Capacity Maturity Model Integration, Quality Techniques, and Agile Manufacturing in Management

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IN THE NAME OF GOD

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INTRODUCTION

One of the main objectives of any organization is to achieve "productivity" (especially continuous and sustainable improvement). Researchers have developed a variety of methods to achieve this objective, including Six Sigma and QFD among others. An organization will choose one of these methods according to the situation, the time required to react, and to obtain a desired result. As a result, it will achieve short or long-term productivity and increased profits.

After examining a number of organizations, several researchers concluded that there are some gaps in the results of current methods used in quality management and developed a model to fill these gaps. To this end, they tested the Capability Maturity *Model* Integration (CMMI) process improvement and training program (used in software companies) in industry, especially in the manufacturing sector, and achieved significant results. The result gaps found with other methods have been greatly reduced and efficiency has been increased. Consequently, Capability Maturity *Model* Integration (CMMI) has become commonly used in industry, especially in the production sector. Capability Maturity *Model* Integration (CMMI) is a comprehensive guide for the planning and execution of processes and can guide an organization to high levels of maturity, increasing productivity by identifying process areas and maturity levels in proportion to their integration.

On the other hand, the Six Sigma technique approach is one of the most well-known techniques used in organizations. Significant results (obtained in the short and long term), have led to this model being further promoted in many organizations. In the Six Sigma approach, attention is paid to reducing errors in the processes and controlling unintended events and occurrences. The main focus of the Six Sigma approach is to create a product according to customer needs, with the least possible number of errors in the production processes, and seeking to improve the quality of products, services, and processes.

With rapid growth in technology, rapid changes in customer needs and demands, and increased information exchange with other organizations and industrial centers across the world, the agile manufacturing (AM) approach has received a lot of attention from organizations. Using this approach, it is possible to adapt to the speed of technological growth and

changes in customer needs to produce a product with the required changes at the lowest cost.

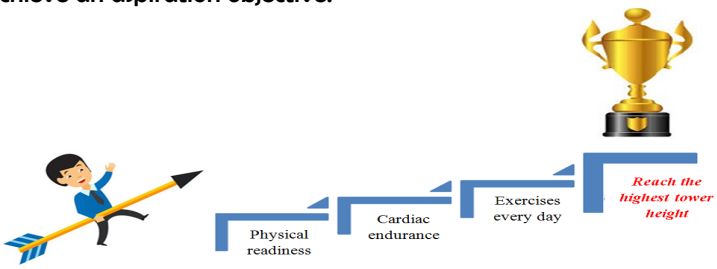
- The aim of this book is to provide useful solutions for organizations to become more competitive domestically and globally, and thus achieve a competitive advantage.
- This book presents the concepts of the relevant models with the formulas removed to better clarify the concepts.
- The book also provides a quick overview of the models and their important points.
- This book also describes the work series of a number of other researchers to introduce a comprehensive and sustainable method by combining them.

