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TOWARDS PROCESS MATURITY IN ACCREDITATION OF ENGINEERING PROGRAMMES WITH SPECIAL REFERENCE TO THE NBA ACCREDITATION

Abstract:

Adoption of systems and processes that focus on improvement in design and delivery of Outcome Based Education (OBE) is a concern of many engineering institutes who either go in for or intend to apply for accreditation of engineering and technology programmes. This need emerges out from the fact that in India the engineering programme accreditation agency, the National Board of Accreditation, Delhi, does not prescribe any specific approach to process improvement methodology, and that part of process design, implementation and improvement is left to individual institutes who apply for programme accreditation. As a result institutes who have robust and mature processes in use for implementation of accreditation system are still scarce. This paper proposes an extension of business process maturity model as used in software engineering and the eMM 2.3 which is used in e-learning to ensure quality in design and implementation of accreditation process.

Keywords:

Engineering Accreditation, Process Maturity, eMM 2.3, Software Engineering Maturity Model in Engineering Education, NBA Accreditation Process maturity

JEL Classification: C18, I23, I29

Introduction:

In a country of nearly 790 thousands of enrollments in undergraduate engineering programmes every year, the NBA is charged with responsibility of ensuring minimum acceptable level of quality through laid down accreditation processes. However, as per the AICTE, the regulator of engineering education in the country, hardly 10 % undergraduate programmes are accreditated in various engineering institutes across the country. Now, AICTE has also decided that by 2022, at least 50 per cent UG programmes will be accreditated. This is not only a challenge for the NBA to address but also brings about a need to design systems and processes that do not leave margin of error in judgment of quality. This will only be possible if the process design is robust. It can be done if a formal approach to ensuring better process design is used.

After becoming a member of the Washington Accord signatory group of countries, the National Board of Accreditation, Delhi, India [1] has been continually refining various aspects of accreditation parameters for diploma, Under Graduate and Post Graduate programmes in engineering as part of the system that keeps on evolving to improve the quality of accreditation system and processes. In several instances of accreditation exercises which were carried out in various institutes of the country it is observed that not all institutes design their accreditation processes which are complete in terms of process dimensions, and its implementation. This leaves scope for gaps in process design, and the benefit of getting the accreditation of programmes does not come to them early. A robust process design methodology is therefore needed to eliminate chance factor in ascertaining quality of accreditation processes.

In this paper an attempt is made to adopt the concept of process maturity as used in software engineering, and in quality assurance of e-learning, specifically eMM 2.3, to show that with modifications the established models can be used to ensure quality in design of accreditation related process in engineering programmes.

Accreditation Criterion of UG engineering programmes: The NBA, New Delhi uses following ten criterion in accreditation of UG-engineering programmes.

Criterion 1: Vision, Mission and Program Educational Objectives (60)
Criterion 2: Program Curriculum and Teaching–Learning Processes (120)
Criterion 3: Course Outcomes and Program Outcomes (120)
Criterion 4: Students' Performance (150)
Criterion 5: Faculty Information and Contributions (200)
Criterion 6: Facilities and Technical Support (80)
Criterion 7: Continuous Improvement (50)
Criterion 8: First Year Academics (50)
Criterion 9: Student Support Systems (50)
Criterion 10: Governance, Institutional Support and Financial Resources (120)

In place of giving details of all criterions, details of the criterion 2 are given here for sake of brevity. This criterion includes two sub-criterion viz. 2.1 Programme Curriculum, and 2.2 Teaching-Learning Processes. The NBA design further breaks the sub criterions in to 2 and 5 processes respectively. These are listed below.

2.1 Programme Curriculum

2.1.1 State the process used to identify extent of compliance of the University curriculum for attaining the Program Outcomes (POs) & Program Specific Outcomes (PSOs), mention the identified curricular gaps, if any

2.1.2 State the delivery details of the content beyond the syllabus for the attainment of POs & PSOs

2.2 Teaching-Learning Processes

2.2.1 Describe the Process followed to improve quality of Teaching Learning

2.2.2 Quality of internal semester Question papers, Assignments and Evaluation

2.2.3 Quality of student projects

2.2.4 Initiatives related to industry interaction

2.2.5 Initiatives related to industry internship/summer training

For the processes of the two sub-criteria each applicant institute / college is expected to evolve its own process design to ensure that the desired output is achieved. In practice it is seen that across various institutes process design significantly varies and so also quality of output. Hence, there is need to use a methodology to design and implement mature process in institutes.

