COMPUTING AND INFORMATION SCIENCES IN INDIA: EDUCATIONAL ISSUES, POLICIES & POTENTIALITIES

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Abstract:
Computing is the driving force for the development and modernization. Apart from the Computing, many other subjects are also equally important and valuable for different sectors and domains. Indian Higher Education is changing rapidly, from the type of educational institutes to number of programs, nature of the programs etc. Traditional knowledge and context of computing education (i.e. from Computer Science) has been shifted over new age programs which are purely international in nature. The affairs of interdisciplinary sciences, also been improved in recent past as far as private universities are concerned. Many things have been changed in private universities regarding the course structures in Computer and Information Science. Though, many more are possible in coming days. This Chapter expressed a possible framework for the development and more progress not only of CS & IT but also the whole world of Computer & Information Sciences. This paper discusses in detail the areas of IT Systems Education in India with respect to Technical, Professional, Research based programs in a conceptual manner.
Key Words: IT Governance, Information Systems, IT Planning, R&D in India, Information Systems & Higher Education Systems

Introduction:
The education systems is changed in recent past and the field of Computing initially were started with the field of Computer Science and gradually other subjects have been added in the university systems due to the development of Research and Development (R&D) affairs. It is worthy that several applied subjects have been started to keep in mind the need of the industries and organizations. Universities and their types have been increased in recent decades and today the number touches 800+ *(Refer Table: 1 for the overview regarding Indian Universities and Table: 2 on Institute of National Importance).* Today many universities have been established under the category of private universities and deemed universities [1], [6]. As far as this study is concerned it has noted that many private universities have been added in recent years and the number touches 279 (as per the study). Importantly in the field of Computing also new subjects have been added like Computer Science and Engineering, Computer Applications, Computer Technology with the degrees of both Science and Technology i.e. B.Sc & M.Sc, B.Tech & M.Tech. Though, the field Computer Application is available in both Science (B.Sc-CA & M.Sc-CA) and another full-fledged nomenclature BCA & MCA. However it is important to note that the field is also comes with the degree in Engineering track (BE & ME). The development in Information space regarding the technologies lead the development of another domain called Information Technology and the field is available with Science (B.Sc & M.Sc), Technology (B.Tech & M.Tech) and Engineering (BE/ME) degrees [2], [3], [7]. Though internationally many other information related fields have been started but not yet started in university systems (not only in private universities) among these subjects few important are include

- ✓ Information Science
- ✓ Informatics
- ✓ Information Systems
- ✓ Information Science and Technology
- ✓ Information Management etc.

Though few deemed universities have started the program on Information Science with M.Sc degree and about 5 have started the degrees in the subjects Information and Communication Technology (ICT). It is important to note that few private universities have started Degrees leading to B.Tech/ M.Tech in Information and Communication Technology (ICT) as well. Moreover the fields of Bio Informatics, Health Informatics, Geo Informatics to Petro Informatics, Telecom Informatics also been started in recent past in the private universities. Though all these are not yet started in both the Science and Technology track in Indian Private Universities. Hence these programs may be started with Science (B.Sc & M.Sc), Technology (B.Tech & M.Tech) and Engineering (BE/ME) degrees [4], [5], [10]. The Computer Application (MCA) program is the highest manpower producing field in India with about 1 Lakh intake capacity [8], [9].

The program was started with applied nature by keeping in mind generation and development of the manpower having the abilities in application and system development. Though internationally universities have been started applied Computing related field called Information Technology with the focus on Database Technologies, Networking Technologies, Communication Technologies, Multimedia Technologies, apart from

common and traditional Software Technologies etc [5], [11]. Hence as far as Indian context initially as an applied field Computer Application program was started but still with the concentration on Software Technologies/ Development/ Engineering. Hence there is a possibility of introducing new components (of IT) focused Computer Application program leading to (BCA & MCA).

And moreover, the fields of Information Technology available in India also in private universities are similar to the Computer Application (just a few additional gradients). Though in recent past due to few private universities efforts a significant growth has been noticed in new age degrees and majors. Apart from these initiatives another noted on 'Collaboration' with the institutions and organizations in recent past [4[, [12].

