia. Improving students' communication skills will better prepare them for their future roles as engineers and ensure that they can effectively convey complex technical information to a variety of audiences. By incorporating communication skills training, engineering programs can produce graduates who are better equipped to succeed in their future careers.

CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING SYSTEMS IN THE ENTERPRISE, SOCIETAL AND ENVIRONMENTAL CONTEXT – THE INNOVATION PROCESS.

In the social and environmental context, engineers play a critical role and have important responsibilities. Engineers must not

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only design and create technological solutions, but also take into account how their work may affect society and the environment. Only a small portion of respondents to the data poll on this subject have a very high awareness of the function and responsibilities of engineers (5.5%), according to the results. A greater proportion of respondents (38.8%) or have a low comprehension (36.5%), compared to a much smaller proportion (1.6%) who have a very low understanding.

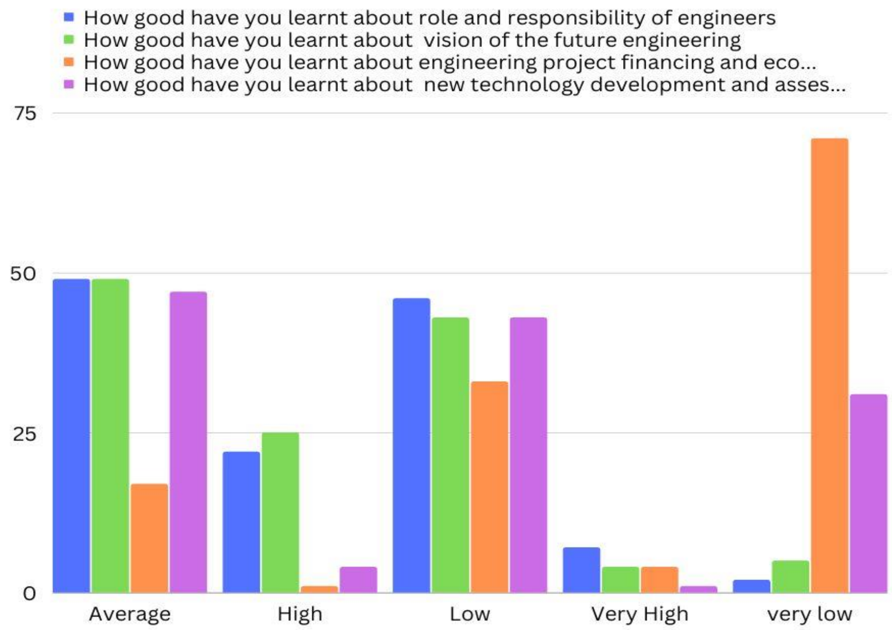

Figure 7:This chart determine the extent of role in social and environmental context based on the subject matter the respondents' have learned

The CDIO curriculum can put more of an emphasis on Standard 4, which is concerned with fostering engineering professionalism, to better convey what engineers' roles and responsibilities are. The significance of ethical, social, and environmental responsibility in engineering practice is emphasized by this standard. Modules covering the ethical factors in engineering practice, such as codes of ethics and ethical decision-making procedures, might be included in the CDIO curriculum. Moreover, modules on the legal framework controlling engineering practice and the social and environmental impacts of engineering projects might be added.

The data study reveals that a sizeable portion of respondents had an average (38.9%) or low (34.1%) comprehension of the future of engineering, while only a small portion have a very good understanding (3.2%). This implies that there is a need for greater instruction and knowledge on the contribution of engineering to the future. To close this gap, Standard 7 of the CDIO curriculum might be used. This standard focuses on the direction that engineering education and practice will take in the future, taking into account new technology, interdisciplinary collaboration, and shifting societal demands.

The CDIO curriculum can contain lessons on cutting-edge technologies and their possible effects on society and the environment to enhance comprehension of the future engineering vision. Additionally, by focusing on cooperation with other disciplines like the social sciences and humanities, these modules may examine the multidisciplinary nature of engineering practice. The inclusion of modules on innovation and entrepreneurship might also motivate students to look for fresh approaches to challenging issues.

