Process Management Model for Higher Education

Improvement of Educational Programs in Software Quality

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Abstract— **This paper presents a Processes Management Model for Higher Education (PMMHE) characterization. With the PMMHE is possible to produce a comparative measurement system (benchmarking) of organizational, tactical, logistical and operational processes for formation, training and coaching programs in higher education institutions. The current PMMHE's release has impact on engineering programs and emerges as a strategy of the Colombian Government in its effort to articulate the university and industry, particularly the software industry and education of software engineering and their related areas at technical, technological and professional levels. The model is defined as knowledge management tool, which provides a scenario of variables and requirements classified by process categories and areas, practices, resources and products of processes, in which the institutions can to develop assessment practices to exchange resources, knowledge assets and best practices. This scenario is seeking to promote the establishment of a process improvement environment in higher education programs of engineering. It is very important to emphasize that the model's strategy is the transition from the subjective to the objective, for obtaining impact and spread and internalization knowledge, beyond the mission statement of institutions. This derivation from hypotheses to the thesis supported in facts, leads the formal use of statistical process control for knowledge management which includes the measurement systems analysis and collect measures about teaching - learning collective and individual processes under constantly balancing between the theory and the practice about the scientific and professional aspect. Also, this paper presents the lessons learned and the assessment for applying the model to 58 companies and 5 institutions of higher education related with the software industry in Colombia.**

Keywords- Process Maturity Model in Higher Education; Measure Systems for Higher Education, Knowledge Management in Higher Education.

I. INTRODUCTION

In the last 10 years, one of our lines of research work has been the development of quality management systems applied in higher education. The focus of our research is the several adaptations of software engineering's innovation frameworks [3], particularly, CMMI, ITIL, PMI, SWBOK, SPICE and ISO (12207-20000-15504...).

Due that academic community at university-level in Colombia are using information and communications technologies (ICT's) in their certification processes for their higher education programs, in great part achieved with our work, currently our actions are pursuing in way of get that the higher education institutions are developing strategies to formalize processes for management, authoring, instruction and assessment of the university programs offered in Colombia.

The document is divided into seven sections. In the first part, we establish introduction and organization of this paper.

In the second part, we provide an overview of the process and competences paradigms that allow defining the different kinds of educational processes. This way, the educative programs appears with organizational, primary, support and adaptive processes. Additionally, we present an overview of the three different studies that support the model proposed: Academic and Administrative Management of Educative Institutions, Quality Assurance System for Higher Education and Software Quality Colombian Network. Finally we establish the research problem we are trying to solve the model and the applications discussed in this paper.

In the third part, we propose that, if the educational programs are in crisis, a paradigmatic change as a discipline is required and we propose the management by processes support in competences for that change. In addition, based on maturity models arguments, we assume that all paradigmatic change can only be possible adopting a critical attitude and then promoting a new paradigm. This part ends with describing the specifications and architecture of the Academicals Programs Framework: Knowledge assets management; Authoring, Development and Maintenance; and, Instruction, Certification and Professional practice.

In the fourth part, we exemplified by a studies case of on how it is adapting the PMMHE framework in training non-formal programs in state institutions and undergraduate and graduate programs in various universities in Colombia. In addition, we reflect briefly on the scope and utility of this framework as benchmarking tool. The application of PMMHE demonstrates that the software paradigms are adaptable in different environments

In the fifth part, we explore the future trends we consider promising for research in the short term: Higher Education Accreditation and Assessment, Personal competences certification and Peers School.

Finally, in the sixth and seventh parts, we present the Conclusions, Acknowledgments and References of the paper.

II. BACKGROUND

A. Relationship beetween Process and Competences Models.

Processes are generally defined as "a set of interdependent tasks transforming input elements into products" [1]. A process generally comprises the following elements [2]: a purpose; the responsibilities of the participants in the process and their duties; the entrance criteria for the elements or conditions needed to begin the process; the inputs (artifacts, information or material) needed to perform the process; the activities, tasks or actions which make up the process; the outputs (artifacts or assets) that result from produced or modified by the process; the exit criteria (elements or conditions) needed for process completion; the process measures that support the process performances or future performances; tools, techniques and knowledge used in enactment the process; the adaptation patterns for tailoring the process in several contexts; the interfaces with others processes; and, records of information to future use.

We have [4] renamed (Fig. 1) the inputs and outputs as input resources, process and product. The input resources may be of use, consumption or transformation. The output resources include products and information. Use resources are used as service functions to the process. The consumer resources are materials that will be consumed during the process. The service functions are performed by roles and each role has competence units (CU) and each CU is associated with the activities of the process. A process can be atomic or compound. The atomic process consists of tasks of direction (leading and management), support, primary and adaptation (instantiation through planning and performance). A composite process consists of sub-processes that can also turn are direction, support, primary and adaptation processes. The politics of the processes includes the objectives and the business rules for each resource category. The scope, knowledge and quality of the process and its products, is seen around all types of resources and is established through the functional and nonfunctional requirement [5] that define them.

