A Comparative Study of General Subjects Taught in Diploma Engineering Education in SAARC Countries

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***Abstract*-- The role of diploma engineers in the development of industries, infrastructures and to help growing the stable economy of the SAARC region is very much noteworthy. However, in facing the challenges of the future, the diploma engineers must possess the necessary non-technical competencies with a stronger emphasis in humanities, including ethics and professionalism. SAARC countries are already incorporated the general courses into the diploma engineering curriculum in this respect. But there are some variation observed in the diploma engineering curriculum. Countries of the SAARC region do not include the same proportion of general subjects into the curriculum. The aim of this research was to find out the exact percentage of the general subjects offered in different SAARC countries with some relative analysis. It was found that maximum weightage of general subjects is given in the diploma engineering curriculum of Bangladesh (20%) that met the standard set by European Engineering Education [1]. India provides 14%) of general subjects which meets the standard defined by Accreditation Board for Engineering and Technology [2]. Whereas Pakistan (12%) and Maldives (8%) are still below the criteria and they need to improve their diploma engineering curriculum by incorporating more general courses.**

Index Term*-- *General subjects, Diploma Engineering, SAARC

I. INTRODUCTION

Nowadays, more emphasis is being given in the field of technical education to produce efficient manpower and hence strengthen the economy. As a result curriculum is being changed to meet the demand. Therefore subjects and contents are also changing. In this direction, this research reveals a comparative scenario of diploma engineering course curriculum by giving focus on general studies within SAARC region. By the term general subject we refer to those sciences which have as their object of study man and his understanding of himself. These sciences draw on various disciplines such as social science, philosophy, literature, art, history, and psychology [3]. In recent trends, the concept is not to produce simply a technical person rather a social human being. If an engineer does not possess interpersonal skills, it is hard for him to survive in the job market for long time. Johnson [4] brings to the attention in a survey, conducted in Australia, which showed

that 97% of employers felt that engineering graduates should have adequate diversity of knowledge and skills to meet the future needs of the professional engineering workforce. So an engineer must be technically sound and at the same time he must have good communication skills. Engineering subjects can make their concepts technically sound and general subjects are necessary to build up their communication skills, interpersonal skills, and administrative skills as well.

Rojter [5] argues that the role of general subjects in engineering curriculum needs to be observed through two main perspectives: Firstly, The nature of humanities and social science subjects in engineering curriculum; and secondly proportional allocation of engineering curriculum to humanities and social sciences. He further says that the nature of humanities and social sciences, which are to be incorporated into engineering courses, must be relevant to workplace discourses in which the engineering profession is embedded. Ashby [6] recommended that subjects concerned with ethics, jurisprudence, languages, social and industrial history, and history of technology were relevant to engineering education. An Australian survey of government, private and multinational companies revealed that knowledge of languages as a desirable attribute of engineering graduates was placed highly by the respondents [7]. Now the question is what should be the percentage of technical subjects and general subjects in engineering curriculum. The Accreditation Board for Engineering and Technology (ABET), a body responsible for accrediting professional engineering courses in the United States, set aside a minimum of 12.5% of engineering curriculum that had to be allocated to humanities and social sciences if these course were to be accredited [8].

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A survey of employers, in Australia, clearly showed that employers were concerned with the lack of social literacy and knowledge concerned with human affairs in amongst engineering graduates. They placed high priorities that these issues needed to be addresses through engineering curricula at even the expense of engineering elective subjects as well as some core engineering and fundamental science subjects [9]. The acquisition through education of humanities and social sciences cannot be regarded just as an extension of knowledge capital. It provides professional engineers with means of new way of critical thinking and inquiry. Hudson [10] in a study of humanities and engineering graduates found that humanities students had highly developed divergent thinking skills whereas engineering graduates were more convergent thinkers. Grinter [11] suggested that 30% of engineering curricula in the United States be allocated to core humanities and social science disciplines.