The data study also demonstrates the importance of economics and project financing education in engineering. Only a small portion of respondents (0.8%) have a strong comprehension of this subject, whereas a significant portion (26.2%) or poor (34.1%) do not. This shows that in order to adequately train engineers to manage engineering projects, more economics and financing modules should be added to the CDIO curriculum.

To improve the understanding of engineering project financing and economics, the CDIO curriculum can include modules on project management, cost analysis, and financial planning. These modules can provide students with the skills and knowledge necessary to effectively manage engineering projects within budget constraints. Additionally, modules on entrepreneurship and innovation can encourage students to explore creative and cost-effective solutions to engineering problems.

In conclusion, the CDIO curriculum can be extremely helpful in producing socially conscious engineers who can handle the difficult problems that society and the environment are currently experiencing. In this context, Standards 4 and 7 are particularly significant since they emphasize the development of ethical, social, and environmental responsibility in engineering practice and equip engineers to define the future of their profession. The CDIO curriculum may give students a thorough education in engineering that prepares them to be responsible, creative, and effective engineers by combining modules on the role and duty of engineers, the vision of future engineering, and engineering project financing and economics.

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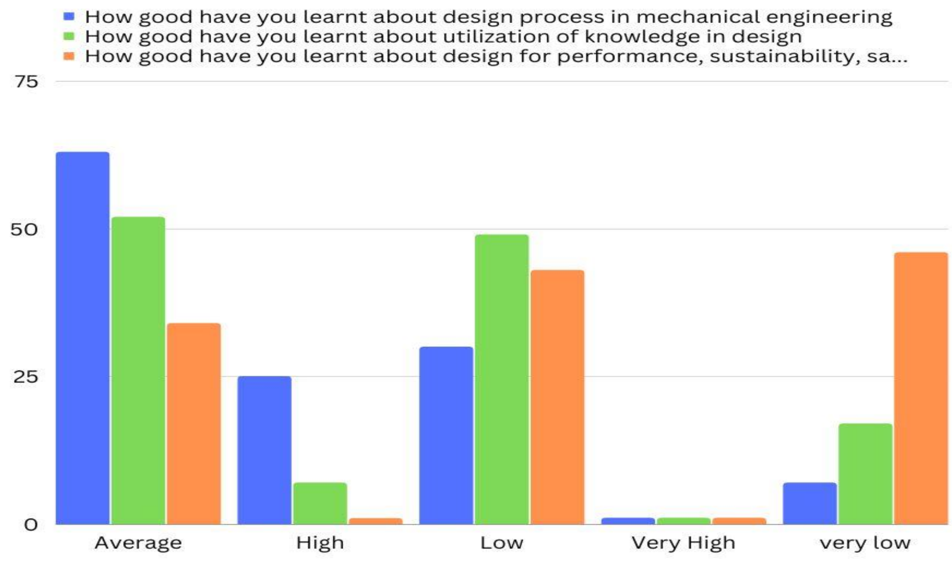

Figure 8:- the extent of your knowledge of mechanical design based on the subject matter you have learned

In conclusion, the CDIO curriculum can be very beneficial in creating socially aware engineers who can tackle the challenging issues that society and the environment are currently facing. Since they highlight the growth of ethical, social, and environmental responsibility in engineering practice and give engineers the tools to determine the future of their field, Standards 4 and 7 are particularly important in this context. By combining modules on the role and duty of engineers, the vision of future engineering, and engineering project financing and economics, the CDIO curriculum may provide students with a full education in engineering that equips them to be responsible, imaginative, and effective engineers.

According to the data survey, the majority of respondents have an average (41.3%) or low (38.9%) understanding of how knowledge is used in design. 13.5% of the respondents, however, had a very limited understanding of how knowledge is used in design. Only a small portion of respondents (5.5%) or very few (0.8%) have a great understanding of the use of knowledge in design.

