Development of Educational Process Capability Maturity Model

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Abstract

Abstract- This study aims to development of educational process capability maturity model, which can be applied in the higher education sector for quality and process improvement in educational services. A new model is established by adopting a philosophy and concepts of the Quality Management Maturity Model for Crosby and Maturity Model CMM-based Software, as well as, using the critical successful factors in higher education.

Currently, a majority of higher educational organizations need to develop an approach or model for measuring their educational process capability maturity due to the global challenges that affected this sector. In addition to the strong competitive environment that required to keep going with this continues improvement and achieve a higher level of performance. Such as these challenges have been imposed on the higher education organizations to evaluate their performance and level of the quality service in order to obtain a high maturity level. Previous studies indicated there is a lack of maturity model in the education sector because most of currently maturity models have designed for industrial sector or electronic learning processes. For this reason, this study has suggested developing a maturity model which can be exact in the higher education sector and improve their quality process. This study will discuss implementation of the maturity model in the higher education organizations.

Keywords
Capability Maturity Model (CMM), Critical Success Factors (CSF), Educational Process Capability Maturity Model (EP-CMM).

1. Introduction
Higher education organizations are considered to be a complex community because of the c characteristics of their service. Although the majority of industrial and services organizations are suffering from similar global challenges. A higher educational score still has special characteristics which are completely different compared with the rest of the production and service sectors. Where, it includes processes, areas and private practices which are applied only in the higher education sectors. For this reason, it's required a continuous improvement in order to provide an educational service that will satisfy all beneficiaries. There are various methods to improve educational processes such as maturity model based software process development (**Capacity Maturity Model and Integrated Maturity Model**). Hence, several models have been formulated from these modes and used to measure organizational capacity, which it has been applied in various and different areas such as; Total quality management, relationship with suppliers, research and development, product reliability, knowledge management and governance

(Fraser et al, 2002), e-government (Carmel & Agarwal, 2002), E-Learning (Marshall & Mtichell, 2004), human resources management (Curtis *et al,* 2009), corporate data quality management (Honer *et al,* 2009), financial management (Shareef *et al,* 2012), and business analysis (Cosic *et al,* 2012).

The results of the previous studies demonstrated according to studies (Marshall & Mitchell,2004) about E-Learning Maturity Model, Maturity Model For Quality Improvement In Higher Education (Baig, et al; 2007), Maturity Model for Mobile Learning (Alrasheedi,2015), Developing Capability Maturity Levels for public–private partnership Stakeholder (Babatunde, et al; 2015), and A Maturity Model for Improving Data Quality (Kirikoglu ,2017) .that can implementation of Maturity models in the each of the software, industrial and service areas commonly has been succeeded in improving their processes. Therefore, like these applications can be utilized to develop the educational process, to ensure the provision of high-quality services and to identify the right practices that can be used as a guide in future improvement. This is can be assisted the higher education origins of self-evaluate their processes and continuous improvement in their performance.

2. Methodology

Despite the acceptance of different maternity models in industrial organizations, particularly in computer education and software applications. However, there is still a need to provide an integrated maturity model for the education process, which can be used as a guide to assist educational organizations to evaluate their liability level. Since the majority of previous studies have confirmed that it is limited in the models that can be measured capacity in higher education organizations. Also, it can be used critical success factors in the model pregnancy levels and may have a significant role in the performance of higher education organizations. This study focused on developing a model to measure the level of maturity of the education process by adopting critical success factors that can be applied in the higher education area, as well as identifying areas for their application.

The search problem can be discussed through the following research questions:-
- Can CMM concepts be applied in the education sector?
- How can the proposed model assistance the higher education organizations to identify aspects that needed to be improved?

The research objectives are; (1) to develop the capacity maturation model of the education process, (2) to carry out the critical success factors within its levels, (3) to contribute and enhancing the quality management level in higher education and progress towards obtaining a higher maturity level and determining the operations of each level.