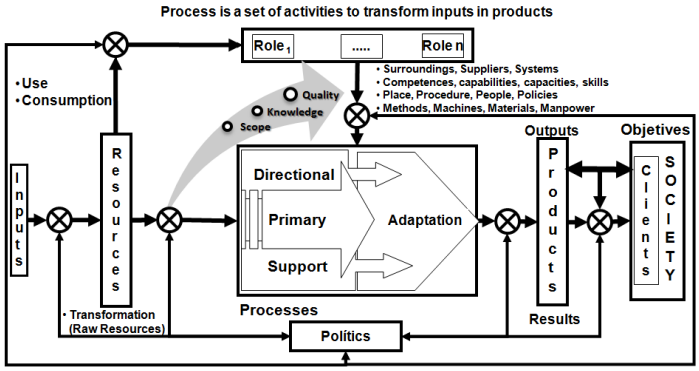


Figure 1. Process Model [4]

A special role belongs to human resources when they are assigned and are responsible for the implementation of relevant activities of the processes. In our work, the role is associated with the units of competence, which are closely linked to the people performance in the processes. This fact raises the competences assigned to the roles of individuals are vital and interdependent with the processes.

B. Academic and Administrative Management of Educative Institutions

In order to establish a collaborative (all for one) and cooperative (one for all) network was conceived the GAYA Project [6] (Fig. 2) as Colombian educative sector unit. This unit was appreciated as a system supported in new telecommunication technologies and different educative agents (entities, government and communities). This unit was developed to model, share, deploy, monitor and make consensus in the different knowledge associated with the educational processes, mainly in aspects as to make and to establish the insurance and model politicians of quality processes about configuration and requirements of inputs, resources and products and/or services.

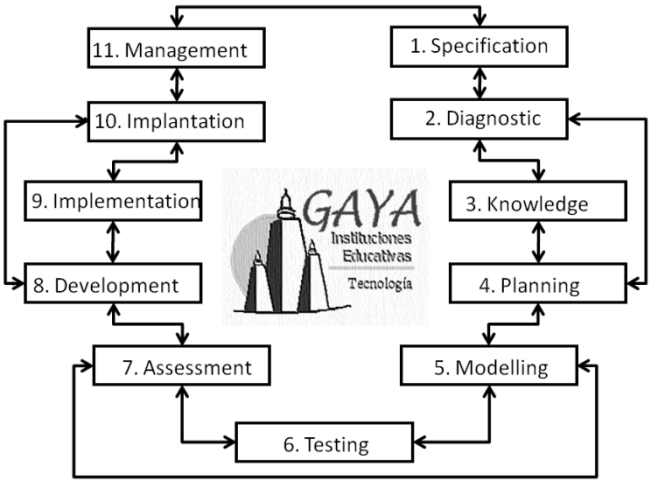


Figure 2. GAYA Model [5]

GAYA is a process to develop an educational institution in five levels:

1. Recognized State: An educational program is in a recognized state when indirect communications features or inadequate, quality management and process implementation limited and inconsistent relationship with users and providers. Processes are ad hoc and even chaotic. Few processes are defined and success depends on individual effort.

2. Normal State: An educational program is in a normal state if it has basic processes to track costs, plans, programs, agendas and functionality. The discipline in this state repeats early successes processes in similar applications.

3. Formal State: An educational program is in a formal state of formalization, whether the activities and administration are documented and integrated as standard processes in the school. Thus, institutional

activities, is developed and maintained, usually using approved procedures.

4. Managed State: An educational program is in a managed state when there are standard measurements about features about resources. Thus, the processes are quantitatively and qualitatively understood and controlled.
5. Optimized state: An educational program is in a sate optimized, when it makes continuous improvement through quantitative feedback, valued in the process.

The processes carried out to climb each of the levels are summarized in the Table I and fig. 2.

TABLE I. PROCESS TO GO THROUGH THE GAYA´S LEVELS

Process	Description
1. Implantation	Identification of needs for determination processes of development
2. Diagnostic	Establishing criteria for selecting organizational entities to model and training needs assessment and knowledge of human resources in the process.
3. Knowledge	Determining organizational entities candidates, for selecting the organizational entity and human resource development will intervene in the process that will be modelled.
4.Planning	Planning scope, policies, objectives, activities and resources required to implement the process on the selected organizational entity in Phase 3.
5. Modellling	Development of an organizational entity modeling pilot using the software.
6. Testing	Simulation or execution of pilot.
7. Assessment	Evaluation of pilot test, which decides whether to continue with step 8 and repeat the steps 5, 6 and 7.
8. Development	Scheduling and resource allocation for mounting the organizational entity modeled, tested and validated in stages 5, 6 and 7.
9. Implementation	Implementation of the organizational entity according to the programming stage 8.
10. Implantation	Training and Installation of the organizational entity produced in step 9.
11. Management	Administration and Organizational use of the entity-mounted stage 10.