Finniston in Britain, recognized engineering practice to be one of productive pragmatism and called for the inclusion of greater humanities content in engineering curricula to transform the engineering profession from a technical profession into a social profession to reflect the realities of engineering workplaces [12]. Wragge and Williams in a major review into engineering education in Australia, recognized that awareness of human affairs plays an essential role in effective professional engineering workplace discourse [13],[14]. The lack of social literacy and knowledge concerned with human affairs amongst engineering graduates was clearly identified by Beswick, Julian and Macmillan [9] in a survey of Australian employers, as an impediment to best professional practice. The employers suggested a greater allocation in engineering curriculum be given to humanities and social science subjects even if it meant that this could be achieved at the expense of some scientific and technical subjects. This was reinforced by Lang et al [15] who also identified engineering graduates to have a poor understanding of their human and social environment. Further research indicated that engineering graduates lacked the cultural awareness and diversity needed for an effective engineering practice and the enhancement of the profession [16], [17].

Research indicates that many universities generally offer general subjects apart from the technical courses. For example in USA 42%, in Australia 25%, in France 30% and in Germany 16% of the total credit was allocated for the Gereral courses [18]. Completeness in the training of engineers, which among others include communication, management and innovative thinking skills, are necessary in preparing engineers who are capable of performing useful functions in the industry, immediately upon graduation [18], [19]. O'Kane [20], in highlighting the future challenges in engineering education, has included globalization, rapidly expanding knowledge and the changing emphasis in scientific fields as the important aspects to be considered when preparing a suitable engineering program.

However, Courses for Diploma programs can be divided into three broad categories, i.e. common courses, basics or foundation courses and technical courses. Common courses include moral education, entrepreneurship and languages. Basic orientation courses include mathematics, engineering sciences, engineering drawing, and computer application and technical courses are core subjects [18]. The purpose of this paper is to explore the allocation of different category subjects in different SAARC Countries. The comparison of contents of subjects being taught to diploma engineering in different SAARC countries is also shown in this study.

A. Rationale for Incorporating General Subjects in Diploma Engineering Education

The primary motivation for integration of general courses is to broaden the knowledge of the graduates and the assumption is that a graduate from such a rich blend of academic courses would be ready for the integrated world of work beyond the academic environment [21]. It is proved that humanities courses furnish our students with the opportunity for personal reflection on the communal and provide personal meanings of the central ideas of culture with self-knowledge, skill of critical thinking and the ability and desire to be a productive member of the community [22]. Johari et al [18] argues that the humanistic skills are very much essential to produce a balanced engineer. He proposed a model of engineering education where he allocates about 70% of the total credits to the engineering content and the remaining 30% to the non-engineering content.

The US National Academy of Engineering (NAE), in its 2000 annual meeting, reflecting on the challenges to engineering education in the third millennium, identifies engineering ethics as an emerging area that needs to be taken into account in professional preparation, because of the enormous impact of engineers on individuals and society [23]. The key category for such formation is the notion of professional responsibility [24] which is the result of a series of objectives synthesized as follows: a) increased ethical sensitivity; b) increased knowledge of relevant standards of conduct; c) improved ethical will-power [25]. Therefore, the relevance of humanities and social sciences to engineering practice cannot be viewed in terms of

just as an acquisition of knowledge capital but also as the acquisition of engineering skills [26].

Accreditation is currently a desired benchmark for any engineering program. Engineering programs in different countries are designed to satisfy the accreditation requirements imposed by national professional bodies to allow graduates achieve the professional engineer status [21]. The recognition and equivalency of the engineering programs in different countries is determined according to the Washington Accord, which provides a mechanism for mutual recognition of engineering qualifications obtained in member countries. The Washington Accord includes elements of General Education or complementary studies in the attributes and professional competency profiles for graduate engineers [27]. Engineering education should become more flexible and must not only teach the fundamentals of engineering theory, experimentation, and practice, but should prepare students for a broad range of careers and life-long learning [28]. General courses may not be listed as a formal condition for accreditation but it is indeed required in all engineering programs [29], [30], [31].