This study is important because it has adopted a modern model and a self-assessment tool named; **"the Maturity Model"**. This model can support the educational organizations to self-assessment, as it can help to identify strengths and weaknesses process and determine their current status and quality compared with other organizations. This study will depend on the method of presentation and theoretical analysis of different maturity models.

3. Maturity model

The Maturity refers to the degree of development and growth, and describes the status of total development (Fully Developed) or Perfected, and Capability means able to do the thing brilliantly (Oxford, 2010). Capability Maturity Model (CMM) refers to the ability to achieve a specific goal and to utilize all resources available to achieve growth and progress according to stages or levels that describe the evolutionary development from the initial stage to the advanced stage. Paulk *et al.,* (1993) defined Capacity Maturity Model as "*the ability to define, manage, measure, and control the efficiency of the process with applications throughout the enterprise*". While its defined by (Jabouri, 2005) as "*a descriptive model to improve the process in successive stages of development and improve the quality level by following a set of management practices to evaluate and improve the ability of the organization to reach its goals".* In general, the Maturity Model is very important for educational organizations after increasing interest in improving the quality of educational processes, reducing each of costs, time and effort. So, CMM-Model has been developed to assist organizations to achieve their objective by evaluating and improving their educational processes compared to the required quality standards and then measuring the level of maturity. Therefore, improvement educational process requires considerate the main difference between maturity and immaturity. Consequently, the mature organizations are able to identify their operations according to their actual plan, based on outline the responsibilities and authorities in each process at a whole organization. In addition to use a quantitative methods to judge the quality of their products and processes (Sarshar and Finnemore 2002). However, till this time, there are some of the organizations that have not yet reached the required level of maturity despite the application of quality systems. Due to the lack of adoption criteria for set-up or development of their future plans.

As a result, their budget estimates and scheduling are all most stabilized, based on a lack of identifying a quality objective requirement to improve their process or solving operational problems (Paulk *et al.*, 1995).

Maturity models are established first time by a quality scientist Philip Crosby (1979). In his book "Quality is free" referred to the Quality Management Maturity Grid (QMMG), which is considered as a first model developed to the assess maturity and describes the expected behavior of the organization at five levels of maturity (*uncertainty, Awakening, Enlightenment, Wisdom and Certainty*). QMMG objective are to understand plans and quality management by identifying effective process and/or it is unnecessary activates which required to the quality improvement (Crosby 1979).

The original concept was developed by Watts Humphrey in 1986 and his colleagues at BMM and Humphrey brought these concepts to **the Carnegie Mellon Institute of Software Engineering**. In the same year, the **US Department of Defense** submitted a request to the Software Engineering Institute to develop a maturity model for operations Software and evaluation of contractors in the implementation of software projects, the model was presented best practices to enable information systems developers to assess the capabilities of secondary contractors (Humphrey 1989) The first version of the model was introduced in 1991 and was modified by Paulk in 1993.

The idea of the Maturity Model is that organizations' processes do not move from zero to optimizing immediately, but progress along the journey of maturity through levels, it becomes apparent that:

1. The Maturity Model divides the evolution of the organization into several consecutive levels describing the path of improvement.
2. Capacity Maturity Model to improve organizational processes by assessing the current state of the organization and proposing improvement measures.
3. Capacity Maturity Model is a self-assessment tool that enables the organization to assess the current level of quality and then develop plans for moving to the next level.