CHAPTER ONE

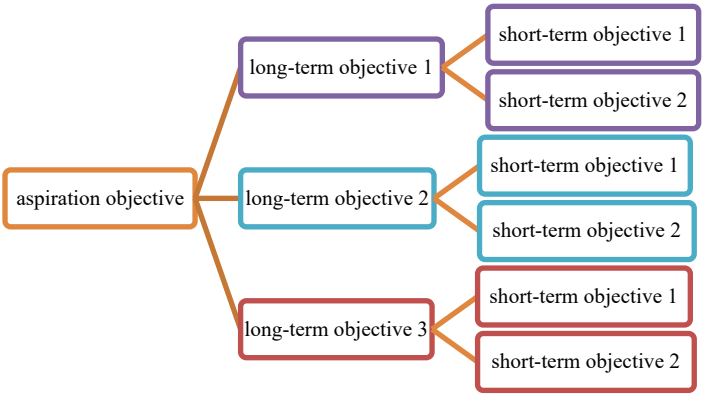
WONDERFUL MANAGEMENT

Introduction

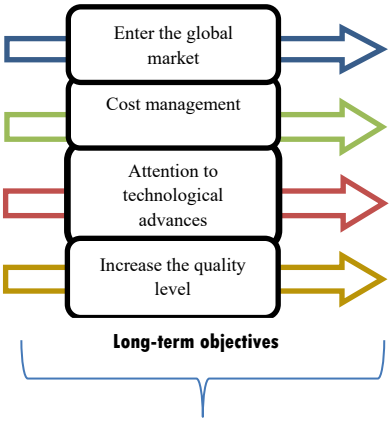
"Management" is an activity that everyone deals with during the course of his or her life. All life-matters involve some form of management, such as time management, cost management, objective management, and so on. Everyone has aspirations and objectives for his or her life. To achieve these objectives, we all need **appropriate planning** and **proper management**. For example, a 15-year-old person may wish, at the age of 20, to stand on the highest point of the tallest tower in the world—this is an aspiration objective and achieving it may or may not be possible. This is the moment when a person decides to plan for the future and, therefore, it is necessary to turn this **aspiration objective** into a set of **simple objectives**. Such simple objectives could include: walking every day; climbing stairs; increasing endurance; and taking physical exercise. Consequently, the achievement of simple objectives must be managed to achieve the aspiration objective. As a result, **a successful person is someone who plans to achieve an aspiration objective.**



Note:
*To better achieve the objectives, each **short-term objective** can be considered a **long-term objective** and to achieve it, **simpler objectives** are defined.*

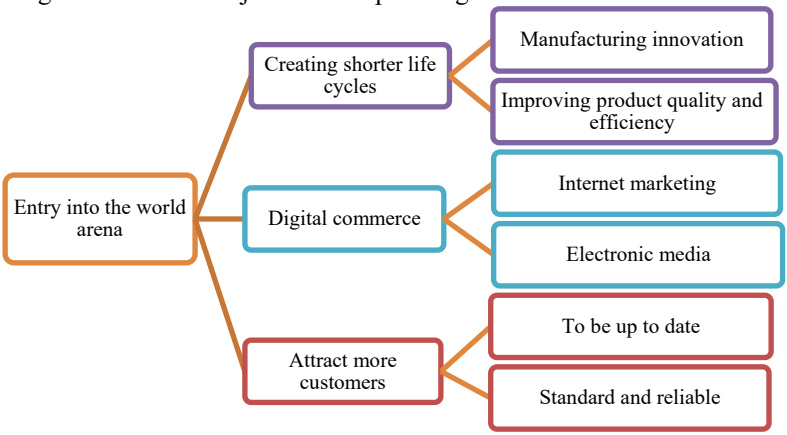


For example, in an organization or company, the ***aspiration objective*** is ***global competition and the manufacture of unique products.*** To achieve this objective, it is necessary to define the long-term objectives, such as: ***entering the global market; increasing the level of quality; creating conditions for employee creativity and innovation; paying attention to customer needs; paying attention to technological advances; and cost management***. For each of these long-term objectives, short-term objectives are considered and planned so that they can achieve the aspiration objective.

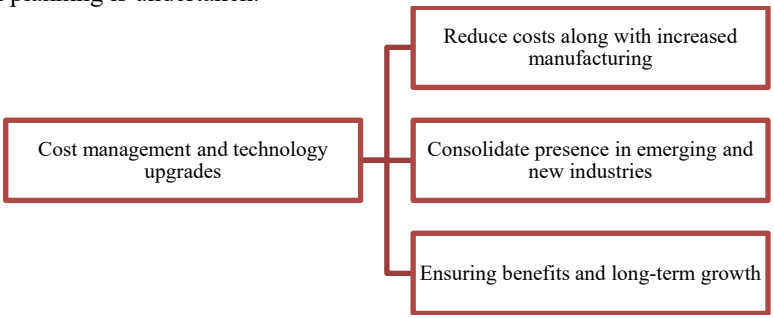


Aspiration objective: to compete at the global level and produce a unique product

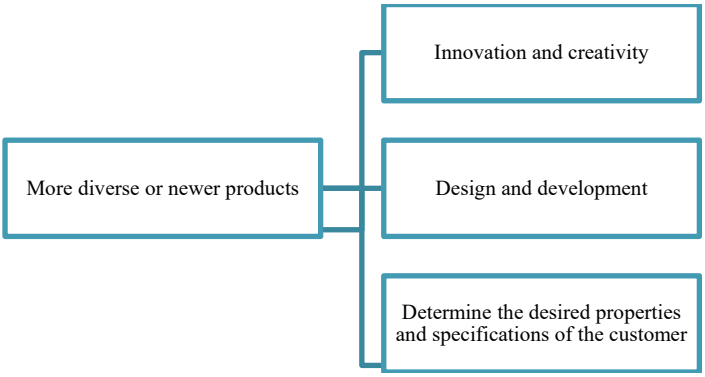
Now, suppose that the **first long-term objective** for the organization is to enter the global market; achievement of this objective will be done by defining the short-term objectives and planning how to achieve them.