Accordingly, current requirement in engineering curricula is that engineering graduates should, apart from being educated in a particular engineering field, be grounded in financial, ethical, legal, economic, environmental fields and be knowledgeable about socio-cultural issues of the society in which they work. In order to achieve such attributes general courses have been infused into the curricula to such an extent that they have become vital components of engineering education.

II. Methodology

Among all the SAARC countries diploma engineering institutes of Bangladesh, India, Pakistan and Maldives were taken as sample for this study. Data were collected directly from the official websites of the particular board of education of the respective countries, provinces or the states. For the convenience of analysis, firstly, all the subjects of diploma engineering were separated into three categories- General subjects, Science subjects and Technical subjects. Total credits of all the subjects and industrial training worked out by adding up the total credits of 6 semesters for each technology. Finally, the percentage of general subjects, science subjects and technical subjects were calculated.

In Bangladesh, all the government polytechnic institutes are controlled centrally by Bangladesh Technical Education Board (BTEB). It means that all the polytechnic institutes are following the same curriculum and syllabus. The whole content of the diploma engineering syllabus was collected from the official website of BTEB [32].

As India is divided into a number of states, the curriculum of diploma engineering is also different in different regions. For this study the Punjab state of India was chosen [33]. All the polytechnic institutes belong to this state are bound to follow the same curriculum. Data were analyzed in the same way as Bangladesh only difference is that here calculation was done using the marks of individual other than credits.

There are four provinces in Pakistan namely 1) Baluchistan (capital Quetta), 2) Punjab (capital Lahore), 3) Sindh (capital-Karachi), 4) Khyber-Pakhtunkhawa (capital Peshawar). For this research purpose data of Sindh and Pakhtunkhawa were used [34]. It was noticed that both the data were exactly same. Data were given in the form of credits and analyzed in the same way of Bangladesh.

In Maldives there are different specialization offering in Diploma in engineering [35]. Out of them seven were considered for this study. Credits for individual subjects were given and data were analyzed according to the same way of Bangladesh and Pakistan.

A. Analysis and Interpretation of Data

Allocation of General Courses: The following figure shows the general subjects offered by different SAARC countries. All the countries offered a number of general subjects where four subjects are in common. These are English and Communication Skills, Social Science, Industrial Management and Environmental Studies.

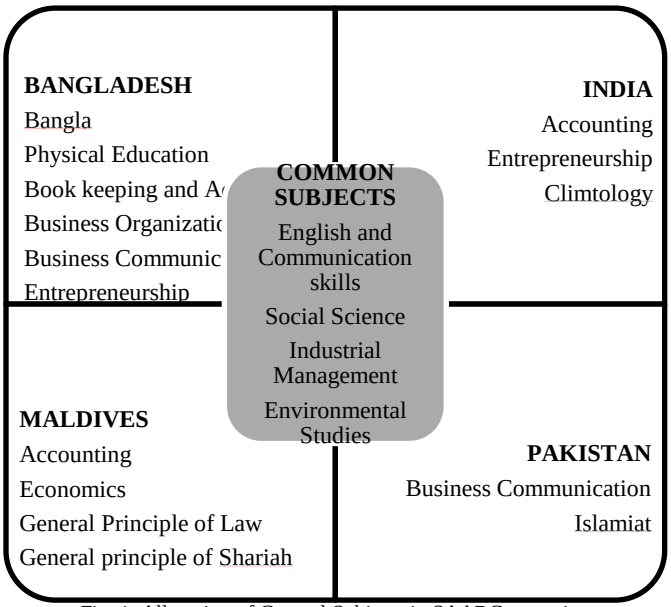

Fig. 1. Allocation of General Subjects in SAARC countries

Comparison of the General Subjects, Science Subjects and Technical Subjects was done mostly on the basis of credits. Bangladesh, Pakistan and Maldives give the value to the subjects through credits. But in India weightage of the

subjects were given by marks. So, calculation for India was done on the basis of marks.