4. Maturity models and their areas of focus

The CMM model is based on concepts such as, organizational development and change are carried out according to continuous stages. These stages are organized and arranged in order to measure the maturity of the organization's operations and evaluate its ability. Capacity maturity levels consist "Five levels". These levels are progressively arranged to describe the situation of maturity development of the organization's capacity acquired into "optimization". Each level helps to prioritize success. These five levels of CMM can be expanded to include additional levels or modify current levels as needed (ISO 9004:2009). A basic changes of different maturity levels are demonstrated in the following:-

4.1 Crosby levels for maturity

Toward to achieve the highest level of quality for products and processes, the quality scientist (Philip Crosby) in his book "Quality is free", which had developed a quality management framework within organizations named; "Quality Management Maturity Grid - QMMG". This framework can be supports directors to identify the level of maturity in their organization. Based on, it can be determined the conversion stages into the next level up to the optimum maturity level (Prothmann and Stein 2011). QMMG model consists "Five levels" aims to evaluate the whole or part process that accomplished by the organization. Table (1) summarized the levels of maturity by the Crosby.

Table 1. Quality Management Maturity Levels for Crosby (QMMG)

Level 1	Level 2	Level 3	Level 4	Level 5
Uncertainty	**Awakening**	**Enlightenment**	**Wisdom**	**Certainty**
Processes at level 1 are chaotic and lack of knowledge of quality management as a management tool to solve problems.	Recognition of quality management in the second level, but the Top Management doesn't have any desire to assign time and cost.	The management Commitment to implement quality improvement programs and start to cure conflicts and assessment of quality costs	The key objectives of this level are quantitative process management and quantitative quality assurance	The entire organization is focused on continuous improvement considers quality to be an important and sets a prevention system and team of quality

4.2 Capability Maturity Model levels

Capacity maturity levels are defined as phases or levels of specific progress that have been developed in order to improve processes in organizations. Also, it's can be identify the level of maturity of a subsection of the organization's processes and its preparation to move to the next maturity level. It also provides a comprehensive description of each process. Paulk (1993) describes five levels of the CMM as shown in the Table 2 (Janakiraman and Gopal 2006).

Table 2. Capability Maturity Model Levels

Levels	Description
Level 1: Initial	Processes are private, sometimes chaotic. Also, it's an inefficient planning, lack of stable processes, and success depends on individual efforts.
Level 2: Repeatable	Set policies to manage the basic project for cost tracking, Schedule, and functions, Setting controls, And to ensure that early initial successes are repeated on projects with similar applications.
Level 3: Defined	Process standards are documented, set and integrate the process standards, all projects use a certified version designed specifically for program development and for maintain them.
Level 4: Managed	Quantitative measures are used in the evaluation and detailed procedures are collected for the operations, and quality of the product, and all processes are quantified.
Level 5: Optimizing	Focus on continuous process improvement through feedback processes, quantitative process, use of creative ideas, technology, new methods and technology to improve work and quality control.

As can seem in the Table 2, an organization must implement a capacity maturity model step by step sequentially whit out ignore any level from these five levels. Because each level is defined to achieve a specific goal related to measuring the level of operational maturity. So, ignoring any level will lead to effect next stage and lack of feedback which is required for its operations improvement in the future. Each level contains only a set of key operational areas with some of its major implications for increasing the overall capacity of the organization and it's an improvement.

5. Capacity Maturity Models in Education
As a result of the successful application of maturity models in the progress of the software area, many of the industrial and service organizations have decided to implement this model to improve their process, especially in the educational sectors. Accordingly, several maturity models have been developed for applying within the education area.

- E-Learning Maturity Model (EMM)

The EMM maturity model is based on CMM concepts. This model can be used to evaluate the educational organizations and their ability to continually develop and support e-learning. Also, it's identified "Five levels" in this model named; delivery, planning, definition, management, and optimization. This model was implemented at universities in Australia to evaluate their e-learning programs (Marshall and Mitchell 2004).

-The Computing Education Maturity Model (CEMM)

The CEMM model levels are established by adopting a "Capability Maturity Model". This model includes five hierarchical levels were named; Initial, Repeated, Defined, Managed and Optimizing. The most important benefit of this model is to help computer teachers to provide a range of practices and strategies to improve the teaching process (Lutteroth *et al.*, 2007). Furthermore, this model builds based on the Online Course Design Maturity Model (OCDMM) to support a trainer design their courses online with a high quality (Neuhauser 2004).