Through the GAYA project was possible to establish the need to define and establish a quality management system for the higher education institutions. This need was referred to the National Education Ministry of Colombia when we presented the results of the pilot project about five Colombian universities. The event was the beginning of a new project: Quality Assurance System of Higher Education (In Spanish "Sistema de Aseguramiento de Calidad para la Educación Superior" – SACES -. SACES is described in the next section.

C. *Quality Assurance System for Higher Education (SACES)*

This project created the SACES System for Colombian Higher Education Institutions (HEI) [7] automatically perform the steps associated with the registration and qualified institutional type processes as: Legal personality recognition, Approval of feasibility study for public higher education institutions, Institutional character change, Recognition as a university, Redefinition for offering preparatory courses and Authorization for creation of institutions. With this process-driven system the presidents of educational institutions can apply the qualified and track record in each of the stages and requirements: Filing, Assignment of pairs, pairs Visit, Evaluation, and Resolution Rules.

The SACES (Fig. 3) is the first process management system that has the Colombian National Education Ministry that manages roles and responsibilities within the process. Specifically, the system has the following processes which are pre-defined roles (Table II) and on which it is possible to establish performance statistics and process and product quality.

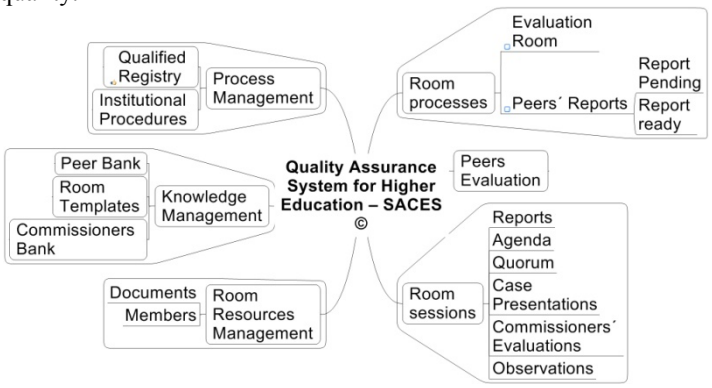


Figure 3. SACES [7]

TABLE II. PROCESSES AND ROLES IN THE SACES

Process	Roles
Process Management • Qualify Registry • Institutional Procedures	Presidents of Institutions System Manager Leader Manager Legal Operator Verifier Operator
Knowledge Management • Peer Bank • Room Templates • Commissioner Bank	Room Secretaries System Manager Leader Manager Verifier Operator Academic Peers Academic Commissioners
Room resources Management • Documents • Members	Presidents of Institutions Room Secretaries System Manager Leader Manager Legal Operator Verifier Operator Academic Peers Commissioners
Room Sesions • Evalution Reports • Commissioner Reports • Peers Reports • Validatios	Room Secretaries Academic Commissioners

Although SACES processes are ISO9000 certified and who use the system do it like a social network, the owners and users have identified the need to formalize the competences to enhance and certify the performance of those using the system. One of the actions to undertake in the short term is the creation of the peer's school to improve verification visits to the institutions.

SACES operates within the legal framework that is supported and verified by academics peer institutions to meet the quality legal requirements. Such conditions are classified as program and institutional Terms.

The program quality terms are: Correspondence between the name of the program, curriculum content and achievement of goals; adequate reason for existence of the academic program; a curriculum; Activities that strengthen academic knowledge; Adequate training in research; The proper relationship with the external sector; Number and quality of teaching personnel; Educational media for teaching; Physical infrastructure in classrooms, libraries, auditoriums, laboratories and spaces for recreation and culture.

The Institutional terms are: Selection and evaluation of students and teachers; Existence of a formal administrative and flexible structure; Self-assessment culture; Graduate program; Institutional Welfare in health, culture, living, recreation and economic and labor conditions; Adequate resources to ensure compliance with quality goals, welfare and ability to project into the future, according to the needs of the region and country.

SACES system as a whole that detects weaknesses around the terms of quality though failing to analyze the processes and resources (including the skills of those involved), thus, the institutions do not yet demonstrate the quality of its processes and one notes the need to go down to the process performance and quality of results to truly determine the quality requirements at all levels.

D. Software Quality Colombian Network

The Colombian Network of software quality (RCCS) [8] (fig, 4) is a knowledge management tool based on an engineering model, which seeks to strengthen the national software industry and related services supported in software quality standards and international specifications.

The RCCS has been designed in response to the call of SENA and COLCIENCIAS to Support the Strengthening of National Capabilities in Software Quality, as an area model to facilitate the collective construction of knowledge part of the various agents involved, with the initial purpose of facilitating the process of implementing CMMI [9], adapted to the culture and national context.