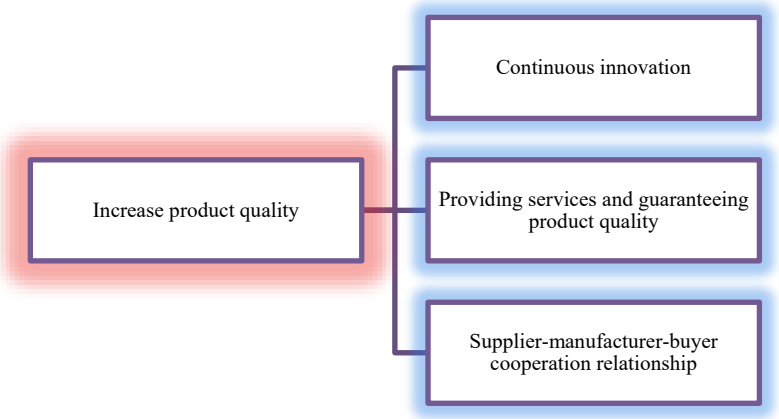
However, after entering the global market, we will come to understand that we need cost management and technology upgrades. Thus, the **second long-term objective** is identified—we define the short-term objectives, then planning is undertaken.



Following this, we may find that the organization needs a more diverse or newer product range as the market for the current product is saturated. As a consequence, we have defined our **third long-term objective**. Again, we define the short-term objectives and then undertake the appropriate planning.



This trend continues because consumer populations develop dynamically. Over the course of this period of time, it is important to note that for each long-term objective, we use a specific method to achieve it. In the above example, in relation to three long-term objectives, three specific methods were also specified. Now, the organization or business is faced with three different methods that can give three different results. How do we coordinate and adapt these methods while achieving the fourth long-term objective of increasing product quality?



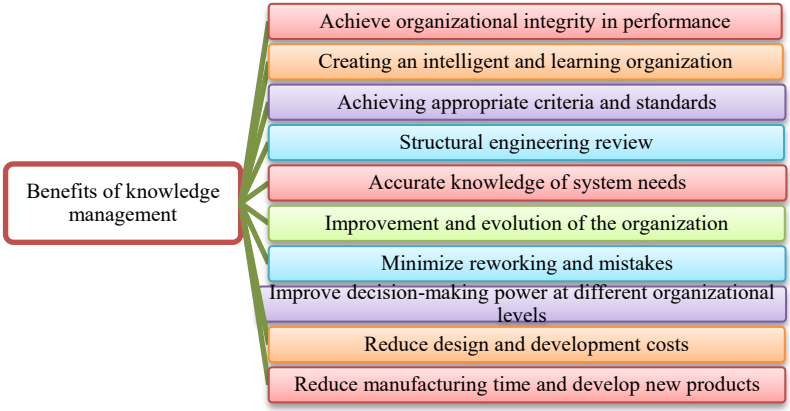
It is clear that **there is a need to integrate methods!**

On the other hand, the researcher might suggest that we must **do work with zero errors.** This means ***doing everything "right and great" the first time****; in particular,* ***doing "the right work" correctly first time.***[1]

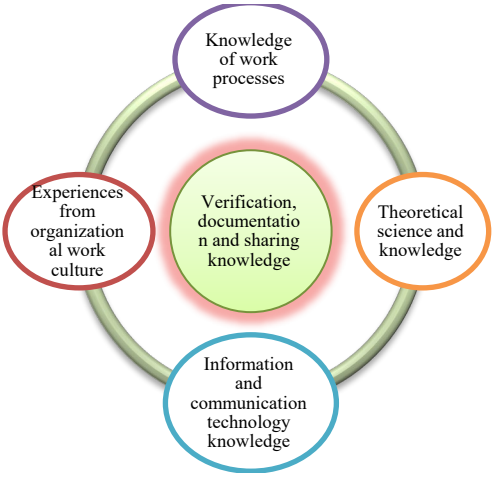
[1] That is, firstly, we must select the correct job and then do the job correctly the first time.

How then do we complete the job without error in an organization with many tasks and complexities? A task may be performed that is related to another task, but the operator is entirely unaware of this; or, with staffing and administrative tasks (such as design and planning), all the steps may be done carefully, but in the last step, we realize that a mistake was made at the first step. How can we repeat all the steps from the beginning while the mind is tired and there is still some doubt about the mistake? What happens if we repeat all the steps from the beginning and realize that the initial solution was, in fact, correct? All of these items indicate that **the administrative steps or industrial and manufacturing steps in the organization require integration and event recording.**

Now, let us assume that we have met all the necessary standards, we have weighed up all the aspects, and all the technology and equipment are ready to produce the product; but the final product is not produced to an acceptable standard? What is the reason? If everything has been done carefully, why has a quality product not been produced? In these cases, **experience and the knowledge of experienced people** are considered *organizational assets* because they are effective in **saving product manufacturing time** and **ensuring acceptable product manufacturing standards**. The following figure presents the benefits of knowledge management.