Allocation of General Courses in Bangladesh: TABLE I presents the percentage of General Subjects, Science Subjects and Technical Subjects with respect to each technology. Finally mean value of General Subjects, Science Subjects and Technical Subjects of all technologies were calculated.

TABLE I
CREDITS AND PERCENTAGE OF DIFFERENT CATEGORY SUBJECTS

Technology	Credits (Percentage)		
	General Subjects	Science Subjects	Technical Subjects
Architecture Technology	33(18.53)	25(14.04)	120(67.43)
Automobile Technology	33(19.87)	25(15.06)	108(65.06)
Chemical Technology	33(19.87)	25(15.06)	108(65.06)
Civil Technology	33(19.87)	25(15.06)	108(65.06)
Computer Technology	33(20.5)	28(17.4)	100(62.1)
Electrical Technology	33(19.87)	28(16.87)	105(63.26)
Electronic Technology	33(19.76)	31(18.56)	103(61.67)
Food Technology	34(20.48)	39(23.5)	93(56.02)
Mechanical Technology	33(19.87)	25(15.06)	108(65.06)
Power Technology	33(18.64)	25(14.12)	119(67.24)
Refrigeration and Air Conditioning Technology	33(19.87)	25(15.06)	108(65.06)
Offset Printing Technology	33(19.87)	25(15.06)	108(65.06)
Graphic Reproduction Printing Technology	33(19.76)	25(14.97)	109(65.27)
Ceramic Technology	33(19.87)	25(15.06)	108(65.06)
Glass Technology	33(20)	25(15.24)	107(64.75)
Marine Technology	33(20.12)	25(15.24)	106(64.63)
Shipbuilding Technology	33(19.87)	25(15.06)	108(65.06)
Aircraft Maintenance (Aerospace) Technology	32(17.87)	22(12.29)	125(69.84)
Aircraft Maintenance (Avionics) Technology	32(18.93)	22(13.02)	115(68.05)
Surveying Technology	33(19.87)	25(15.06)	108(65.06)
Average	20%	16%	64%

It is observed that 64% allocation of the total credit was given to Technical subject whereas only 20% and 16% allocation was given to General subjects and Science Subjects respectively in the diploma engineering education of Bangladesh.

Allocation of General subjects in India: The following table shows technology wise percentages of General Subject, Science Subject and Technical Subject in India.

TABLE II
MARKS AND PERCENTAGE OF DIFFERENT CATEGORY SUBJECTS IN INDIA

Technology	Marks (Percentage)		
	General Subjects	Science Subjects	Technical Subjects
Architectural Assistantship	850 (14.2)	700 (11.72)	4425 (74.15)
Chemical Engineering	650 (12.87)	575 (11.38)	3825 (75.74)
Civil Engineering	600 (10.38)	700 (12.12)	4475 (77.50)
Computer Engineering	750 (14.28)	575 (10.95)	3925 (74.77)
Electrical Engineering	700 (14.70)	750 (13.72)	3650 (71.57)
Electronics and Communication Engineering	750 (14.70)	575 (11.27)	3775 (74.03)
Electronics (Microprocessors)	750 (14.70)	575 (11.27)	3775 (74.03)
Electronics and Telecomm. Engineering	750 (14.70)	575 (11.27)	3775(74.03)
Fashion Design	750 (14.50)	0 (0)	4425 (85.50)
Leather Technology (Footwear)	750 (15.55)	450 (9.40)	3625 (75.120
Garment Technology	750 (14.85)	350 (6.93)	3950 (78.21)
Information Technology	750 (14.28)	575 (10.950	3925 (74.76)
Leather Technology	750 (15.87)	575 (12.16)	3400 (71.96)
Mechanical Engineering	750 (13.88)	700 (12.96)	3950 (74.15)
Medical Lab. Technology	650 (12.94)	250 (4.97)	4125 (82.08)
Plastic Technology	750 (14.40)	450 (8.65)	4000 (71.57)
Average	14%	10%	76%