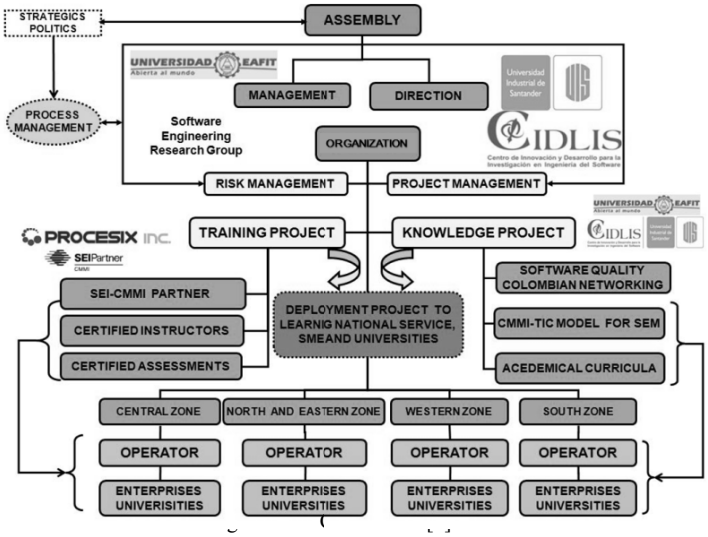
The country has been divided into four geographical areas: North-East Zone, South-West Zone, Center Zone and Coffee Zone.

RCCS network has as main objectives:

- Define and manage programs to support the implementation of software quality models for Small and Medium Enterprises (SMEs) in the sector nationally.
- Develop research projects and methodologies applied in quality models for industry and others who meet the purpose of strengthening the domestic software industry.

RCCS is developing seven sub-projects to achieve its objectives:

1. Creation and implementation of RCCS
2. Training and Certification of CMMI leader appraisals.
3. Training and Certification of CMMI instructors.
4. Implementation the CMMI model in software SMEs
5. CMMI initial assessment of software SMEs
6. Development of a model of Software quality for SMEs
7. Educational programs improvement in software quality



The training and education activities related to this paper are defined in sub-projects 4, 6 and 7. In the sub-project 4 met the needs of education and training demanded by SMEs. In the sub-project 6 was determined the process model. And, in the sub-project 7 will be defined improvements to educational processes in software quality.

The processes established to improve educational programs are (Fig. 11): Process management (improvement, definition and training), Project Management (planning, monitoring and control), support (decision making, asset management, measurement and quality assurance).

The development of sub-project 7 has served as a benchmark to create an approach to integrate the results of GAYA y SACES projects, provided a way to integrate the academic and management processes of academic institutions regarding the management, the authoring and the instruction related to the competences model and academic degrees.

E. Issues, Controversies, Problems

Considering the problem as the difference between a desired state and current state, now we summarized the problems set out from the issues, controversies, scenarios and results achieved in the projects described in the preceding paragraphs.

Some of findings encountered in our observations are as follows:

1. The various stages (fig. 10) involved in the process of teaching - learning of basic education, professional basic education and applied engineering professional Education in engineering education programs are not fully formulated and are delivered as if they were

independent and this fact causes weaknesses when graduates seek to integrate the workforce.
2. Most Universities do not develop training activities for the integration of graduates from academic programs to the productive sector, thus, there are delays in their incorporation into the workforce.
3. In the case of information technology and communications, the universities do not distinguish between educational programs in science and engineering; for example, do not differentiate between academic programs in computer science and software engineering.
4. Many Universities are more concerned about the financial benefits that the results of the professional performance of graduates.
5. Higher educational institutions do not manage the knowledge and the competences of the processes associated with the educational program management.
6. There is not benchmarking models of processes in the higher educational institutions without which it is difficult to define policies for the processes improvement because without such studies cannot establish the best practices of learning and educational management in Colombia.
7. The curriculums are made without contextualizing with the reality because they are not integrated into the current social processes.
8. The Colombian educational objectives are process-oriented to integral formation but this is not aligned with these objectives because to do so would require competences-based curricula because the competences are directly relationship with the processes.
9. Although some international approaches to develop and adapt competency-based curricula have been transferred to our environment such approaches are not fully understood and properly adapted because there are no techniques to define maturity levels of learning - teaching proven strategies in order to adapt our environment and there is no effective, clear and practical methodology to develop and manage competences-based curricula.
10. The community is not prepared to appropriate formation, leading, coaching and teaching with competency-based curricula.

III. HIGHER EDUCATION PROCESSES MODEL

From the background now we will try our framework for our Processes Management Model for Higher Education (PMMHE). PMMHE is the product of the software educative programs improvement sub-project (Objective 7 of RCCS project). PMMHE has as principles, the top management structures developed with the GAYA [6] and SACES [7] projects to establish the basis for designing the teaching-learning processes to treat the primary process of formation.

