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SUSTAINABLE DEVELOPMENT GOALS (SDG) IMPACT ASSESSMENT IN ENGINEERING FINAL YEAR PROJECTS OF APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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ABSTRACT----------
Over one hundred universities have signed and committed to international declarations to embed sustainability within their curriculum, research, operations, education and outreach. However, despite the policy developments and declarations at the national, regional and international level, not much has been achieved in terms of implanting education for sustainable development holistically under the curriculum.

This paper signifies how universities can play a pivotal role in implementing sustainable development goals (SDGs). It recognises the benefit that universities have in responding to social challenges through their functions and operations, mainly through research, innovation and academic prowess. This research is a case study of a higher education institute under APJ Abdul Kalam Technological University. The analysis has been done through knowledge evaluation of 400 students in terms of marks obtained, and SDG Impact assessment from more than 70 projects submitted by students.

KEYWORDS: ***Sustainable Development Goals (SDGs), University, Impact Assessment, project, students.----------***

1. INTRODUCTION

The 2030 agenda of the SDGs has been set to transform the world by ensuring human well-being, economic prosperity, and environmental protection. The UN General Assembly has outlined a total of seventeen goals and 169 targets, Sustainable Development Goals (SDGs) aim at tackling multiple and complex challenges faced by humankind (Nilsson et al., 2016). Although a framework has been proposed to characterize SDG interactions (Nilsson et al., 2016), a systematic, data-driven analysis of interactions between all SDG indicators is currently missing. Several studies (Martens and Carvalho, 2017; Okland, 2015; Sabini et al., 2019) have provided valuable insights into the relationship between the concept of sustainability and the lifecycle of projects; there has been less research into the relationship between project success and achieving the SDGs.

Universities and higher education institutes are one interesting place to study perceptions of sustainability and to measure changes in perspective over time through assessments and projects. A survey on sustainability can measure the perspectives in freshmen students and measure how the implementation changes through their time at the university (Meyer, 2016). Furthermore, sustainability surveys can be used to gather information and to educate the people taking the survey for the advancement of sustainability at the institution (Horvath et al., 2013; Décamps et al., 2017). Bhowmik et al. (2018). Universities can play a crucial role in SDGs implementation through research, teaching, learning, community involvement and curriculum orientation towards SDGs.

Integrating SDGs with the principles of Education for Sustainable Development (ESD) into undergraduate courses (Bhowmik et al., 2018) through university teaching and learning. Training can be offered to all curriculum developers and course coordinators, to orient the syllabus towards SDGs. Higher education institutes constitute the future generation and experts who can find relevant ways of inching towards the SDGs through discussions, deliberations and research. It can also influence the community of students, researchers, teachers, etc to have the right skills and attitude to adhere to the SDG goals of a sustainable campus and therefore, sustainable communities. Researches towards sustainability imparts the students with work-related experience, and it fosters guidance which translates to behavioural change towards natural resource utilisation at work, in projects at the campus, in the community and even at home (Castellanos, 2016).

Inculcating certain pedagogies, teaching and learning approaches and strategies fosters the competencies or skills necessary to deal with sustainability. Certain skills such as problem-solving, critical and creative thinking,

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competence in action, future thinking, etc in turn create empowered and globally- responsible citizens and professionals who can become active change-makers (Wals et al., 2010). It's critical to develop these competencies amongst the students for the development of sustainability literacy (Stibble et al., 2009).

This paper aims to explore how the students of a higher education institute under the APJ Abdul Kalam Technological University in Kerala is implementing SDGs in their final year undergraduate projects as well as in other activities associated with the university and its curriculum. The research also focuses on the assessment of knowledge on Sustainability through marks obtained from the students of various departments of the college for the module- Introduction to Sustainable Engineering. The objective of this study is to analyse and assess the knowledge of students in Sustainable Development Goals and to impart the awareness and address the most pressing challenges that the world face through projects and activities in the University. A detailed report of assessment of SDG Impacts consisting of the final semester project has been obtained through a qualitative analysis among the students from various departments of the university. The following section discusses the research design and methodology.

Fig 1: The Global Goals for Sustainable Development (Communications material, United Nations, 2019).

2. RESEARCH METHODOLOGY

Several types of research have focussed on sustainability in higher education institutions and universities through various research methods, strategies and questionnaires. More than 100 universities have signed international declarations and have committed to include sustainability within their curriculum, operations, education, research and outreach. Despite the declarations of policy developments at the regional, national and international level, mere efforts have been put in for holistically embedding SDGs in the curriculum.