TABLE II shows that Leather Technology offered the maximum percentage (more than15%) of General Subjects whereas Civil Technology offered the minimum (10.38%). Electrical Technology offered maximum Percentage of Science Subjects while Fashion Design Technology offered not a single Science Subjects. But Fashion Design Technology offered the maximum percentage of Technical Subjects (85.5%). Finally the mean value of General Subjects, Science Subjects and Technical Subjects considering all the technologies shows 14%, 10% and 76% respectively.

Allocation of General Subjects in Pakistan: Table 3 represents at a glance the Credits and percentage of General Subjects, Science Subjects and Technical Subjects in different Technologies in Pakistan.

TABLE III
CREDITS AND PERCENTAGE IN DIFFERENT TECHNOLOGIES OF PAKISTAN

Diploma of Associate Engineering	Credits (Percentage)		
	General Subjects	Science Subjects	Technical Subjects
Civil Technology	7 (10.44)	9 (13.42)	51 (76.12)
Chemical Technology	8 (11.76)	12 (17.64)	48 (70.60)
Electrical Technology	8 (11.27)	10 (14.08)	53 (74.65)
Electronics Technology	8 (12.30)	11 (16.92)	65 (70.7)
Mechanical Technology	8 (11.60)	13 (18.84)	69 (69.56)
Average	12%	16%	72%

It is observed from the above table that almost all the technologies offered same number of general subjects except civil engineering. Technical subjects offered in each department are almost the same.

Allocation of General Subjects in Maldives: TABLE IV represents the Credits and percentage of General Subjects, Science Subjects and Technical Subjects in different Technologies in Maldives at a glance.

TABLE IV
CREDITS AND PERCENTAGE IN DIFFERENT TECHNOLOGIES OF MALDIVES

Technology	Credits (Percentage)		
	General Subjects	Science Subjects	Technical Subjects
Diploma in Mechanical Engineering	0 (0)	12 (8.87)	123 (91.12)
Diploma in Architecture	27 (20)	0 (0)	108 (80)
Diploma in Building Construction	3 (1.67)	24 (13.33)	153 (85)
Diploma in Electrical Engineering	9 (6.52)	0 (0)	129 (93.47)
Diploma in Electronic Engineering	0 (0)	0 (0)	135 (100)
Diploma in Construction Management	24 (17.78)	0 (0)	111(82.22)
Diploma in Civil Engineering	12 (8.88)	36(26.67)	87 (64.45)
Average	8%	7%	85%

It is seen from the table that Mechanical and Electronic technologies did not offer any General subject. On the other Hand Architecture, Electrical, Electronic and Diploma in Contraction Management did not offer any Science subject. All the technologies offer maximum amount of Technical subjects. Diploma in electronic engineering offered 100% Technical subjects.

Comparison of General Subjects: The following figure represents the overall allocation of different subjects in the four countries.