The results of the data survey show that the majority of respondents have very low (36.5%) or low (34.1%) comprehension of design for performance, sustainability, safety, aesthetics, and other criteria. A small percentage of respondents (27.8%), had a strong understanding (0.8%) or very high comprehension (0.8%) of design for performance, sustainability, safety, aesthetics, and other criteria.

Mechanical design is the primary focus of the design-implement experiences and workplaces (Standards 5 and 6) in the CDIO curriculum. In order to create a curriculum that provides a thorough understanding of mechanical design, including design processes, knowledge utilization in design, and design for performance, sustainability, safety, aesthetics, and other factors, it is imperative to address the knowledge gaps found in the data survey.

To address the knowledge gaps, the curriculum should include relevant coursework, case studies, and hands-on projects that provide students with practical experience in mechanical design. The curriculum should also incorporate industry collaboration and internships to provide students with exposure to real-world design challenges and opportunities.

Also, it is crucial to emphasize in the curriculum the social responsibility components of mechanical design. The ethical and social ramifications of mechanical design, including its effects on the economy, society, and environment, should be highlighted in the curriculum. Designing for sustainability, safety, and beauty while taking into account the social and environmental settings of their creations should be encouraged in the curriculum.

In conclusion, the knowledge gaps in mechanical design that were discovered in the data survey should be addressed in the CDIO curriculum development for undergraduate engineering education in Ethiopia. The design process, knowledge usage in design, and design for performance, sustainability, safety, aesthetics, and other issues should all be covered in the curriculum, with a focus on the social responsibility components of mechanical design.

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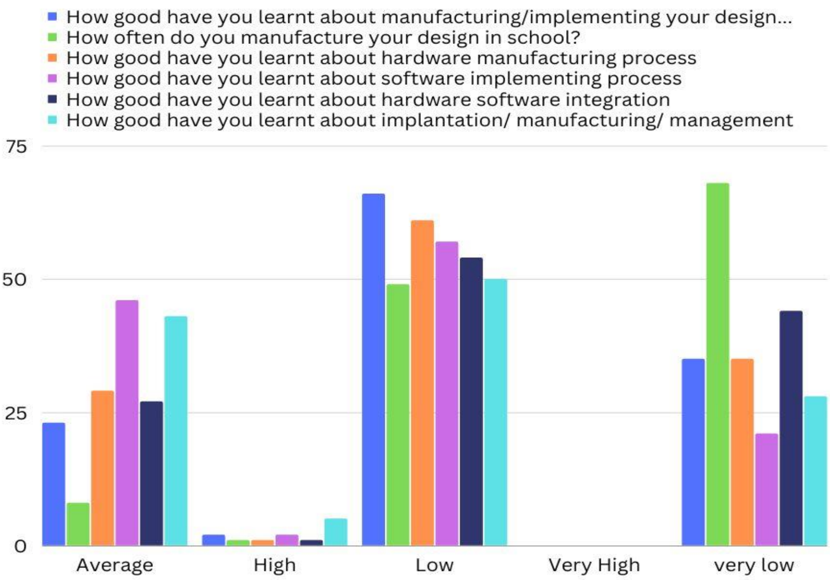

Figure 9:- Extent of knowledge of manufacturing based on the subject matter learned

The CDIO Curriculum Development Standard 5 focuses on enhancing students' knowledge and abilities in producing and putting designs into practice. According to data survey and research, a sizable fraction of students have little background knowledge and expertise in this field.

The data, for instance, reveals that only 1.6% of students have a high degree of comprehension of the production and implementation process, while 27.8% have a very low level of knowledge. In a similar vein, only 54% of students have had any experience manufacturing their designs while in school. This suggests that the practical components of the curriculum should be improved, and students should have more opportunity to put their plans into practice..