- Mobile Learning Maturity Model (MLMM)

Mobile education is based on innovative methods of education. This model is designed to evaluate the level of maturity of mobile education in universities. This model has been applied at **"Five universities in Saudi Arabia"**. It also includes five levels named; preliminary, established, defined, structured, and continuous improvement (Alrasheedi 2015). Table (3) shows a comparison between the maturity models demonstrated in the educational.

Table 3. Comparison between the maturity models of education

Models / Levels	ML	CEMM	EMM
Level 1	**Preliminary** :The organization doesn't consider mobile devices important in education.	**Initial :** Process aren't Disciplined and organized	**Delivery** : Process are unstable and dedicated.
Level 2	**Established:** The importance of mobile devices and their use for academic purposes.	**Repeatable**: Planning and implementing courses based on past practices.	**Planning**: The goals are clear and planned for e-learning.
Level 3	**Defined** : Mobile is a Critical tool for interaction between students, teachers and employees.	**Defined** : Stable courses	**Definition** :The processes are determined to support e-learning.
Level 4	**Structured** :The University uses effective policies, techniques and measurement programs.	**Managed** : measurement programs for course levels	**Management** : Ensuring the quality of both the e-learning resources and Student learning outcomes.
Level 5	**Continuous Improvement** : Evaluate programs to ensure continuous improvement.	**Optimizing:** Changes to the process are carefully managed.	**Optimization** : Continual improvement in all aspects of the e-Learning.

6. Capacity Maturity Model Proposed in Higher Educational

This study has been based on the maturation models that have been practiced in the education sector, which have effectively contributed to improving and measuring the maturity level of the educational process. Specific of these contributions such as; (1) determine the current practices required for the completion of the optimization process, (2) identify the organization's competitive position compared with other international and local organizations, (3) provide managers with feedback about the quality level for the organization's educational performance, and (4) control the development of its educational processes.

Presently, the education sector has a special importance around the world. So, some of the CMM levels have been modified to become more consistent in its practices. Although the modern version of the "Maturity Model" used at of education organization is "the Capability Maturity Model Integration (CMMI)", but remain till now CMM is the best model for many reasons like; it's simple and easy to understand, also, it can be tested and verified in educational organizations [8]. CMM used for the development of the Educational Process- Capability maturity

model (EP-CMM), as this model focus on the gradual improvement of the organization's performance and operations according to five levels. This 5th level includes several areas that can help the educational organizations optimize their process upon the next stage until it reaches to maximize its educational processes. Therefore, it becomes a mature organization accomplished by providing their educational services with the highest quality.

In this study, the maturity levels have been adapted according to continuous improvement based on Deming's cycle. The levels of the developed model can be illustrated as follows:

Level 1: Initial

At this level, the educational organization indicated a lack of identifying the significance of adopting a quality standards, unclear their operations plan, and uncertain work environment. Therefore, there are no specific procedures and instructions for work, but it depends on the individual efforts to complete its operations and provide its services. As a result, the organization is immature.

Level 2: Planning

This is a second level, which must be any educational organization adopted. At this level, the educational organization has developed: the actual plans, procedures, and arranging all material requirements to ensure the success of the implementation of its plan and achieve its objectives. Thus, quality management planning can be achieved by supporting top management, using a successful experience for other educational organizations, supporting direct management to apply quality standards, adopting an effectiveness of strategy planning, curriculum development, and focusing on the owners.

Level 3: Management

At this level, quality management education is established as significant technique that can supports the process of continuous improvement during the implementation of the quality improvement program for the educational process. The most important specifications of this level are: managing and coordinating the experiences of the staff and the work teams, implementation of training programs, recording processes for each of the educational and administrative levels.