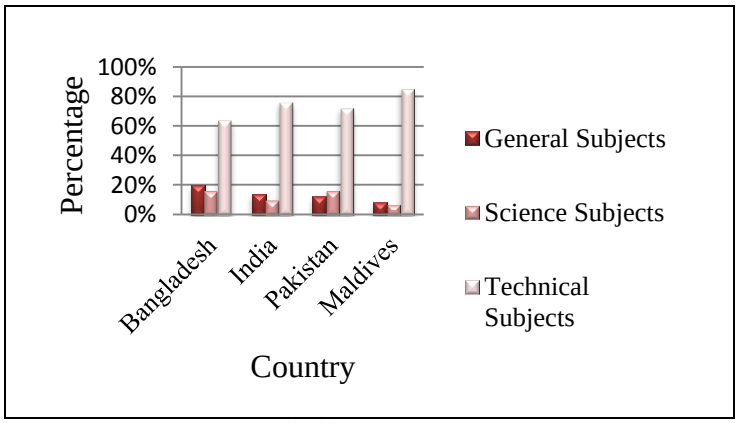

Fig. 2. Comparison of Different Subjects in Four Countries

Fig. 2. shows comparative percentage of different category subjects among four SAARC countries. It is observed that Bangladesh offers 20% General Subjects of the total credit whereas Pakistan and Maldives offers 12% and 8% respectively. India offers 14% general subjects. Bangladesh and Pakistan offered same amount (16%) of Science Subjects whereas India and Maldives offered 10% and 7% of Science Subjects respectively. It is noticeable that all the countries offer highest percentage of Technical Subjects. Maldives offered the maximum (85%) of Technical Subject whereas Bangladesh offers comparatively less amount of Technical Subject. India and Pakistan offers 76% of Technical Subject.

TABLE V
GENERAL SUBJECTS OFFERED IN DIFFERENT SAARC COUNTRIES

Subject	Bangladesh	India	Pakistan	Maldives	Total
English	√	√	√	√	4
Bangla	√				1
Social Science	√				1
Economics	√		√		2
History and Culture	√		√	√	3
Physical Education	√				1
Islamiat			√		1
Accounting	√	√			2
Business Organization	√		√	√	3
Business Communication	√		√	√	3
Industrial Management	√		√	√	3
Entrepreneurship	√	√			2
Building and municipal drawing		√			1
Project management		√	√	√	3
Principle of management		√		√	2
Study Skills (for Engineering Education)				√	1
Total	11	6	8	8	33

The above table shows the number of General subjects offered in SAARC countries. Each row shows a specific subject offered by number of countries. For example English is offered by 7 countries. On the other hand each column shows number of general subjects offered in a specific country. For example, Bangladesh offers total 11 General Subjects, India

offered 6 etc. It is shown that Bangladesh offers the highest number (11) of General Subjects whereas India offered the lowest (6). On the other hand English is offered by all the countries. Business Organization, Business Communication, Industrial Management and History and Culture are offered by all the three countries except India. Project Management subject is absent in Bangladesh only. Bangla is offered in Bangladesh and Islamiat is offered only in Pakistan because of the regional demand.

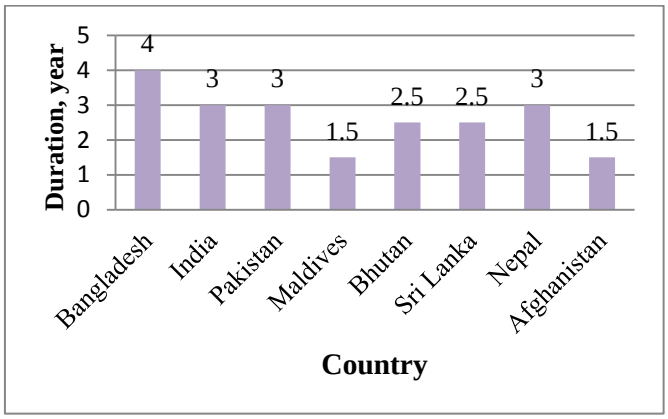

Fig. 3. Duration of Diploma Engineering Course in Different SAARC Countries

The above figure reveals the duration of diploma engineering courses not only in the selected four countries but also the other neighboring counties for better understanding. It is observed from the figure that duration of the course is maximum in Bangladesh (4 years) whereas minimum in Afghanistan and Maldives (1.5 years). It is 3 years in India, Pakistan and Nepal and 2.5 years in Bhutan and Sri Lanka. The diploma engineering courses in all the countries are semester system except in Pakistan, it is annual system.