The statistics indicate that only a small percentage of students have a good degree of understanding about the manufacturing process (0.8%) and software implementation process (1.6%) in terms of hardware and software. This emphasizes the necessity of offering more thorough instruction on these subjects to guarantee that students have the abilities to create and implement goods that adhere to industry standards.

Furthermore, the findings show that a sizable fraction of students have little expertise in manufacturing management, implementation, and hardware-software integration. This suggests that the curriculum needs to be improved in order to give students more chances to learn about these topics and hone the necessary abilities.

It is crucial to adapt the curriculum to include more practical training and hands-on experience in production and implementation to address these difficulties. This can be done by utilizing workshops, internships, and industrial training programs, which give students the chance to work in actual workplaces and get real-world experience.

In addition, the curriculum needs to include more instruction on hardware-software integration, implementation, and manufacturing management. This can be accomplished by combining classroom lectures, lab activities, and hands-on projects.

In conclusion, the data analysis of the Standards 5 in the CDIO Curriculum Development indicates a need to improve students' knowledge and skills in manufacturing and implementing designs. By incorporating more practical training and providing more opportunities for students to work in real-world settings, the curriculum can better prepare students for successful careers in engineering and related fields.

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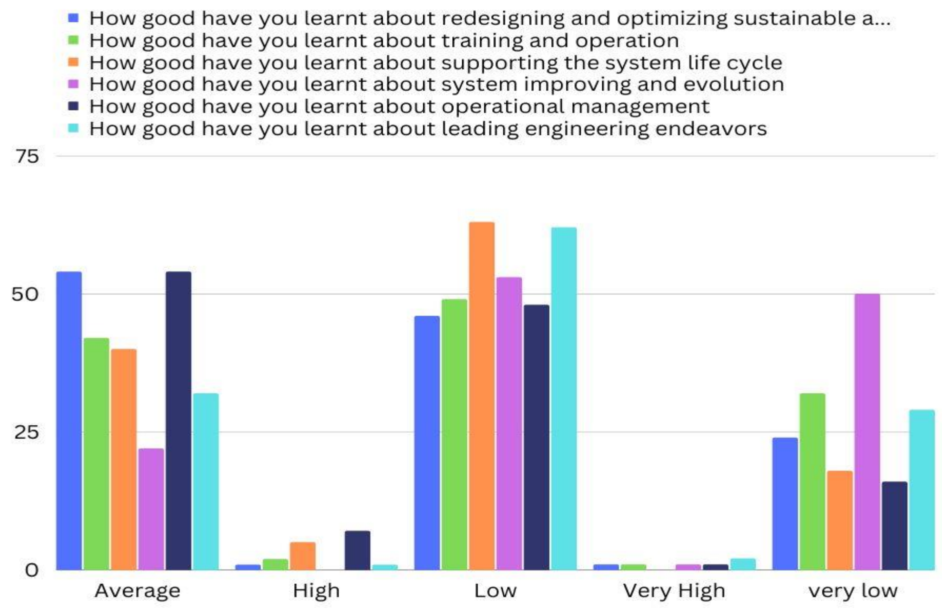

Figure 10:- the extent of knowledge of operating machine that you have manufactured and assembled based on the subject matter you have learned

The CDIO approach to engineering education places a strong emphasis on the value of giving students real-world design and implementation experiences. The CDIO curriculum' Standard 5 is dedicated to emphasizing the skills that students have developed through their design projects about manufacturing and machine operation. According to the information in this section, Ethiopian undergraduate engineering students generally have poor to medium levels of understanding in this field.

The first question was on how well the students understood how to improve and design safe and secure operations. Since the majority of respondents (56.4%) rated their level of competence in this area as either extremely poor or low, there is space for improvement. This can be a sign that safety and sustainability are not given enough attention in the current engineering programs. The CDIO program's coursework and design projects that specifically target sustainable and secure design concepts might be expanded to meet this issue.

The second inquiry focused on the students' operational and training expertise. Once more, the majority of participants (64.3%) evaluated their level of familiarity with this subject as either extremely low or low. This suggests a need for additional practical instruction, practice using machines, and coursework on the theory of machine operation. Further lab-based courses and design projects requiring students to operate and maintain equipment could be added to the CDIO curriculum.