The Education in this project has the perspective of the process approach, also called project-based learning or problem-based learning (PBL), which induces competences-based learning.

A. Competences-Based Learninig (CBL).

Now explain briefly CBL, defining its parts and some examples (Table III) and Figures 5 and 6.

TABLE III. CBL COMPONENTS

Parts	Description
Role or degree	An academic program which is composed of several competence units. For example (Fig. 7): Patron, Waiter, Cook and Cahier Roles
Competence Units	Each of the areas of process that plays a role. For example, support, planning, development of the work of cooking, cooking management processes for the example in Fig. 7
Competence Unit Assessment	Overall rating being made to all units of competence about perfomance and product and process quality.
Competence Elements	Each of the practices that a place within a competence unit.
Perfomance Criteria	Each of the sub-practices that a place within a competence element.
Evidence required	Each of the Work Product produced in a sub-practice
Essential Knowledges	All knowledhges units to run a sub-practice.
Knowledge units(Fig. 6)	Each is composed of the doing core, and the assesment unit and the the body of knowledge. For example; Fry potatoes. Demands to know about potatoes, how they are fried, and how it does the quality test of process and product.
Assessment units	Overall rating being made to the doing core using the Analyssis Unit and Synthesis Unit.
Analysis Units	Lets break down all parts in order to do performance and quality assessment.
Synthesis Units	Allows synthesis concepts in order to do performance and quality assessment.
Doing Core	Each is composed of the being core, the knowledge core and the assesment core.
Being Core	Each is composed of the phisical core and mental core charactristics of the person.
Knowledge Core	It is the basic knowledge of the a person.
Phisical Core Characteristics	Appearance of a human body.
Mental Core Characteristics	Psychological aspect of a human.
Analysis Core Characteristics	Key analytical aspect of a human.
Synthesis Core Characteristics	Key synthetical aspect of a human.

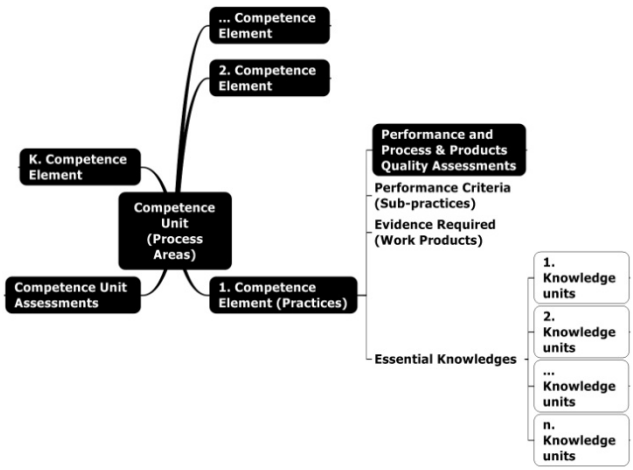


Figure 5. Competence Unit

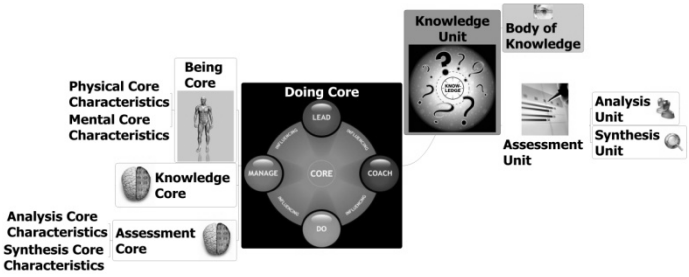


Figure 6. Knowledge Unit

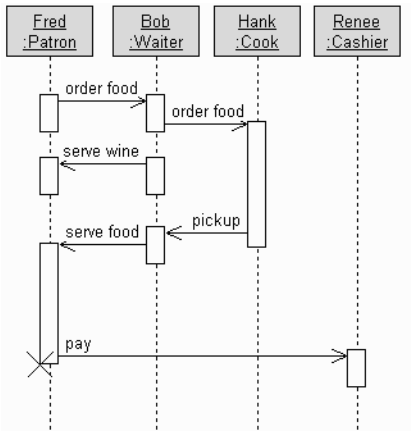


Figure 7. Restaurant Service Process [16]

The process of competency-based education is structured around a process as is the case for example (Fig. 7) where the process is the restaurant service, and each of the roles would trivially, to develop educational qualifications. This teaching-learning process requires teamwork, mentors, special educational materials, instructors, resources, managers for the teaching process, records of evidence, assessments, among others.

B. *Description of PMMHE.*

Such components are shown in the abstraction that represents "MANAGEMENT AND DIRECTION" in the upper block of the architecture model (fig. 8). The components that emerge in this structure correspond to three processes: Academicals Programs Assets Management (Knowledge assets management); Authoring Process (Authoring, Development and Maintenance); and, Instruction Process (Instruction, Certification and Professional practice).