TABLE VI
WEIGHTAGE OF ENGLISH AS GENERAL SUBJECT IN SAARC COUNTRIES

Country	Subjects	Credits	Total
Bangladesh	English I	2 Credits	7 Credits
	English II	2 Credits	
	English III	3 Credits	
India	English and Communication Skill-I	3 Credits	6 Credits
	English and Communication Skill-II	3 Credits	
Pakistan	English	2 Credits	2 Credits
Maldives	English for Study Purpose	9 Credits	9 Credits

The above table reveals the weightage of English as a General subject in different SAARC countries. It is seen from the table that Maldives offers maximum credits for English in most of the technologies. On the other hand Bangladesh offers 3 English subjects in all technologies having total credits of 7. India offers 2 General Subjects related to English of 6 credits. Pakistan offers one English subject of 2 credits.

III. Discussion and Conclusion

Based on the analysis and interpretations, overall findings of this study are discussed below:

Bangladesh: Bangladesh offered in total 32 technologies of diploma in engineering education where 16 general subjects which is consist of 33 credits. In addition, total 14 Science subjects was offered which consist of 45 credits. Bangladesh offered 20% general subjects, 16% science subjects and 64% technical subjects in the diploma engineering course on average. Computer and Food technology offered the highest percentage of General Subjects which are slightly above 20% whereas Aircraft Maintenance (Aerospace) technology offered the lowest percentage of General Subjects which is slightly less than 18%. For most of the technologies seventh semester is reserved for industrial training.

India: India offered in total 28 technologies of diploma in engineering. It offered total 6 general subjects and 6 Science subject in all technologies of diploma engineering. India offered 14% general subjects, 10% science subjects and 76% technical subjects in the diploma engineering course on average. Leather Technology offered the maximum percentage (more than15%) of General Subjects whereas Civil Technology offered the minimum (10.38%).

Pakistan: Pakistan offered in total 12 technologies of diploma in engineering. It offered total 7 general subjects, 4 Science subjects in all technologies of diploma engineering. Pakistan offered 12% general subjects, 16% science subjects and 72% technical subjects in the diploma engineering course on average.

Maldives: Maldives offered in total 7 technologies of diploma in engineering. Mechanical and Electronic technologies did not offer any General subject. On the other hand Architecture, Electrical, Electronics and Diploma in Contraction Management did not offer any Science subject. All the technologies offer maximum amount of Technical subjects. Electronic engineering offered 100% Technical subjects. Maldives offered 8% general subjects, 7% science subjects and 85% technical subjects in the diploma engineering course on average.

It is noticeable that all the countries offer highest percentage of Technical Subjects compare to other general subjects and science subjects. Maldives offered the maximum (85%) number of Technical Subjects whereas Bangladesh offers comparatively less amount of Technical Subjects. On the other

hand Bangladesh offered maximum number of general subjects (11 General Subjects). India and Pakistan offers nearly 75% of Technical Subjects. From the overall point of view it is revealed that all the countries offered maximum amount of Technical Subjects and minimum amount of Science Subjects and moderate amount of General Subjects. Among the countries Bangladesh, India and Pakistan have given more emphasis on the general subjects. These countries also included general subjects according to the local demand such as Bangladesh offered Bangla, Pakistan offered Islamiat which reflects their local demand.

To develop knowledge and skills for graduates, it would require assessable knowledge and continual disciplines. It is also necessary to generate tacit knowledge through sharing processes which meta-cognitive thinking occurs during the educational process [36]. General Courses serves this very well in the diploma engineering education framework. Incorporating general courses in diploma engineering education will help graduate developing the ability to respond critically to technological issues in civic affairs which is very essential in the context of the SAARC region.

Finally, all the SAARC countries should follow the proportion of general subjects proposed by the Accreditation Board for Engineering and Technology where at least 12.5% of engineering curriculum that had to be allocated to humanities and social science subjects [2]. In addition, nowadays English and communication skill are seemed to be very essential for all professionals. Diploma engineers are not an exception. To improve English and Communication skill of the diploma graduates, all the polytechnic institute may introduce an English Language Club.

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