The third question asked about supporting the system life cycle. A significant number of respondents (64.3%) rated their knowledge in this area as either very low or low. This suggests a need for more coursework on the entire life cycle of machines, including design, manufacturing, operation, and maintenance. The CDIO curriculum could include design projects that require students to consider the entire life cycle of their machines, including end-of-life considerations and recycling.

The fourth query focused on system evolution and improvement. 82.0 percent of respondents said they knew little or nothing about this topic. This suggests a need for greater instruction on how to enhance and advance current systems, as well as additional chances for students to participate in the redesign of current machinery. Instead of beginning from scratch, design projects for the CDIO curriculum could instruct students to improve existing devices or systems.

The fifth question asked about operational management. A significant number of respondents (50.8%) rated their knowledge in this area as either very low or low. This suggests a need for more coursework on the management of machines, including maintenance schedules, inventory management, and operational efficiency. The CDIO curriculum could incorporate more coursework on operations management, as well as design projects that require students to consider the operational management of their machines.

The final query centered on managing engineering projects. 72.2 percent of respondents said they knew nothing or very little about this topic. This shows a need for additional instruction in management and leadership techniques as well as more chances for students to assume leadership positions in design projects. Further courses on project management, leadership, and communication techniques could be added to the CDIO curriculum.

Overall, the data presented in this section suggests that there is a need for improvement in the knowledge of manufacturing and operating machines among undergraduate engineering students in Ethiopia. To address these issues, the CDIO curriculum could be revised to include more hands-on training, coursework on machine operation and management, and design projects that require students to consider the entire life cycle of machines. Incorporating these changes could help prepare students for careers in engineering that require a deep understanding of manufacturing and machine operation.

The information gathered on the depth of leadership, entrepreneurship, and research expertise in Ethiopian undergraduate engineering education offers important insights for the creation of the CDIO curriculum. The survey's findings show that the majority of students know next to nothing about entrepreneurship, leadership, and research. In particular, only 1.6% of respondents had very high levels of expertise, while 34.9% have very low levels of understanding on establishing leadership and organization. Similar to this, only 1.6% of respondents had a high degree of understanding about how to develop a business strategy, compared to 36.5% who have a very poor level of expertise.