1) *The Knowledge Asset Management Process (KAMP).*

The KAMP follows the guidelines established for project GAYA to improve academicals programs and manage baselines during the development or use of the academicals programs.

2) *Authoring Process (AP)*

The AP is designed to make the processes of academic program development under the vision of processes competency-based formation using project management as a support tool to develop an engineering process with:

- Specifications to support an academic program with units of competence, elements of competence, performance criteria (activities of a process), knowledge, applications and the establishment of evidence required to certify the skills acquired.
- Design to produce teaching-learning develop knowledge assets (learning objects) that are seen as technological applications which consist of reusable software components supported by software and hardware system and human resources
- Verification, Validation and Integration of components.
- Develop a comprehensive improvement process for resources, content, practices and the same authoring.

AP also includes development and maintenance processes to manage, maintain and update knowledge of authoring, to make them consistent, permanent and relevant to the learning process.

3) *Instruction Process (IP)*

The instruction process [11] is established following learning sequences through teamwork activities to solve problems through projects. The projects are supported by a tutor, a coach and several assistants, who are charged with overseeing all activities of the students. Tutors, coaches and assistants must be certified in the training process before offering academic education programs.

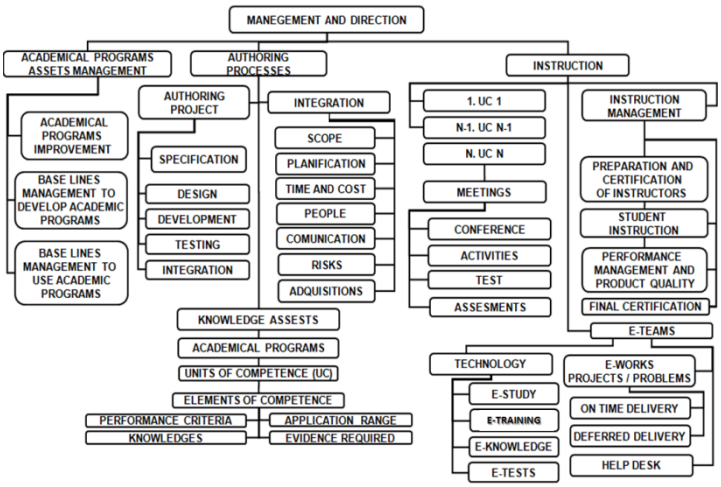


Figure 8. PMMHE [8]

IP may include certification procedures and, eventually, be linked to occupation; a fact that makes feasible the continuous monitoring practices of certified human resources and allows continuous improvement process directly into jobs.

C. *Curriculum development methodology for competency-based educational programs*

The methodology PMMHE combines the steps of GAYA methodology [6] with the steps of the Educational Software Engineering methodology [17] and has 11 stages (Fig. 9). The structure of the methodology combines project management with an adaptation of the software development life cycle. The

structure includes the possibility of having the bodies of knowledge (for example, the Software Body of Knowledge) or the construction of bodies of Knowledge from processes in situ or from experimental prototyping construction processes. The bodies of knowledge should be associated with functional decomposition as specified in UML sequence diagrams [18] in which every lifeline represents a role type with its performance criteria (practices that can be executed).

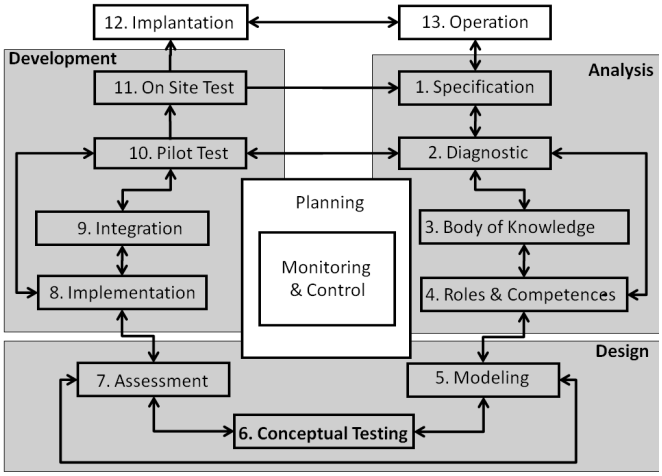


Figure 9. PMMHE [6]

It is absolutely indispensable that the programs have information and communication technologies for development of all activities.

The model is an adaptation of the CMMI models [9] [10] [11] [12] [13] [14] for development, acquisitions and services. The relationship is shown in Table IV where authorship associated with development, management and acquisitions services. It should be noted that the acronyms mean: The Asset management of academics program process (KAMP), Authoring Process (AP) and Instruction Process (IP).