Case for mature processes:

Initially process design and maturity models were introduced in software development industry. Capability Maturity Model (CMM) [2] and Capability Maturity Model Integration (CMMI) [3] were put in practice. Numerous developments in process designs have taken place since then. A review of some of these developments may be seen in [4]. In the context of information systems, it is stated in [4] that the business process is the set of procedures or ways to organize the sequence for transforming inputs in outputs. In other words it is a set of tasks or activities performed to achieve a specific purpose or a particular result [5], to produce a particular product or service [6].

In 2.1.1above, it is ‘curriculum gap analysis process’ that is used to identify extent of compliance of university prescribed curriculum for attaining the Programme Outcomes (PO), and Programme Specific Outcomes (PSO). The output of this process will be in form of ‘identified content, practicum, practices, and / or behaviors’ which must be made part of ’teaching-learning’ for attainment of the requisite POs and PSOs of the undergraduate programme. It is seen in practice, different colleges approach it differently, and their actions may be classified in one of the following cases.

- There is no formal process used for gap analysis
- Process used does not connect to attainment of POs, and PSOs.
- Used process is incomplete and can partially leads to attainment of some POs, and PSOs.
- Used process meets requirement to attain all POs and PSOs, but in part only.
- Used process leads to attainment of POs, and PSOs, but is not effective and efficient.
- Used process leads to attainment of POs, and PSOs, and is effective and efficient.

The fact that many colleges start without specifying a formal process for gap analysis and do it in ad hoc manner, yet there are others who fall somewhere in between the two ends of process maturity from ad hoc to efficient processes. The case of a college having efficient processes in

place is scarce. This matches with the process maturity description of [3, 7] quoted in [4] that process maturity is an evolutionary improvement path from immature or ad hoc processes, to mature, disciplined, with improved quality and efficiency.

To an institute / college, currently functioning with Input centric approach what options are available to prepare for Outcome Based Education and subsequently for the NBA accreditation? As a shift from input centric systems to Outcome Based Education(OBE) is a major reform, use of proven models which can be adapted to conform to fulfill requirement of processes as per the NBA criterions is suggested. However, in practice from evaluation visits data it is seen, that colleges start process design in ad hoc ways on the basis of their own perceptions. So much so that in some cases even formal description of processes becomes vague. Therefore, in line with [6], range of work activities, information and knowledge and its sequence of operations must be clearly stated first in order to produce a particular product or service. This is applicable to all the processes falling with in various criterions of the NBA. Further improvement of the designed processes should be made part of initial design that goes on to serve the requirements of Criterion 7: Continuous Improvement too. Again a systemic approach is needed for process improvement. In fact, essence of accreditation system and process design is 'Improvement' only. It starts with improvement in initial systems, in this case input centric, to become outcome based, and has to go on evolving to become fully OBE compliant.

Systemic study of process improvement has been done in variety of ways earlier. Kulpa and Johnson [8] have summarized these into five categories: Business Process Reengineering, Benchmarking, Process engineering/workflow management, Reverse Engineering and Model Based Process Improvement. This study adopts a hybrid model that uses conventional Process Maturity Model and eMM2.3 based approach. The latter is described in [9]. We propose use of Conventional Process Maturity Model for Curriculum Development and eMM2.3 Model for Teaching-Learning Processes. For this purpose we provide process details of the two cases below.