Engaging with Sustainable Development objectives and targets will greatly benefit universities by helping them demonstrate university impact, capture demand for SDG related education, access funding streams, build partnerships, and define the globally responsible university. The focus for Indian Universities on SDG and related domains is relatively low compared to other European Universities. The United Nations University SDG guidelines elaborate how Universities can contribute to the SDGs in a variety of domains, such as

1. *Learning and teaching* – by providing students with the skills, knowledge, resources and motivation through in-depth academic training, expertise to implement SDGs, capacity building for students and professionals and empowering young individuals.
2. *Research* – by providing necessary knowledge, solutions, technology, pathways and innovations to implement the SDG solutions.

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3. *Organisational Governance, culture and operations of the University* – basically through employment, finance, campus services, human resources, student administration, support services, etc.
4. *External leadership* – Strengthening public engagement and participation in addressing the SDGs and helping design policies, and demonstrating commitments to the SDGs.

This paper focuses on two aspects of the students of a higher education Institute under the APJ Abdul Kalam Technological University of Kerala.

(i) The first section provides a detailed assessment of scores obtained for the module "Introduction to sustainable Engineering" among the students from six different departments in the year 2018 (Batch of 2022). This research methodology has been initiated to achieve the existing gaps in previous knowledge assessment methods implemented by researchers. A detailed overview of the syllabus and course structure with the scores helps to analyse the level of knowledge and awareness among the students on Sustainability and its impacts. The marks were obtained from the university website of the specific institution. The research and analysis are limited to one institution owing to time constraints.

Syllabus and a brief overview of course structure by the University-

Introduction to Sustainable Engineering – Sustainability: need and concept, challenges, Environment acts and protocols, Global, Regional and Local environmental issues, Natural resources and their pollution, Carbon credits, Zero waste concept ISO 14000, Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Technology and sustainable development, Sustainable urbanization, Industrial Ecology.

Course Objectives prescribed by the University-

1. To have increased awareness among students on issues in areas of sustainability
2. To understand the role of engineering and technology within sustainable development;
3. To know the methods, tools, and incentives for sustainable product-service system development.
4. To establish a clear understanding of the role and impact of various aspects of engineering and decisions on environmental, societal, and economic problems.

Marks were obtained from students of Electronics and Communication Engineering, Mechanical Engineering, Biotechnology Engineering, Computer Science, Mechanical Automobile and Mechanical production engineering departments. Marks were obtained from approximately 400 students, with 62-65 students from each department. The scores are classified into eight sections according to the university norms -

i) Outstanding (O) for scores above 90,
ii) A+ for scores ranging from 85- 89,
iii) A for scores ranging from 80- 84,
iv) B+ for scores ranging from 70-79,
v) B for scores ranging from 60-69,
vi) C for scores ranging from 50-59,
vii) Pass (P) for scores ranging from 45-49, and
viii) Fail (F) for scores below 45.

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Table1: Number of students with the respective range of marks from each department for the module: 'Introduction to Sustainable Engineering'

Range of marks/ Department	>90 O	85- 89 A+	80- 84 A	70- 79 B+	60- 69 B	50-59 C	45-49 P	<45 - Fail	Total students
Electronics and Communication	0	4	8	33	14	3	0	3	65
Mechanical Engineering	2	6	13	31	9	1	0	0	62
Biotechnology	2	8	9	25	12	3	0	1	60
Mechanical Automobile	0	2	6	36	17	0	0	1	62
Computer Science	7	9	8	26	8	3	0	0	61
Mechanical production	0	1	5	35	16	4	0	3	64

(ii) The second part of the research focuses on the SDG Impact assessment in the projects done by the students. Projects and research works have been obtained from various departments of the Institute, a total of 70 projects were narrowed down from all the departments. The students involved in the respective projects have provided an output analysis based on the measuring objectives and questionnaires on SDG target assessment provided to them for this research. The projects were assessed based on the impact it creates for the 17 SDGs and the 169 targets listed for all the goals. For every SDGs, the impact assessment criterion was categorised as follows-

- Direct positive impact
- Indirect positive impact
- No impact
- Indirect negative impact
- Direct negative impact
- More knowledge needed

This qualitative analysis has provided a rational judgement among the students and eventually their interests in various fields. To determine the impact on an SDG, the relevant cause-effect relations were considered by the students to determine if an impact is positive or negative and direct or indirect. A positive impact helps to implement the SDG and a negative impact prevents its implementation. A direct (positive or negative) impact will have an immediate one-step effect on a particular SDG and an indirect (positive or negative) impact is a secondary effect. The criteria have been fixed to assess the students on the knowledge gained from the study of the module and its practical implementation in real life. Apart from the five output criteria, the list of 169 targets set by the United Nations SGDs was circulated among the students to elaborately analyse the project output and to distinguish the category in which the project falls into and the impact that it creates. The assessment is composed in Table 2.