Level 4: Measurement

At this level, the educational organizations are concerned to develop quantitative measurement tools, the development of the measurement programs for the educational and administrative process, adopt feedback to solve their issues, the continuous emphasis on quality management improvement programs. As well as, it's using the quantitative tools in managing their processes, and the comparison between of measurement according to evaluated results in order to reduce and correct deviations in its process performance.

Level 5: Learning

This level is the highest level of the quality maturity. Whereas, the educational organization focuses on continuous improvement, so it becomes "learning organization". Because, it's using a creative ideas, techniques and modern methods to improve their processes, adopted the successful application and experiences in the future plans, continuous monitoring of the standards and evaluation methods that adopted in improving their educational processes, focus on a new technology and making change management a regular process.

The processes of each level of maturity of the five levels of the proposed model in higher education are the most critical success factors in education and achieve results if satisfactory competitive performance of the organization and the number of views of the writers and researchers in the classification of critical success factors, which are factors of success supportive and support the quality of the process Education and the commitment of higher education organizations to improve the educational process, these factors are summarized in Table (4).

Table 4. Classification of critical success factors in education according to the views of the writers and researchers

Researcher/ authors	Critical Success Factors
Ishikaw (1976)	The role of the department of quality, Training and Education, Participation of employees and Team work, Strategic Planning and Continuous Improvement.
Crospy (1979)	Top management support, role of quality department, Training and Education, Participation of employee and Team work, Strategic Planning, Continuous Improvement, Corrective action and Quality cost.
Juran (1981)	Top management support, Training and Education, Supplier quality management, Participation of employee and Team work, Product design, and Continuous Improvement.
Deming (1986)	Top management support, Training and Education, Supplier quality management, Participation of employee and Team work, Continuous Improvement, and Quality costs.
Saraph *et al.,* (1989)	Top management Support, role of quality department, training and education, quality management of suppliers, quality of data and reports, and employee relations.
Black & Porter (1996)	Supplier quality management, employee participation and team work, strategic planning, continuous improvement, and communication.
Kanji *et al.,* (1999)	Training and education, supplier quality management, employee participation and team work, measurement and evaluation, curriculum design, and stakeholder focus.
Rao *et al.,* (1999)	Top management support, training and education, strategic planning, measurement and evaluation, Product design, and stakeholder focus.
Bayraktara *et al.,* (2008)	Top management support, training and education, strategic planning, measurement and evaluation, process control, curriculum design, continuous improvement, appreciation and reward, students, and focus on stakeholders.
Asifi *et al.,* (2011)	Top management support, strategic planning, measurement and evaluation, process control, curriculum design, continuous improvement, focus on stakeholders.
Zakuan *et al.,* (2012)	Top management support, training and education, employee participation and team work, measurement and evaluation, and stakeholder focus.
Nadim & Al-Hinai (2016)	Top management support, training, employee participation and team work, strategic planning, measurement and evaluation, process control, curriculum design, continuous improvement, and focus on stakeholders.

As can be seen in Table 4, that all the processes of each level of maturity are the most critical success factors in education. Where the results can be shown if satisfactory competitive performance of the educational organization. The second level indicates that its operations are many compared to the rest of the other levels due to the importance of the level which is the basis for any organization to carry out its work properly, while maintaining the idea of the basic model as a diagnostic and reference tool for the improvement and development of workers, teams and the whole organization. The use of quantitative methods in the third level to improve the level of performance and move to a higher level of maturity, and the link of technology at the highest level (V) as a phenomenon is constantly changing, which improves the educational process.