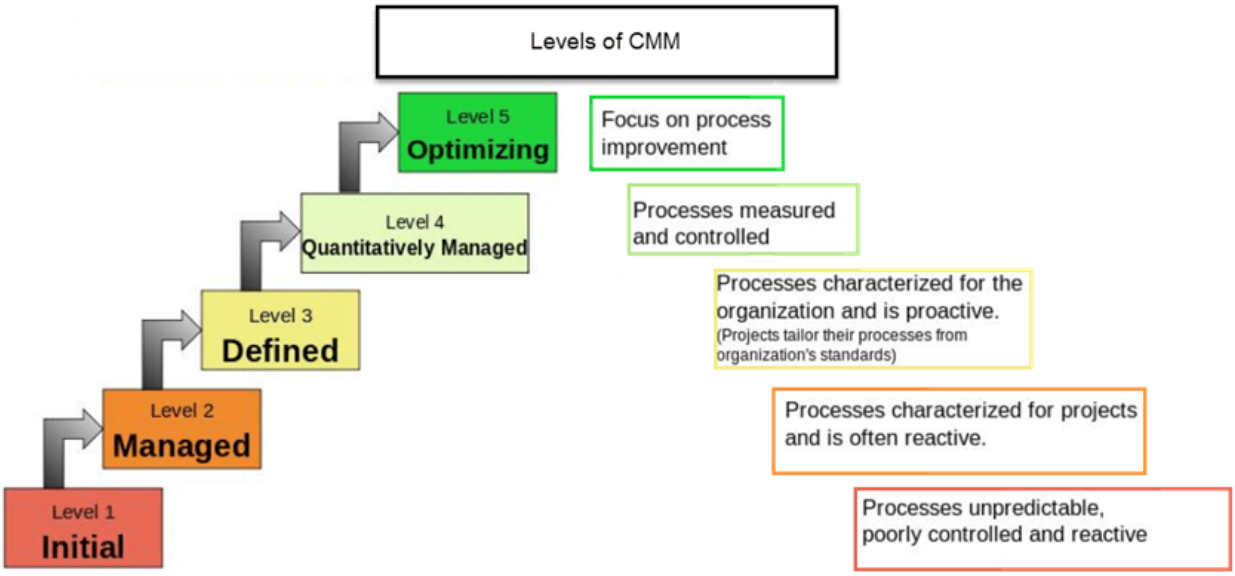
Conventional Software CMM and Curriculum Development Process Model:

The CMM has five levels as listed below.

1. Initial
2. Repeatable/Managed
3. Defined
4. Quantitatively Managed
5. Optimizing

A diagram as given in [10] and shown Figure: (1) depicts the five stages of the models as follows.

Figure 1: Five levels of Capability Maturity Models (CMM)



Source: CMM Levels ***https://www.guru99.com/capability-maturity-model-cmm-cmm-levels-a-fool-s-guide.html***

In context of Curriculum Development the five levels, their associated activities, and their benefits may be stated as shown in the Table (1) which is adapted from [10].

Table 1: CMM levels and associated activities as applicable to Curriculum development

Levels	Activities	Benefits
Level 1 Initial	• At level 1, the curriculum development process is usually chaotic and ad hoc • A capability may be characterized on the basis of the individuals choices and not of the any laid down process • Progress not measured • Curriculum developed often widely varies against requirements of	None. A developed curriculum is Total Chaos

	Programme Outcomes.	
Level 2 Managed	• Requirement of Programme Outcomes (POs) is addressed/ managed • Curriculum development components and processes are defined • Identify and control component proper mix, etc. • Processes may differ between different levels of curriculum development projects, e.g. for diploma, UG, and PG programmes	• Processes of curriculum development become easier to comprehend • Education managers and curriculum developers / faculty and experts spend less time in explaining how things are done and more time in executing it • Quality is integrated into development process • Costing might be high initially but goes down overtime
Level-3 Defined	• Clarify requirements of Programme Specific Outcomes (PSOs) • Comprehend curriculum design requirements of Tier-I and Tier-II institutions including gap-analysis for Tier-II colleges against university prescribed curriculum, develop an implementation process • Makes sure that curriculum meets the POs and PSOs requirements and helps in attainment of stated Programme Educational Objectives (PEOs). • Analyze decisions systematically • Rectify and control potential problems	• Process Improvement becomes the standard • Curriculum development progresses from being "compiled from various sources" to being "engineered" • Quality appears at various stages in the development project with the involvement of entire team in the process • Risks of developing a proper curriculum are mitigated
Level-4 Quantitatively Managed	• Manages the curriculum development project's processes and sub-processes qualitatively and quantitatively • Understand process performance, qualitatively and quantitatively manage the curriculum project	• Optimizes Process Performance across the institution • Fosters qualitative & quantitative curriculum development in an institution.

Level-5 Optimizing	• Detect and remove the cause of defects early • Identify and deploy new teaching-learning and assessment tools and process improvements to meet POs, PSOs, and PEOs.	• Fosters Institutional Innovation, development and Deployment • Gives impetus to Causal Analysis and Resolution

Source: CMM Levels ***https://www.guru99.com/capability-maturity-model-cmm-cmm-levels-a-fool-s-guide.html***

eMM2.3 Model for Teaching-Learning Processes

Accreditation of engineering programmes encourages use of ICT in teaching-learning. Teaching-learning processes, in general, and ICT enabled teaching-learning (T-L) , in particular, require use of an effective approach to T-L process management to ensure use of matured process models for reduced use of ad-hoc approaches, hence use of eMM 2.3 is suggested. Defining T-L processes of an engineering programme, therefore, improves the overall ability of institutions to perform well in given process area. This helps in bringing in overall effectiveness in teaching-learning of a programme. A simple schematic depiction of eMM 2.3 may be stated in terms of five process categories related to teaching-learning including e-learning are as under.