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Table 2: SDG IMPACT ASSESSMENT IN BTECH PROJECTS

Sl. No.	PROJECTS OF STUDENTS OBTAINED	Direct Positive	Direct Negative	Indirect Positive	Indirect Negative	No Impact
1.	Production of biodegradable plastic from agricultural waste	✓				
2.	Driving Assistance using VANET's during the obstructed vision of Traffic			✓		
3.	Oil wastewater treatment and recycling	✓				
4.	Development of cellulose-based bactericidal nanocomposites containing nanoparticles and their use as active food packaging	✓				
5.	Virtual assistance for college			✓		
6.	Isolation of hydrocarbon-degrading bacteria from environment	✓				
7.	Bone conduction			✓		
8.	Fabrication of desalination unit to produce potable water for stranded fishing boat	✓				
9.	Isolation of bacteriocin producing organism and production of bacteriocin			✓		
10.	Water quality analysis of Karamana river and to device household water treatment system	✓				
11.	Isolation of antimicrobial properties from tree barks			✓		
12.	An indoor location estimation using BLE beacons considering movable obstructions			✓		
13.	Rating prediction system from Social networks			✓		
14.	Isolation of hydrocarbon-degrading bacteria from petrol pumps			✓		
15.	Aiding recruitment processing with CNN			✓		
16.	Preparation of a composite antimicrobial food packaging with the use of polylactic acid, a bacteriocin and nanoparticles			✓		
17.	Voice recognition based home automation	✓				
18.	Intelligent pH indicator film composed of agar/potato starch and anthocyanin extracts from purple sweet potato			✓		
19.	Structural analysis of electric car chassis					✓
20.	Design and analysis of control loops for Coriolis vibratory gyroscope using FPGA based RISC controller			✓		
21.	Isolation of DNA from soil using nanoparticle magnetic separation			✓		
22.	The intelligent visual Surveillance system	✓				
23.	Production of bio cement	✓				
24.	Greening Traffic Lights: EVM detection and traffic signal preemption system using AI	✓				
25.	Hat type hearing system using MEMS microphone array	✓				
26.	Non-invasive BioMed sensing for cross-section imaging & gesture recognition	✓				
27.	Analysis of antibacterial properties of 3 different medicated soaps			✓		
28.	Multi-person tracking and reidentification			✓		
29.	Optimization of uplink radio access method in LTE			✓		
30.	Biodiesel production from castor oil and its optimisation	✓				
31.	Emotion Recognising CHATBOT			✓		
32.	Preparation and analysis of pineapple pulp cough syrup	✓				

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33.	Patient Health Monitoring using IoT	✓				
34.	Meta-analysis of gene expression in prostate cancer			✓		
35.	Design and Fabrication of Automated Manual Gear Transmission in Motorcycles	✓				
36.	Wastewater treatment using Moringa Oliefera leaves			✓		
37.	Smart waste bin	✓				
38.	Investigation of amplifier performance and modulation techniques in WDM systems			✓		
39.	Natural insect repellent from various plant extracts housed in a polymeric base			✓		
40.	Cross-Lingual Voice Morphing				✓	
41.	Design and construction of indoor small scale hydroponic unit			✓		
42.	Detection of landslide disaster by telemetric sensing mode network system			✓		
43.	Pharmacogenetic and molecular study of Indian medicinal plants			✓		
44.	Fabrication of self-balancing monowheel			✓		
45.	Isolation and identification of bacteria from spoiled fruits			✓		
46.	Divyadrishti: Assistive autonomous blind aid project	✓				
47.	Bioplastic from banana peel	✓				
48.	Personalised News Article Classification with an alert system			✓		
49.	Construction of water purifier using watermelon seeds as a filter aid and a natural filter membrane and checking the water purity by comparing water from the normal purifier			✓		
50.	Spot News: News content aggregation and delivery app			✓		
51.	Comparing the efficiency of biodiesel obtained from various sources and the purification of bio petrol			✓		
52.	Diabetics Prediction	✓				
53.	Mood Based music recommendation system					✓
54.	Comparison of various denoising techniques for removing ECG artefacts in EMG- simulation & analysis			✓		
55.	Machine Learning based tool for students' academic result prediction			✓		
56.	Churn Prediction System			✓		
57.	Analysis of molecular aspects of sucrose transport and its metabolism in wheat			✓		
58.	Pre-treatment to enhance biodegradation of waste activated sludge			✓		
59.	Heart disease Prediction using data mining techniques	✓				
60.	Analysing Kerala floods using satellite imageries & Deep learning Methods	✓				
61.	Paralysis eye-tracking			✓		
62.	Indian Classical Dance: Mudra Classification using HOG features and SVM Classifier			✓		
63.	Study of wound healing property of leaf sheath scales, scales covering inner sheaths of coconut Tree	✓				
64.	Encryption based cockpit image recorder			✓		
65.	Study of soil bacteria colonies from different fields and role in the cultivation			✓		
66.	Implementation of Supply chain using blockchain			✓		