Table 1: The overview regarding Indian Universities

Universities	In Numbers	Location
Central Universities	47	Pan India with 28 States and UT
State Universities	370	Pan India with 28 States and UT
State Private Universities	290	Except some states and UT
Deemed Universities	123	Except some states and UT

Table 2: Institute of National Importance

INI/ Higher Educational Institutions	In Numbers	Location
Indian Institute of Technology [IITs]	23	Bhubaneswar, Chennai, Delhi, Gandhinagar, Guwahati, Hyderabad, Indore, Jodhpur, Kanpur, Kharagpur, Mandi, Mumbai, Patna, Ropar, Roorkee and Varanasi
Indian Institute of Information Technology [IITs]	23	Gwalior, Allahabad, Jabalpur, Kancheepuram, Sri City, Guwahati, Vadodara, Kota, Trichy, Una, Sonepat, Kalyani, Lucknow, Dharwad, Kurnool, Kottayam, Manipur, Nagpur, Pune, Ranchi, Surat, Bhopal, Bhagalpur
National Institute of Technology [NITs]	31	Agartala, Allahabad, Arunachal Pradesh, Bhopal, Calicut, Delhi, Durgapur, Goa, Puducherry, Hamirpur, Jaipur, Manipur, Meghalaya, Mizoram, Nagaland, Jalandhar, Jamshedpur, Kurukshetra, Nagpur, Patna, Raipur, Rourkela, Sikkim, Silchar, Srinagar, Surat, Karnataka, Tiruchirappalli, Uttarakhand, Warangal
Indian Institute of Engineering Science and Technology [IIESTs]	1 (4 are in process)	Shibpur (West Bengal)
Indian Institute of Management [IIMs]	20	Calcutta, Ahmedabad, Bangalore, Lucknow, Kozhikode, Indore, Shillong, Rohtak, Ranchi, Raipur, Tiruchirappalli, Udaipur, Kashipur
Indian Institute of Science Education and Research [IISERs]	05	Calcutta, Mohali, Thiruvanthapuram, Pune, Bhopal
Other Central Funded Higher Educational Cum Research Institutes	Approximately 150+	Pan India with 28 States and UT

Suggestions and Core Possibilities:
There are various possibilities in respect of Computing and Information Science education systems in India. The following are some of the core issues and possibilities in this regard

Issues & Possibilities: 1
Internationally most of the universities have started different kind of subjects and areas in Information space such as
- ✓ Information Science
- ✓ Informatics
- ✓ Information Systems
- ✓ Information Science and Technology (IST)
- ✓ Information Systems and Management (ISM)
- ✓ Computer and Information Science (CIS)
- ✓ Information Management etc.

And in India these programs are not yet started but good number (40000+) of Higher Educational Institutes (HEIs) are established in India. Importantly many similar and related departments have been established with the nomenclatures CS, CSE, CA, IT in Science and Technology/ Engineering track and there these Information centric applied programs may be started.

Issues & Possibilities: 2

Skills are very much important these days. For each and every sector and track hands-on knowledge are required and as far as Computing and Information Sciences it is very much important and relevant. Initially (and still in most institutes) the Computer Science programs were started in India and still it has concentrated on different areas *viz. Theory of Computation, Compilers and Operating Systems, Computer Architecture & Parallel Processing, Embedded System, VLSI Technology, Theory of Computation, Numerical Methods, Automata Theory, Computer Graphics and Image Processing, Machine Learning with AI, Software Engineering, Visualization, Cryptography* and thus it is helpful in the organizations in the scientific affairs rather common IT Jobs.

Hence here it is worthy to note that a Major/ Concentration/ Specializations may be started in the areas of common Computer Science degree like B.Sc/M.Sc-CS (AI & Machine Learning), B.Sc/M.Sc-CS (VLSI & Microprocessor). Similarly the same approach and style may be adopted in other CS/CSE degrees like BE/B.Tech & ME/M.Tech. These areas of CS which are not so core of the field may be also offered as a Major/ Concentration/ Specializations in Computer Application programs viz. BCA/MCA (Computer Graphics & Animation) [6], [12].

In the areas of IT *(which is mainly consist with Database Technologies, Networking Technologies, Communication Technologies, Multimedia Technologies, Software Technologies etc)* also the Major/ Concentration/ Specializations may be offered in different stream Science and Technology with a program like B.Sc/M.Sc-IT (Database Technologies) or such as BE/B.Tech & ME/M.Tech-IT (Web Systems & Tech).

In the super specialty age several areas of IT have been emerged the in the industries and corporate sectors and few important of these are include

- ✓ Cloud Computing
- ✓ Virtualization
- ✓ Information Security
- ✓ Cyber Forensic
- ✓ Big Data Technologies
- ✓ Data Sciences
- ✓ Animation
- ✓ Computer Games
- ✓ Multimedia
- ✓ IT Infrastructure Management etc.

There are few universities have started above programs and degrees leading to B.Tech/BE & M.Tech/ME as a Specialization/Honors in the CSE track and few universities have started programs as a full-fledged specializations. In future such specialization may be started in other program and streams (Science) leading to the B.Sc & M.Sc viz. M.Sc-Cloud Computing/ M.Sc-Information Technology (Cloud Computing).