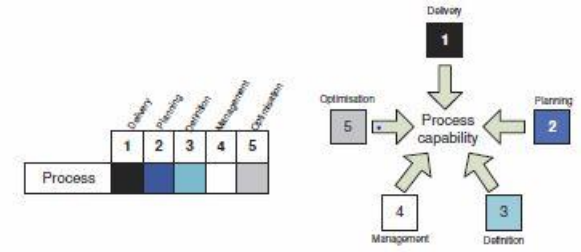
eMM 2.3 Model:

- **Learning**: L1 to L10 i.e. 10 processes that directly impact on pedagogical aspects of e-learning
- **Development**: D1 to D7 i.e. 07 processes sourrounding the creation and maintenanace of e-learning resources
- **Support**: S1 to S6 i.e. 06 processes sourrounding the support and operational management of e-learning
- **Evaluation**: E1 to E3 i.e. 03 processes surrounding the evaluation and quality control of e-learning through its entire lifecycle
- **Organization**: O1 to O6 i.e. 06 processes associated with institutional planning and management

Process Dimensions and Levels of each dimension:

Each process may have five dimensions to it. These are: Delivery, Planning, Definition, Management and Optimization. Roni, H. [11] depicts these dimensions as shown in figure (2).

Figure 2: Five Process Dimensions



Source : Development of Higher Education E-Learning Using E-Learning Maturity Model (eMM), Roni, H. [11]

Table 2: Process, Process dimensions, and Practice levels

Process Dimension ☛	Delivery	Planning	Definition	Management	Optimization
PROCESS ☟	Practice level:	Practice level	Practice level	Practice level	Practice level
	Fully Adequate (3), **Adequate** (2), **Partially Adequate** (1), **Not Adequate** (0), **Not Assessed** (-)'				
Learning: L1..L10	3	2	1	0	--
Development: D1..D7					
Support: S1..S6					
Evaluation: E1..E3					
Organization: O1..O6					

Within process dimensions, each process is further broken down in five different 'Practice Levels'. These vary from 'Fully Adequate, Adequate, Partially Adequate, Not Adequate, to Not Assessed', as shown in the Table (2). Implementation of these eMM processes in various dimensions to a practice level as seen through study, provides exact status of an institution w.r.to teaching-learning combined with e-learning.

eMM 2.3 and Accreditation Process Models Gaps and Further Work:

National Board of Accreditation, Delhi [1] describes the criteria 2 on 'Process followed to improve quality of Teaching Learning', in accreditation of UG-Engineering Programmes of tier-I institutions, in which following processes/aspects figure prominently.

- Use of various instructional methods and pedagogical initiatives
- Processes to support weak students and encourage bright students
- Quality of classroom teaching
- Conduct of experiments
- Continuous Assessment in the laboratory
- Student feedback of teaching learning process and actions taken

Above processes clearly render themselves for development and implementation of sound and matured processes on part of institutions to be able to produce credible evidence for accreditation of the programmes. Through interactions at various levels of academic functionaries in engineering institutions it emerged that these areas require considerable work to design and implement the eMM 2.3 levels of process maturity.

Conclusion:

Institutions applying for programme accreditation to the National Board of Accreditation, Delhi need to follow systematic approach to process improvement for implementation of certain practices that are vital for ensuring effective implementation of outcome based education through optimization of sequence of activities for improvement of their result. Of the several approached to process improvement Maturity Model Based Process Improvement has drawn considerable attention.

Maturity levels guide the evolution of an organization from a state in which practices are poorly defined and incoherent to a level of innovation and continuous optimization. Through this study a hybrid process maturity model for curriculum development and teaching-learning process evolution in context of Programme Accreditation by the NBA, Delhi is presented that guide their evolution from a state of immature or ad hoc processes, to mature, disciplined, with improved quality and efficiency. It is seen that engineering institutions need to make concerted efforts to reap benefits from this evolutionary design, leading to evidence of sound practices for accreditation of engineering programmes by the NBA, Delhi.

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