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67.	Sentimental Analysis of tweets					✓
68.	Production of biodegradable plastic from agricultural waste	✓				
69.	Driving Assistance using VANET's during an obstructed vision of Traffic			✓		
70.	Quality control of milk-testing: the quality of milk from different companies and sources			✓		

There could be different impacts for an SDG from various perspectives, but we have solely assessed each of the projects under one impact category. If an object has a positive (direct or indirect) impact on one particular target and a negative (direct or indirect) impact on another, we have chosen the most relevant impact. The decisions completely depend on how we have valued and prioritised different impacts against each other to narrow down to one. This knowledge-based approach will make the assessment credible and useful.

As emphasised by the UN, the interrelation and integrated nature of the SDGs are crucial for their implementation; therefore, the SDGs should be treated as a 'whole'. This depicts that one particular action to achieve a Sustainable Development Goal should avoid negative impacts on others. With the acquired knowledge, we'll be able to identify positive impacts (opportunities), negative impacts (risks), and knowledge gaps about a particular project. Detecting these knowledge gaps is a significant result in itself, the output of which will have a better understanding of how the assessment criteria relates to the SDGs and towards formulating a more comprehensive sustainability strategy.

3. RESULTS AND DISCUSSION

The study results and the discussions are presented in this section. In section 3.1, the knowledge assessment of results obtained from the marks of students for the module " Introduction to Sustainable Engineering" has been outlined. The subsequent section discusses the Sustainable Development Goals (SDG) – Impact Assessment of the BTech projects of the higher education institutions to assess the implementation of SDGs practically. The projects were obtained from 70 groups of students from various departments of the institute, each group consisting of 4-5 students.

3.1. Knowledge assessment from the marks obtained

The output from the result analysis obtained from the students for the module "Introduction to Sustainable Engineering " determines an average outlook among the students around the concepts of SDGs and the associated topics with the curriculum. There is a need to raise awareness and to give importance to the subject and raise the bar of standards that are determined now to a global standard by the higher educational institutes and universities to achieve 100 per cent. SDGs need to be brought into the limelight especially among the researchers looking for a presence in new space and to build their profile which can eventually help them connect to various goals.

The output obtained from the knowledge assessment from the marks obtained for the students have been discussed below in Fig 2.