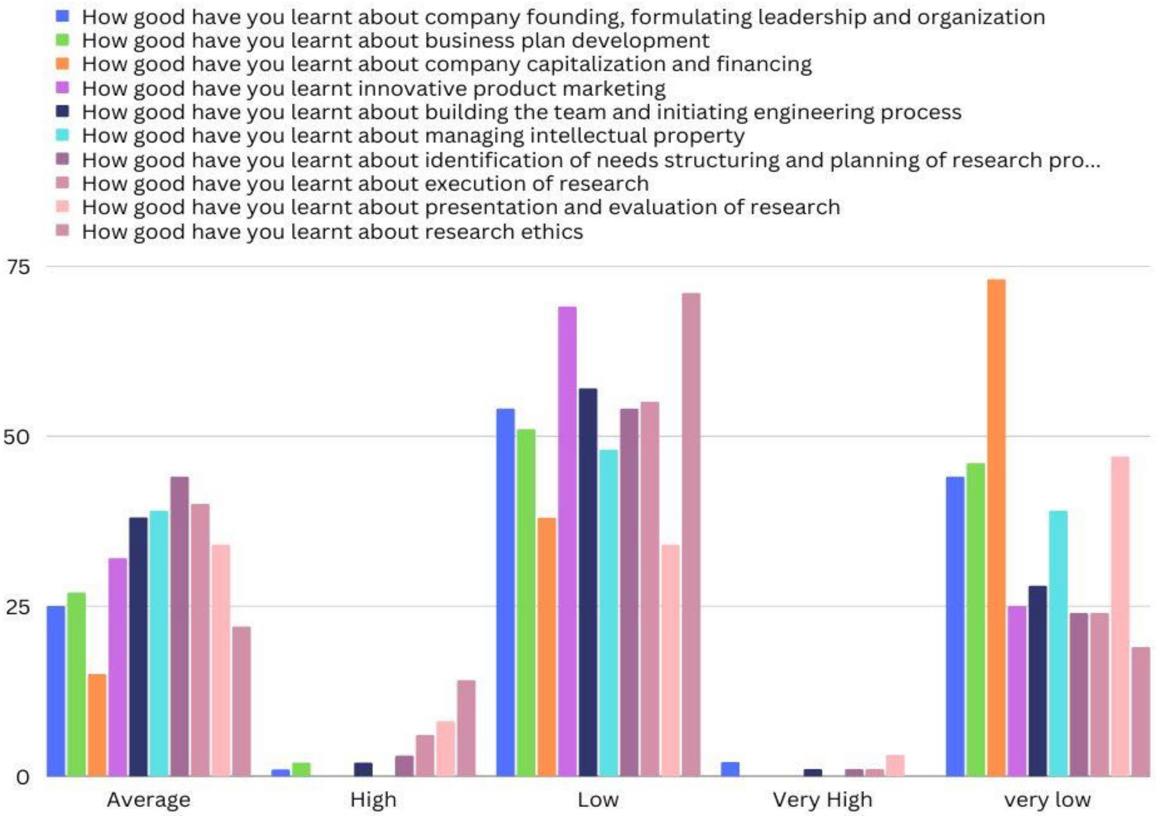

Figure 11:- extent of your knowledge of leadership, entrepreneurship and research based on the subject matter you have learned

The majority of respondents have a low degree of understanding regarding company capitalization and finance, innovative product marketing, managing intellectual property, identifying demands, organizing and planning of research projects, as well as presentation and evaluation of research. This suggests that there is a sizable gap in the leadership, entrepreneurial, and research education of engineering students in Ethiopia.

To address this gap, the CDIO curriculum should focus on providing students with knowledge and skills in these areas. The curriculum should include courses on business plan development, company capitalization and financing, innovative product marketing, managing intellectual property, and research project management. These courses should be designed to provide students with hands-on experience, allowing them to apply the concepts they learn in real-world situations.

In addition, the curriculum should place a strong emphasis on helping students improve their interpersonal and personal abilities, such as problem-solving, teamwork, and leadership. These abilities will equip students to be successful leaders and entrepreneurs and are crucial for success in the engineering sector.

As a result, there is a substantial gap in the education of students, according to the data gathered on the depth of knowledge on leadership, entrepreneurship, and research in Ethiopian undergraduate engineering education. To close this knowledge and skill gap and place a strong emphasis on the growth of interpersonal and personal abilities, the CDIO curriculum should be created. So, the CDIO curriculum can better position students for success in engineering and other fields.

STRENGTHS AND WEAKNESSES OF THE ETHIOPIAN UNDERGRADUATE ENGINEERING EDUCATION SYSTEM

Modern education must include a strong component of engineering instruction. Engineers must have the requisite skills and knowledge to contribute to society's growth and development given the increasing demand for technological improvement. Like many developing nations, Ethiopia is attempting to enhance its engineering education system. We shall assess the advantages and disadvantages of Ethiopia's undergraduate engineering education system in this essay, paying particular attention to Standards 3, 6, 7, 8, and 9 of the CDIO curriculum framework. We will also offer ideas for development.

Standard 3 - Integrated Curriculum: A curriculum that integrates academic subjects with interpersonal, personal, and technical abilities is known as an integrated curriculum. The theoretical side of engineering is clearly emphasized in Ethiopian

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engineering school, but the development of practical skills receives less attention. As a result, students lack the abilities needed to apply their academic knowledge to real-world issues. By including the development of practical skills in the curriculum, this flaw can be fixed. Project-based learning, internships, and other types of experiential learning can help with this. Courses teaching interpersonal, as well as product, process, and system building skills, should also be included in the curriculum.