However, such people are not always available to us. ***Documenting people's knowledge*** *and* ***integrating it*** *is an important way of ensuring future manufacturing capability.*



If we assume that we have complied with all of the above and delivered an acceptable product to the customer, is this enough? Does time stand still while we rejoice in our success? Will competing companies not take action? Will the customer use only this product for hundreds of years to come? Where is *our foresight, attention to customer needs, technological advancement, which can be summed up in the phrase "take advantage of opportunities and threats against the organization"* in our planning? As such, there is a need to devise a method with **appropriate flexibility in the face of change**.

Note:

Flexibility is a requirement for every organization.

Given all of the above and the manufacturing of diverse products, what happens if we wish to improve a previous product? How do we know if improvement is needed? If improvement or development is needed, how do we implement this improvement or development with the least amount of reworking? Here, *all the **steps** and the **interactions of these steps** in product manufacturing must be considered*.

On the other hand, in improving or developing a product, we must look at four items. These are: (1) *understanding where we have been before*; (2) *knowing where we are now*; (3) *deciding where we want to go*; *and* (4) *prioritizing the **reinforcement of strengths** and the **avoidance of obstacles***.

As such, we need to pay full attention to the inside of the organization and the outside of the organization to determine the appropriate response.

Road map:

The **need for integration** can be met by the **Capacity Maturity Model Integration (CMMI)** process. The **need for flexibility** can also be met using ***agile manufacturing***. However, it should be noted that product manufacturing requires ***appropriate product quality*** and product quality should never be forgotten. Also, ***systems engineering*** will lead to comprehensive attention being paid to all issues, making it easier to ***decide to improve or develop***.

Note:

Integration→ **CMMI**
Flexibility → **Agile Manufacturing**
Quality → **Six Sigma or Other Methods for Quality Improvement**
Improvement and/or Development→ **Systems Engineering**

Book structure:

In the second chapter of this book, the **Capacity Maturity Model Integration (CMMI)** process (including capacity levels and maturity levels) is introduced. If you have created an organization, it is possible to use this model to ***optimize that organization***; if you are just starting out, you should ***use all available resources*** properly. **Agile manufacturing** is also introduced to address ***on-time delivery, technology upgrades, and customer needs***. Chapter 4 on **systems engineering** describes how to achieve ***systemic improvement or development***, while in the fifth chapter, the **Six Sigma**[2] quality technique is discussed. To implement this, specific quality improvement methods are needed, each of which is explained in a separate chapter. At the end of each chapter, a schematic roadmap is presented.

To achieve better management, several points need to be considered:

A) Do everything in due time and with patience and care.

Sometimes, we wish to undertake some work. To get the work done faster, we try to connect "the top and the bottom" of the job. For example, we may want to design a product according to a particular standard, but say "we have a lot of work today, we do not have time. But we have time tomorrow and we will do better to make it according to what we have learned and according to our opinion." As a result, we end up doing the work for today with low accuracy and at high speed, while tomorrow, we

[2] The Six Sigma technique is one of the best techniques; it can be applied to achieve product quality and productivity. This technique is a comprehensive method with several steps. To perform each step requires several quality methods, which are expressed in each step.

will have more work and will not have the opportunity to return to previous work to correct it. As such, correction and improvement may lag for an extended period of time without us making any changes. When we finally make the effort to undertake the correction and improvement of this work, we will encounter several problems:

1) Correction takes a long time—it would have taken less time when we first did the job; but now, we feel that spending a long time on its resolution is no longer worth it.

2) The next piece of work has already been done; if we modify the previous work, we must do all of this subsequent piece from the beginning, i.e. do a "rework."

3) We have so many important issues in front of us that we end up saying "this issue is not important and we will not do it."

Ultimately, in this scenario, there will be no correction and improvement *because it will require a lot of time and energy*.

Therefore, we must always keep in mind that it is better to do the job properly the first time and according to the precision and circumstances that we want. This is a "to-do" principle. The first step may take longer than before,[3] but we have gained in valuable areas:

- We did the job better.
- We do not have the stress of failing to complete the previous job.
- Our minds are not focusing on past issues and we think more deeply about the future.
- There is no need to return to this prior step and if there is a need for improvement, less time will be needed.