D. Benchmarking from PMMHE

One consequence of the adaptation and comparison of PMMHE with the CMMI constellations is that the CMMI tools can be adapt to develop benchmarks for comparative measurements around the Process areas and roles. From this perspective, also, we can infer that it possible adapt the CMMI assessment methods [14] to solve the second problem that emerged in paragraph II.E. The assessment process can be done at individual or organizational unit using the measuring process of RCCS [8].

IV. PMMHE PROTOTYPE

Currently, we are verifying and validating PMMHE through curriculum development environment for software engineering. To determine which curriculum to mediate, we established the followings criteria:

1. Find the more difficult process of assimilation by the companies participating in the project RCCS.
2. Developing a competency-based academic program that would not affect the autonomy of educational institutions and instead enhance its programs.
3. Establish affinity groups to the perspective of the issues set out in the paragraph II.E.

The chosen program associated with project management and included aspects of process management, engineering and support (Fig, 10). The validation project was called " Improvement of Educational Programs in Software Quality", in Spanish: "Mejora de Programas Educativos en Calidad de Software -MPECS"

TABLE IV. PROCESSES CMMI AND COMPETENCES IN PMMHE

Constellation	Categories	Process Areas	R[1]
Common for all Constellations	**Process Management**	**Organizational Innovation & Deployment**	**All**
		Organizational Process Performance	**All**
		Organizational Training	**All**
		Organizational Process Focus	**All**
		Organizational Process Definition	**All**
	Project Management	**Project Planning**	**All**
		Project Monitoring and Control	**All**
		Risk Management	**All**
		Quality Project Management	**All**
		Integrated Project Management	**All**
		Requirement Management	**All**
	Support	**Process & Product Quality Assurance**	**All**
		Configuration Management	**All**
		Measurement & Analysis	**All**
		Decision Analysis & Resolution	**All**
		Causal Analysis & Resolution	**All**
Adquisitions	Adquisitions and Delivery	Agreement Management	KAMP
		Adquisition Requirement Development	KAMP
		Solicitation & Supplier Agreement Development	KAMP
		Adquisition Validation	KAMP
		Adquisition Verification	KAMP
		Adquisition Technical Management	KAMP
Development	Engineering	Requirement Definition	AP
		Requirement Management	AP
		Technical Solution	AP
		Product Integration	AP
		Verification	AP
		Validation	AP
Services	Process Management	Organizational Services Management	IP
	Project Management	Service Continuity	IP
		Supplier Agreement Management	IP
		Capability & Availability Management	IP
	Service Establishment and Delivery	Service Delivery	IP
		Service System Development	IP
		Service Transition	IP
		Insident & request management	IP
	Support	Problem Management	IP

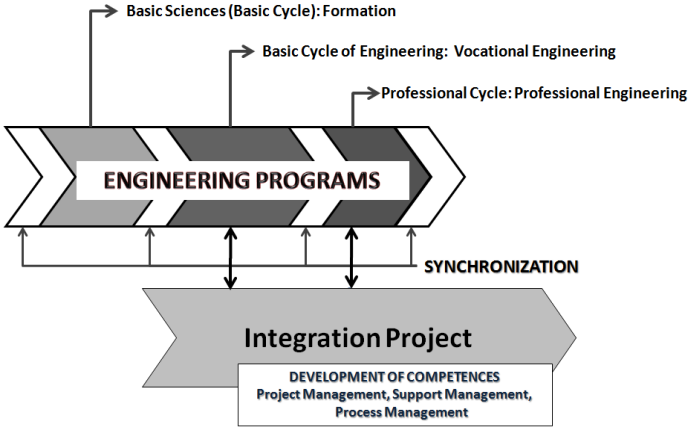


Figure 10. MPECS Project

[1] Relationships between CMMI process areas and MPECS.

The Work in the project covers 5 universities in all regions of the country's strategic and the National Apprenticeship Service (SENA). The roles covered in the project include administrative, faculty and students. Each role is associated with some areas of the CMMI process adapted by the competences-based model for educational sector as shown in fig. 11, establishing the relationships between the curricula development guides for educational programs of the SENA, the Competency Lifecycle Framework (CLF)[2] [10] and the CMMI model as described in Tables V and VI.