Engineering Workspaces, Standard 6 Engineering classrooms and laboratories that promote hands-on learning are essential for the discipline. Adequate engineering workspaces and laboratories are lacking in Ethiopia. Students' ability to develop practical skills is hampered because they lack access to the tools and resources they need. It is crucial to make investments in the creation of engineering workstations and laboratories in order to remedy this deficit. Partnerships with businesses, government assistance, and fund-raising initiatives can all help to achieve this. Courses that require students to use engineering workstations and laboratories should also be included in the curriculum.

Integrated Learning Experiences (Standard 7) Integrated learning experiences are ones that combine subject-specific information with interpersonal, personal, and professional skills as well as knowledge of how to create products, processes, and systems. The development of practical skills and academic knowledge are not sufficiently integrated in engineering education in Ethiopia. Students as a result have a limited comprehension of how to apply theoretical knowledge to real-world issues. Project-based learning, internships, and other types of experiential learning must be included in the curriculum in order to solve this deficit. Courses teaching interpersonal, as well as product, process, and system building skills, should also be included in the curriculum.

Active Learning, Standard 8 Student-centered learning is the main goal of the teaching and learning strategy known as active learning. It entails the participation of the students in the learning process through tasks including group work, problem-solving, and conversations. There aren't enough active learning techniques used in engineering education in Ethiopia. Students are passive consumers of knowledge during lectures, which are the main teaching modality. Active learning strategies need to be incorporated into the curriculum to alleviate this deficit. It is possible to accomplish this through talks, problem-solving, and group effort. The curriculum should also include subjects that require students to engage actively in their learning.

Standard 9 - Improvement of Faculty Competence: Improving Ethiopia's undergraduate engineering education critically depends on faculty members' personal and interpersonal abilities, as well as their ability to create products, processes, and systems. Nowadays, theoretical concepts dominate the undergraduate engineering curriculum in Ethiopia, with limited emphasis on laboratory-based practical training. This causes students to lack technical knowledge and have a difficult time applying theoretical ideas to actual engineering challenges.

To solve this problem, educators must receive the proper training and tools to enable them to give students hands-on instruction in engineering labs. For students to obtain practical experience and apply theoretical ideas to real-world issues, faculty members need to have the knowledge and abilities to design and carry out engineering experiments.Faculty members should also receive training in interpersonal and communication skills because these abilities are crucial for successful teaching and mentoring. Faculty members should be provided the opportunity to exercise and hone these abilities in their teaching and mentoring activities, as well as encouraged to enroll in workshops and training courses that concentrate on improving them.

Moreover, faculty members should be trained in product, process, and system building skills, which are essential for the development of engineering solutions. These skills include the ability to design, develop, and implement engineering projects that address real-world problems, and the ability to work collaboratively with others in interdisciplinary teams.To enhance the competence of faculty members, there should be a focus on providing training programs and resources that are tailored to the specific needs of the Ethiopian undergraduate engineering education system. These training programs and resources should be designed and delivered by experienced faculty members, industry professionals, and international experts in the field.

The increase of faculty teaching abilities is essential to the advancement of undergraduate engineering education in Ethiopia, according to Standard 10 - Enhancing Faculty Teaching Competence. Nowadays, theoretical concepts are emphasized more than practical training in laboratories in Ethiopia's undergraduate engineering education program. This causes students to lack technical knowledge and have a difficult time applying theoretical ideas to actual engineering challenges.

To address this issue, instructors must receive the proper training and tools to enable them to give students hands-on instruction in engineering labs. For students to obtain practical experience and apply theoretical ideas to real-world issues, faculty members need to have the knowledge and abilities to design and carry out engineering experiments. The utilization of active experiential learning techniques, which are crucial for efficient teaching and learning, should also be taught to faculty members. These techniques include, among others, team-based learning, project-based learning, and problem-based learning. Since these techniques work well to increase student engagement, motivation, and knowledge retention, instructors should be encouraged to adopt them.