Issues & Possibilities: 3

Importance of Information in different sectors has been increased day by day in recent past. Similarly the role of Computing and Information Technology also been increased in almost all the sectors. Hence it is all about the requirement of Information Science (combination of information and computing/IT). In recent past this requirement has been lead the development (mainly in international universities) of various domain specific Information Science/IT/Informatics and among these few important are

- ✓ Bio Informatics
- ✓ Health Information Science/ Informatics
- ✓ Library Information Science
- ✓ Geo Information Science
- ✓ Business Information Science
- ✓ Environmental Information Science
- ✓ Quantum Information Science etc.

In India only few domain centric Informatics/IT programs has been developed and among these few important are include Bio Informatics, Geo Informatics, Health Informatics. It is a fact that in other areas also such field may be developed as there are enormous jobs/ markets available in different degrees. Moreover like CS/CSE/IT the programs on Domain based Informatics/IT may also be started viz. B.Sc/M.Sc/BE/B.Tech /ME/M.Tech in Health Informatics/Eco Informatics/ Business Informatics. In some of the fields where domain based Informatics/IT are available in full-fledged manner may be started in specialization/ major/ concentration (i.e. M.Tech-IT (Business Informatics). In other context the field may also be started as full-fledged manner i.e. B.Tech/M.Tech-Health Informatics/Information Science.

Issues & Possibilities: 4

Collaboration is another important issue in Computing and Information Sciences. As the field in broad enough and interdisciplinary in many cases so that it needs collaboration in various space for the solid development. In case of Engineering and Professional Subjects/ Degrees the collaboration may be undertaken

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with other business/ field specific institutions and organizations for collaborated programs and joint programs. Where a part or partially may be offered by both the venture for real-life and Hands-on experiences.

However in some cases the degrees and subjects may be offered with other academic institutes and universities; here joint degrees may be offered by multiple institutes. There are many HR based organizations developed and reputation in recent past and they are offering various collaboration for the new and emerging experiences and here there are huge potentialities to offer the professional Information Science programs. Even in domain centric program also collaboration is required for example M.Sc-Health Informatics may be undertaken in the Healthcare and Hospital settings.

Issues & Possibilities: 5

Inter linkage is another important issue for the development and modernization of Computing and Information Science academics. More clearly if related departments are exists for example Computer Science/CSE, Computer Application Information Technology they may be uses their resources based on requirements. These may include sharing of manpower, infrastructures, technologies and more. For the case of Domain centric Informatics also Information Science programs may be started viz. for Geo Information Sciences the institute may take the cooperation from the Geo Sciences/ Geography related departments.

Issues & Possibilities: 6

The development of broad and applied fields requires proper and sufficient funding and finance and as far as Computing/Information Sciences it is very much important and required for the manpower development, infrastructure, technologies and application.

Issues & Possibilities: 7

The study has been conducted with a case of private universities and among these institutes growth is noticeable. Though government supports and initiatives are always important and valuable. As far as Information Sciences academic units are concerned it is important and urgent that government should take proper steps for the establishment of new age programs, specializations, majors and collaboration with other organizations and corporations.

Issues & Possibilities: 8

Still the development of Computing and IT programs/ fields successively running in the private sectors and in Government sectors also the universities and HEIs may started the programs, new age skilled degrees, domain specific programs, joint programs etc.

Digital India and Computing/Information Sciences:

To support the development of smarter systems and new age systems, The Government of India has been launched 'Digital India' program for the building of an IT enable information society. In 'Digital India' project most areas are associated with the Information Technology and Computing and thus it is highly associated with the right, available and skilled manpower. All the agenda and programs (but not limited to) under the Digital India mentioned bellow are IT and Computing depended

- ✓ Broadband Highways.
- ✓ Universal Access to Mobility.
- ✓ Public Internet Access Program.
- ✓ E-Governance-reforming Government by the technology.
- ✓ E-Kranti-the electronic delivery services.
- ✓ Information for All.
- ✓ Electronics Manufacturing.
- ✓ IT for Jobs.
- ✓ Early Harvesting Program.

Hence manpower only from the traditional Computer Science, Computer Application and Biased Information Technology programs may be difficult enough to prepare ready and skilled human resources and thus universities need to produce skilled and emerging manpower in this field viz. Cloud Computing, Virtualization, Information Security, Cyber Forensic, Big Data Technologies, Data Sciences, Animation, Computer Games, Multimedia, IT Infrastructure Management etc.