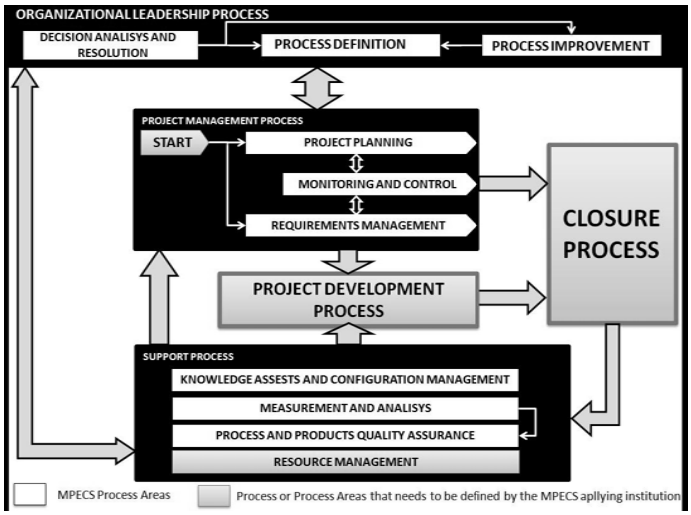


Figure 11. MPECS Prototype Model [8]

Each institution is using MPECS, adapting it to the regional and institutional needs according to MPCES Meeting [3] Strategies [20] shown in Figure No. 12. The Methodology of Meetings covering the project life cycle MPECS: Initiating, Planning, Implementation, Monitoring, Control and Closing. MPCES prototyping has been used for process improvement in Management of business practices, research project management, and degree project management, among others.

The MPCES program roles have been established are: asset managers (learning objects managers), tutors, instructors and assistants. Students play roles of project leader, planners, knowledge managers, coordinators of development and developers.

Upon completion of the prototype implementation MPECS hope to have completed:

1. The benchmarking of the participating entities with respect to the process management, project management and support and their process areas.
2. Proof of certification of competence for all roles we have defined.
3. The benchmarking of the roles, not people, which will allow us to define levels of maturity of such roles.
4. Have established improvements for the problems referred to in paragraph II.E.

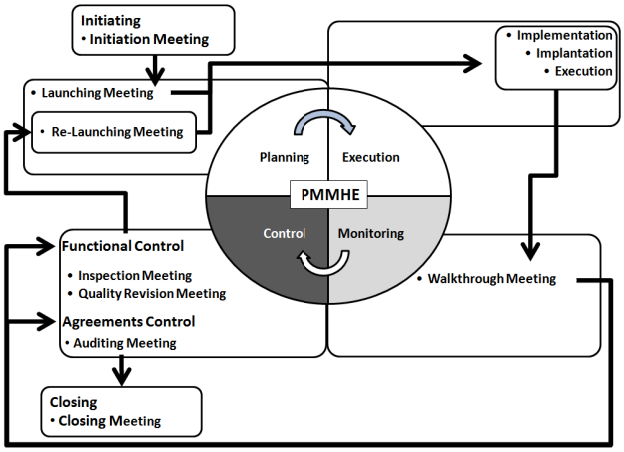


Figure 12. Strategy for development of MPECS prototypes

TABLE V. PROCESSES AND ROLES IN MPECS

Process	Roles
Project Management	Team Leader Planning Manager Leader Manager
Product Development	Design Manager Test Manager Team Member Inspector Manager
Process Management	Process Manager Quality Manager
Support	Support Manager

TABLE VI. RELATIONSHIP BETWEEN MPECS COMPETENCES MODEL AND CMMI MODEL

MPECS Competences Model		CMMI Model
Unit of Competence		Process Area
Competency Cluster [10]	Element of Competence	Practices
	Perfomance Criteria	Sub-Practices
	Evidence required	Work Product
	Essential Knowledges	-
	Other Applications	Amplifications

V. FUTURE TRENDS

With the work we are expected to proceed with completing the following perspectives:

1. Create a benchmarking model for programs of higher education in order to establish objective improvement processes [15].
2. Create a benchmarking model for graduated students.

[2] The CLF is a matrix that identifies the specific competencies required for a particular CMMI-based professional role in the lifecycle phases for each unit of competences. The competency clusters for MPECS are: Achieving and managing agreements; Decision making and problem solving; Project planning and managing; Interpersonal communications and facilitation; Integration, articulation and expression of information; Understanding and adapting to organizational contexts; Model interpretation of the unit of competence; Product or service tailoring, adaptation and application; and, Professionalism.

[3] A meeting is any activity as assemblies, meetings, conferences, inspections or other gatherings that requires careful planning and detailed to achieve the results on each of the processes to develop in each institution to ensure the success of prototype curricular improvement MPCES.

3. Create benchmarking model for assessments leaders, teachers, attendees and educative managers at educational institutions.
4. Develop a software system for integral managing of academic programs based on competencies considering the management, authoring and instruction processes.
5. Adapt and integrate the competency model to be compatible with frameworks of human capital management [19]

VI. Conclusions and Acknowledgments

We have presented in this paper work related to the improvement process in engineering education processes of the institutions of higher education. The paper has shown the ongoing work that has evolved from the research to the implementation of educational quality assurance systems. The document shows how a project from emerging in the software production sector, impacts academic programs, to consider opportunities for improving performance of the graduates as they develop their professional activities. The study discusses the process of learning - formal learning as a competences certification model that impacts all administrators, educators, students and alumni of the educational institutions relationship with engineering.

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