In order to evaluate the success of teaching and learning initiatives, faculty members should also receive training in the assessment of student learning. In addition to measuring subject-specific knowledge, assessments should also gauge students' interpersonal, personal, and procedural skills as well as their ability to create products, processes, and systems. To make sure that students are obtaining the targeted learning outcomes, faculty members should be encouraged to employ a variety of assessment methods, including formative and summative evaluations.

Focus should be placed on offering training programs and resources that are suited to the unique requirements of the Ethiopian undergraduate engineering education system in order to improve the teaching proficiency of faculty members. These educational resources and training programs must be created and given by qualified academic staff, business leaders, and subject-matter specialists from around the world.

The CDIO framework standard 11 emphasizes the significance of holistically evaluating student learning, which includes disciplinary knowledge, product, process, and system building abilities, as well as personal and interpersonal skills. Given that it tackles some of the concerns that have been pointed out as shortcomings in the curriculum, this standard is particularly pertinent for assessing the advantages and disadvantages of the undergraduate engineering education system in Ethiopia.

As mentioned in the opening lines, a significant problem in the Ethiopian undergraduate engineering education system is the emphasis on theoretical knowledge. Another noted issue is the students' lack of technical expertise, which is also attributed to the lack of actual instruction in laboratories. By using assessment strategies that prioritize a comprehensive knowledge of student learning, these flaws can be fixed. Teachers may make sure that students are getting a well-rounded education that will prepare them for their future employment by evaluating student learning in terms of personal and interpersonal skills, as well as disciplinary knowledge and product, process, and system development skills.

For students to be ready for their future professions in engineering, it is crucial to evaluate student learning in interpersonal and personal skills. Interpersonal skills like communication, teamwork, and leadership are essential for success as engineers frequently work in team contexts. However, for a person to succeed in any industry, they must possess personal qualities like time management, critical thinking, and problem-solving. It is equally crucial to evaluate how well students are learning to construct products, processes, and systems because these abilities are essential for success in engineering. For the development of these abilities, engineering workspaces and laboratories that encourage hands-on learning are required. The absence of these resources in the Ethiopian curriculum is a shortcoming that can be rectified by adding evaluation strategies that place an emphasis on these abilities.

A variety of evaluation techniques can be used to judge how well students are learning in the areas of personal and interpersonal skills, disciplinary knowledge, and skills for creating products, processes, and systems. Exams and quizzes, as well as other conventional methods, can be used to evaluate disciplinary knowledge, whereas group projects and projects can be used to test product, process, and system building abilities. Self-assessment, peer evaluation, and other techniques can be used to evaluate personal and interpersonal skills. Nevertheless, there is currently no efficient method in place for the Ethiopian curriculum to assess students' progress in these areas. All of these abilities must be included in a thorough assessment of students' learning, which calls for a more integrated approach to assessment.

A more thorough approach to assessment is required to solve the flaws in the Ethiopian undergraduate engineering education system. Assessing student learning in personal and interpersonal skills, disciplinary knowledge, and skills for creating products, processes, and systems should be a priority for educators. In order to do this, engineering workspaces and laboratories should offer possibilities for practical learning in the curriculum. This can be accomplished by offering the tools, materials, and instructional assistance that are required to promote hands-on learning. The curriculum should also be revised frequently to reflect new advancements in the industry and emerging technology. Students will be equipped for the evolving requirements of the engineering profession as a result.

In order to provide feedback to students, professors, and other stakeholders for the goals of continuous development, a system of program evaluation should be put in place. This will guarantee that the curriculum is always changing to meet the requirements of both the engineering profession and the demands of the students. The Ethiopian undergraduate engineering education system can address its weaknesses and prepare students for prosperous careers in engineering by incorporating assessment practices that prioritize personal and interpersonal skills, disciplinary knowledge, and skills for creating products, processes, and systems.

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