Table (5) shows a comparison and a description of the focus areas of both the Capability Maturity Model and Capability Maturity Model for Educational process (Baig et al., 2007). The capability maturity levels in Higher education can be illustrated as follows:

Table 5. Areas of focus for the Capability Maturity Model & Capability Maturity Model for Educational process developed

Levels	PE- CMM	CMM
1	Initial : There are no operations	Initial : There are no operations
2	Planned: - Support the application of quality standards. - Strategic Planning. - Curriculum design - Focus on students - Focus on faculty members - Focus on other stakeholders (labor market and community)	Repeatable: - Requirements management - Project planning - Follow up the progress of the project - Software quality assurance - Management of processors
3	Management : - Coordination between employees and team work. - Training programs. - Preparing the required documents	Defined: - Focus on the process - Definition of the process - Training and coordination between the programs of team work - Software Engineering - Management of integrated programs
4	Measurement : - Process Management quantitatively - Reverse feedback rings - Benchmarking	Managed: - Software Quality Management - Quantitative process management
5	Learning: - Continuous improvement and continuous review of standards and standards - Management of technological change	Optimizing: - Prevent defects and errors - Management of technological change - Change management process

The second level of operations are might compared to the rest of the levels, because of the importance of the level being the basis for any organization in the implementation While maintaining the idea of the basic model as a diagnostic and reference tool for the improvement and development of team work and the enterprise as a whole, and the use of quantitative methods in the third level to improve the level of performance and move to a higher maturity level, and the link of technology at the highest level, (Fifth) as a constantly changing phenomenon which improves the educational process.

6.1 Areas of operation and their objectives for the levels of maturity model in educational organizations

Table 6. Areas and objective of the Capacity Maturity Model the developed to educational process

Areas of operation	Objectives
First level: Initial	
There are no operations	The work is done on the basis of error and right, and there are no specific procedures and instructions for the work.
Second Level: Planning	
Support the application of quality standards.	Support is expressed through the role of top management in allocating resources for quality programs, applying standards, prioritizing the organization and understanding the benefits of its commitment to quality management. Its role in developing quality improvement strategies and programs, identifying incentives and training programs for employees, as it serves as a compass directing its policy and objectives, plans and programs and everyone in the organization towards the achievement of its main goal is the satisfaction of the beneficiary.
Strategic Planning.	A roadmap to ensure that the educational organization becomes what it wants to be in the future and determines its objectives and the development of access methods, given the achievement of the results of the organization and sets measurable objectives and specific action strategies.
Curriculum design	The essence of the education process as a plan to achieve educational goals and to meet the needs of stakeholders, and should be reviewed and updated regularly in view of the needs of beneficiaries and technological progress.
Focus on students	They are the main customers and the organizations of higher education seek to meet their needs, collect and evaluate their grievances, and support social activities and feedback.
Focus on faculty members	The focus of the educational process to achieve its objectives, which is to bear the brunt of the process of brain-building and the construction of mental queens next to the achievement of creativity and mastery up to the stage of self-education is able to continuity.
Focus on other stakeholders (labor market and community).	To meet the needs of the different organizations (governmental and private) with educational outputs that are scientifically, skillfully and technically qualified and operated in accordance with their specialties and suitable for the available career opportunities, as well as providing different services to the community
Third Level: Management	
Coordination between employees and team work.	Empowering employees to participate in administrative decision making and improvement activities appropriate to their levels in the organization and work collectively. One way to achieve employee participation is to use and form (team work) that represent a small group of individuals who have a common goal oriented towards performance and success
Training programs	Improving the quality of the participants' performance and improving their efficiency in all aspects of the educational process, and because its programs require the acquisition of new skills, as well as the changes in each level of quality require continuous training, so the application of quality begins and ends with training.
Preparing the required documents	Identify all procedures necessary to obtain academic accreditation, adhere to standards, document administrative and educational procedures, and required documents.
Fourth Level: Measurement	
Process Management quantitatively	Quantitative control over the performance of educational service operations (use of control panels, Pareto chart, histogram, *etc*.) .
Reverse feedback rings	Building workshops consists of a group of individuals using several methods such as (brainstorming, cause and effect diagram, etc.) to identify problems and develop solutions.
Benchmarking	Conducting a benchmarking with other leading educational organizations helps improve processes when performing educational service operations, identifying strengths and weaknesses and thus making the necessary changes.
Fifth Level :Learning	
Continuous improvement & review of standards	Continue to improve process performance and service delivery process through feedback and continuous review of standards.
Management of technological change	Use new technology and structured style for the purpose of performing work efficiently.