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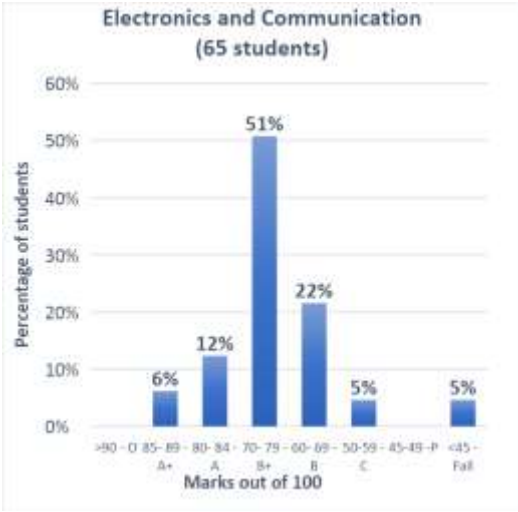
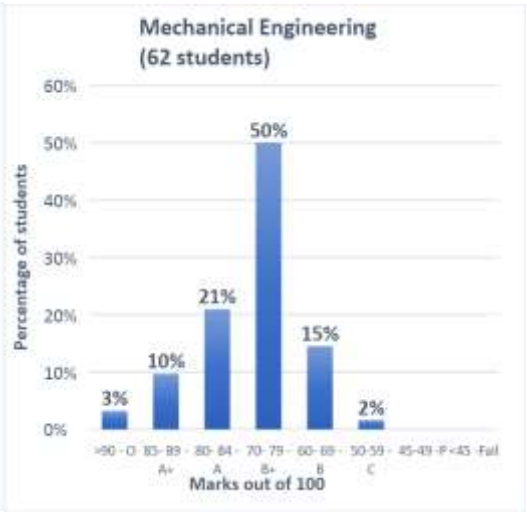
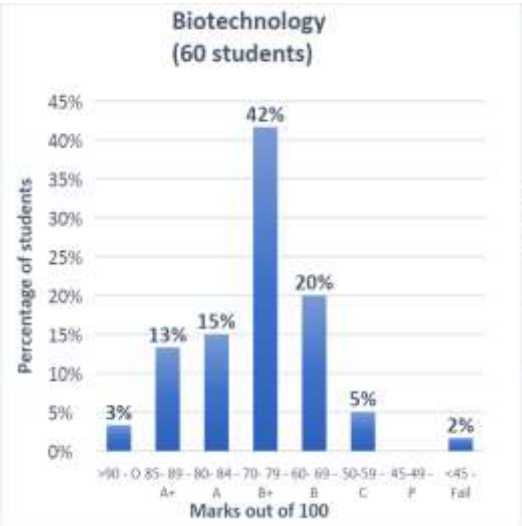
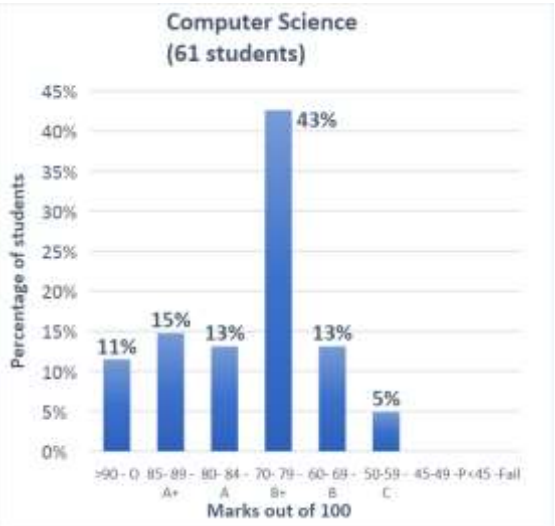
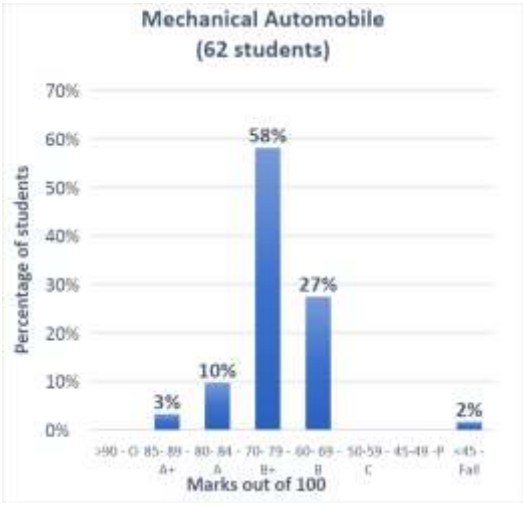
Fig2: Knowledge Analysis of students for the module – Introduction to Sustainable Engineering

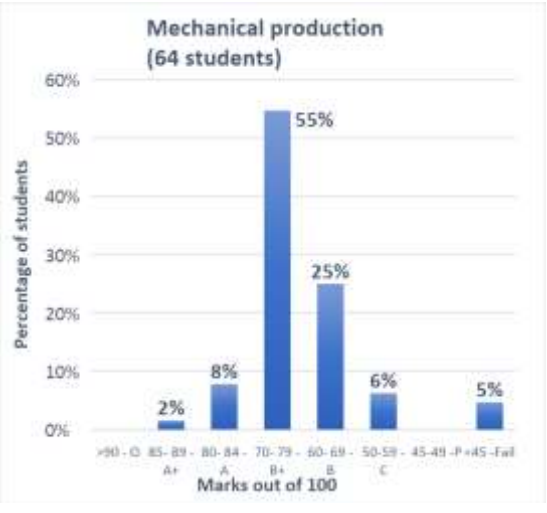












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The knowledge dimension among the majority of 400 students assessed, stood at a range from average to above average for the course module chosen for evaluation. However, more than 75-80% of students from each class are aware of sustainability and the need for it in society, economy and environment.