Moreover the broad subjects other than CSE/CS, CA. IT are also solicited for the solid and healthy growth and among these areas some important are include but not limited to the following—

- ✓ Information Science (B.Sc/M.Sc/B.Tech/M.Tech)
- ✓ Informatics (B.Sc/M.Sc/B.Tech/M.Tech)
- ✓ Information Systems (B.Sc/M.Sc/B.Tech/M.Tech)
- ✓ Information Science and Technology (IST)- (B.Sc/M.Sc/B.Tech/M.Tech)
- ✓ Information Systems and Management (ISM)- (B.Sc/M.Sc/B.Tech/M.Tech)
- ✓ Computer and Information Science (CIS)- (B.Sc/M.Sc/B.Tech/M.Tech)
- ✓ Information Management (B.Sc/M.Sc/B.Tech/M.Tech) etc.

Conclusion: With this study it has been possible to learn about the characteristics of Computing and Information Sciences including how Computer Science, IST were formed including the main benefits of

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'Information Sciences' particularly to the community or society. It is also possible for the drawing out the basic differences between Computer Science, Computer Application, IT and IST and judge the key value of Information Sciences for the professionals and academic field. The study helps a lot to learn about the Higher Education Systems in India with reference to the Private Universities. It helps in exploring the current nomenclatures, degrees, programs etc in the private universities it has also valuable due to exploring the status of skill based subjects, programs etc in Indian private universities [8], [12]. It has significance to know about the domain specific Information Science and its availability in Indian academia in isolated manner. Emerging programs started in the private universities in Computer Applications also been studied with special reference to the possible skill based program and also domain specific programs. The study helps in private universities offering Engineering Degrees with emerging specialization with possible skill based programs and domain specific programs. A clear picture has been framed regarding research degrees specifically in the field of IT and Computing in India emphasizing Private Universities. The current status of collaborated, industry integrated programs started in Private universities is important affairs that we learn about this in-depth study in the fields of IT and Computing. The concept of Lateral Entry Scheme in Indian Private Universities leading to the fields of Computer Science, Computer Applications also a vital point in higher education systems in India. Multiple duration based Computing/ CA programs in Indian Private Universities also been offered. The changing flexibility in IT and Computing related programs and subjects offered in Private Universities also an important issue. India is moving towards more digitally equipped and IT associated nation and thus Digital India initiative also undertaken and thus we need a solid and efforts in building multiple entities. In this regard collaboration with the organizations, institutions and proper funding, initiation of newer subjects, programs are highly solicited. Hence here solid and ready manpower etc are very much required. Hence for building a true and modern nation (may be Digital India) and society (including for a Digital Economy) the proper and allied technologies is very much required and here in this context ready and new age programs, subjects, educational models are important and valuable.

References:
1. Basak, S. C., & Sathyanarayana, D. (2010). Pharmacy education in India. American journal of pharmaceutical education, 74(4), 68.
2. Dayal, I. (2002). Developing management education in India. Journal of management Research, 2(2), 98.
3. Desai, S., & Kulkarni, V. (2008). Changing educational inequalities in India in the context of affirmative action. Demography, 45(2), 245-270.
4. Gereffi, G., Wadhwa, V., Rissing, B., & Ong, R. (2008). Getting the numbers right: International engineering education in the United States, China, and India. Journal of Engineering Education, 97(1), 13-25.
5. Gupta, D., & Gupta, N. (2012). Higher education in India: structure, statistics and challenges. Journal of education and Practice, 3(2).
6. Paul, P. K. and Bhuimali, A. and Aithal, P. S., (2017). Indian Higher Education: With Slant to Information Technology- a Fundamental Overview. International Journal on Recent Researches In Science, Engineering & Technology, 5(11), 31-50.
7. Paul, P. K., Aithal, P. S. and Bhuimali, A., (2017). Computing & Allied Engineering Domain in India with Reference to Private Universities: A Case Study of Bachelors Programs, International Journal on Recent Researches in Science, Engineering & Technology, 5(11), 51-63.
8. Paul, P. K., Aithal, P. S. and Bhuimali, A., (2017). MCA (Information Science and Management): The next Generation Interdisciplinary Specialization for Better Social Informatics and Digital Humanities Practice. International Journal of Scientific Research in Mathematical and Statistical Sciences, 4(5), 27-32.
9. Supe, A., & Burdick, W. P. (2006). Challenges and issues in medical education in India. Academic Medicine, 81(12), 1076-1080.
10. Tilak, J. B., & Varghese, N. V. (1991). Financing higher education in India. Higher Education, 21(1), 83-101.
11. Tilak, J. B. (2008). Transition from higher education as a public good to higher education as a private good: The saga of Indian experience. Journal of Asian Public Policy, 1(2), 220-234.
12. Umashankar, V., & Dutta, K. (2007). Balanced scorecards in managing higher education institutions: an Indian perspective. International Journal of Educational Management, 21(1), 54-67.