7. Conclusion

In this study, the model presented and developed for the Maturity of the Capability of the educational process can be tested in the higher education organizations as a self-assessment tool to identify the areas of strength and weakness in its operations, which were distributed on five levels including critical success factors in higher education to determine the actual location of the educational organization within. The five maturities levels and begin to prioritize improvement to move to a level of maturity above the current level. The educational organization whose level of maturity is in the second level will improve to move to the third level of maturity, which falls within the third level, will want to move and improve to a higher level, the fourth. If it is in the fourth level, you want to move to the highest level of maturity, which is the fifth. As the educational organization decides to make improvements, the results of applying the model will serve as the cornerstone for improving the performance of its operations as follows:

- Preparation for the evaluation process: requires the organization to understand the mechanism of application of the model and levels, as well as the focus areas for each of the five levels.
- Selection and formation of a resident team supported by senior management, training them to understand the model levels, and on how to use the model as an assessment tool.
- Prepare the necessary inputs for evaluation and determine the time period for completion of the evaluation process.
- Implementation of the evaluation process by the Maturity Model of the educational process.
- Analyze the results of the evaluation by the resident team and prepare a list of results.
- The evaluation team shall prepare a report showing the organization's current location within (the five maturity levels) and the main areas at each level that it has not met, with a diagnosis of strengths and weaknesses.
- Develop an improvement plan, to improve the current level and move to a later maturity level.

The Steps to apply the Educational Process Capability Maturity Model (EP-CMM) is shown in Figure 1.
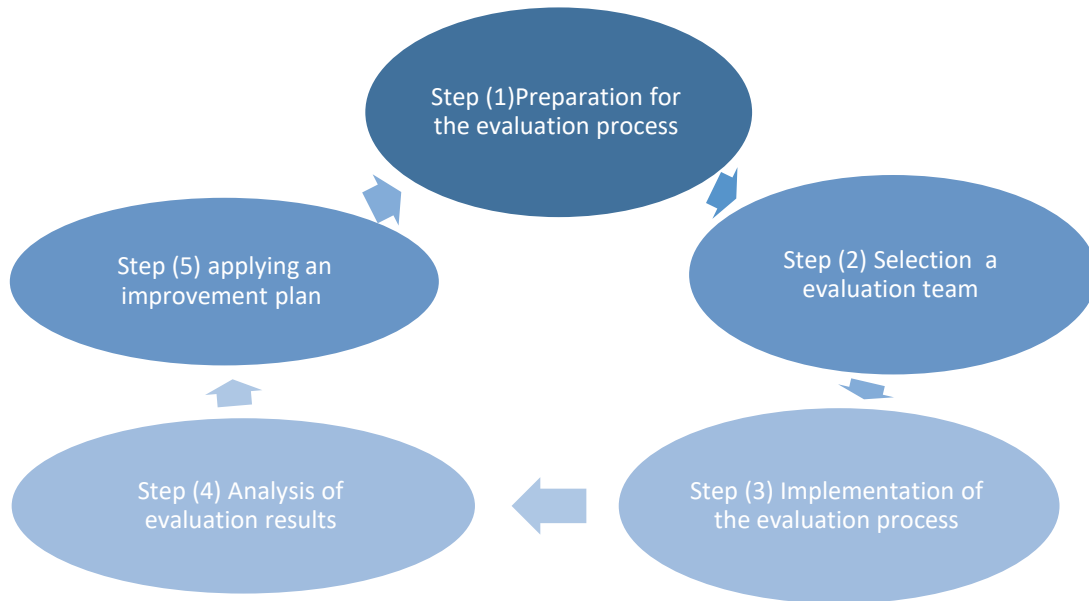

Figure 1. The Steps to apply the Educational Process Capability Maturity Model (EP-CMM)

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