Universities are hubs of invention and discovery and have played a vital role in the development of almost every major technology of the twentieth century. It can help drive the development of social as well as technological innovations and solutions across SDG challenges. Students must be provided with the drive to inculcate innovation around SDGs right from the freshman year and academic achievements and promotion criteria could be developed to value their contributions.

3.2. SDG Impact Assessment of the BTech projects

The SDG Impact assessment of the projects gives the understanding of the student's notion on each of the projects from a sustainability point of view. The criteria and questionnaires for assessment were shared among the students and the outputs were categorised solely from the perspective provided to them. As there could be more than one approach for a particular project and the impact depends on the perspective, so the students have charted the impacts which brings a positive output from their projects. So, the knowledge-based approach by cross-referring the SDG targets has provided a broad understanding among students as well helped them understand the gaps and the need for improvements.

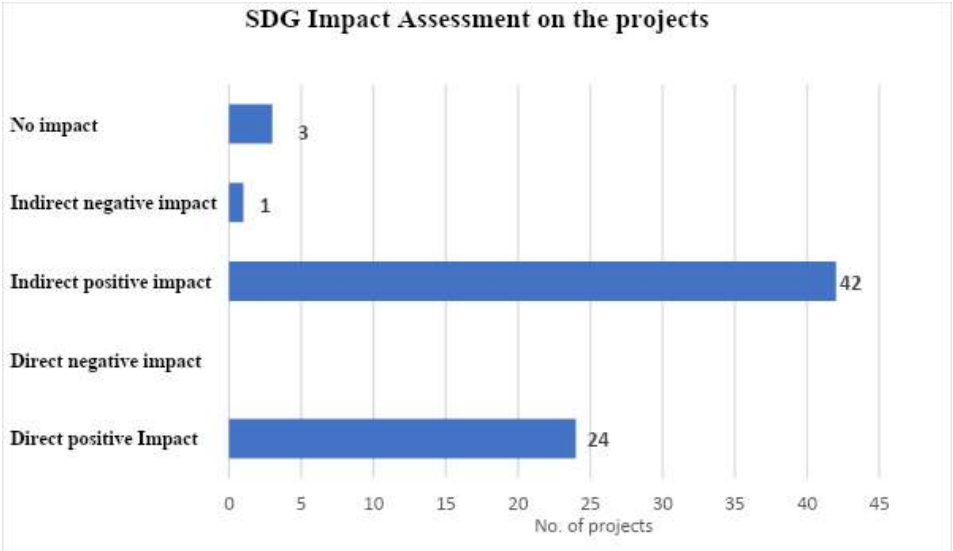

Fig3: SDG Impact assessment of the 70 projects obtained from the students

The impacts for each of the projects were finalized and categorized using the UN's SDG Impact assessment tool guide. A total of 70 projects (each project consisted of a team of 4-5 students) were shortlisted from all the departments and the final outputs were categorized as given in Fig3. According to the prioritization of the projects, none of the projects has a direct negative impact. The majority of the projects were classified under 'indirect positive' followed by 'Direct positive' impact. There were three projects which didn't provide any major impact and one project was classified under Indirect negative impact, only because of the perspective with which it was analysed.

4. CONCLUSION AND RECOMMENDATIONS

Universities can expand their role as hubs of innovation to support student projects with business intentions by collaborating with other start-ups and high tech companies that provide technologies and services for sustainable development. Collaborating with businesses can help to develop new technologies and provide viable solutions to address the SDGs. Promotion and support from teachers and universities play a vital role in the implementation, research and development of student projects. Innovation challenges to address SDGs brings the spirit to incorporate more positive outputs to the projects, maximise co-benefits and minimise negative impacts.

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Universities should take a lead in supporting and incubating innovation for sustainable development solutions among the higher education institutes to foster learning. Developing collaborative relationships with industry, government, communities, private sector, and non-governmental organisations can help broaden the project quality and outlook among the students.

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