B) Prioritize tasks in planning.

Often when we think about our daily tasks, we somehow worry about when and how to do all this. As such, we *prioritize the hardest work in planning.* When you start and try to finish this hard job of planning, you will feel that you have lifted a heavy burden from your shoulders. As a result, you will feel more relaxed, you will have more self-confidence, your daily worries will be reduced, and everything else will be done more quickly and accurately.

Always remember that the priority is "*do the hard work*", i.e., do **tasks that require difficult decisions and a strong will**. Doing this hard work requires **a lot of patience, perseverance, and motivation**. If you take a step every day to advance your objectives, you will find that those objectives are not so distant.

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[3] We connected "the top and bottom of the job" last time, but now we want to do "the job" carefully.

Note:
Make hard work the highest priority and do it with joy and motivation.

Warning:
"Hard work" concerns "work plans" and jobs that require a lot of effort, experience, and training. Hard work does not mean choosing something/work you do not know about, as by doing it, you will become tired and be distracted from the main task.

C) Create motivation for yourself.

- If you feel you have no interest in doing something or in undertaking a particular piece of work, give yourself a chance to rest. For example, if you complete a particular section or finish some reports, you can go out and have fun.
- Set ***big and special objectives*** for yourself. Bigger objectives motivate a person more than smaller objectives. A big objective has a greater effect and can be a strong source of motivation.
- Act like a "motivated person." If you are bored and do not have the motivation to work, *imagine that* you are full of motivation. The good thing about this is that as soon as you start, you slowly feel that passion has come alive in you.
- Plan to do and then complete a ***small task***. For example, clean your desk, pay a bill or receipt, or visit your employees—you just need to start doing something. Once you have done this, you will feel ready to do the next piece of work. So, if you do not have the patience to do anything, start a small task so that its completion will enthuse you.

D) Start your work slowly.

Instead of trying to get started at speed, ***take the first steps slowly***. When you start work calmly and with relaxation, your brain does not receive the command that it must be completed as quickly as possible. But what happens if the human brain feels the need to finish its work schedule quickly? Often, the person may not start the job at all. ***Starting a business without haste is better than not starting it at all.***

E) Do not compare yourself to others.

Comparing yourself to others in terms of the results of your efforts and where you stand deprives you of human motivation and creativity. There will always be countless people who are more capable than you and there are few who surpass everyone, both materially and spiritually. *As such, just focus on **yourself**, **the plan you have in mind**, and, of course, **the results you achieve**. Do this to find out how you can improve and implement "mental planning*."

It is also important to reexamine your results, because you can find past mistakes and avoid repeating them or making similar mistakes. Another benefit is that it creates "double motivation." Understanding what have been the results of your efforts and where you stand helps increase your energy and enthusiasm; you will often be amazed at your success.

F) Always remember your successes.

Always and all the time, remember your successes, *instead of thinking about your failures and mistakes.* It is better to write them down, particularly the details, because it is very easy to forget about successes and occasionally referring to your written notes can bring back good memories in you and of course, keep alive the motivation for work and effort in you.

G) Act like a hero.

Read the life stories of your heroes, follow their behaviors and deeds, and listen to their words. Discover what was so special about their work that made them so successful? However, always remember that these people are like us and other people, and therefore, let them inspire you, instead of placing them on a pedestal and praising them unconditionally.

H) Try to make your work environment more bearable with a little fun.

Remember to make space for some fun and jokes (in the workspace you create or in the plans you have in mind). As a result, you will increase your motivation to do the job and complete it.

I) Do not just look for comfort and do not be afraid of failure.

Say goodbye to laxity, which is a form of laziness, and fight problems to motivate yourself. Instead of fearing failure, accept it as useful and important information and a natural part of success. Experience failure and ask yourself, what does this failure teach me?

J) Read about what you want to do.

When you start a job, do some research on the work process. You will be better aware of the value of the work ahead and the problems you may encounter. Sometimes unwarranted expectations and waiting unnecessarily reduces a person's motivation and wastes their initial enthusiasm and seriousness. By managing your desires, you can avoid wasting the energy that results from your passion. As such, maintain your

motivation to the very end. *It is useful and instructive to know about those who were in a similar situation to you, what happened, what path they chose, and what steps they took.* **You can choose the right method and start your activity by combining their chosen method and what you have in mind.** This situation can reduce your anxiety and you can better control the work situation. Both emotionally and practically, this awareness gives encouragement and assurance, because you know at least to some extent that others who have gone that way have encountered similar events.

K) Determine why you want to do this work.

If you do not know why you want to do this work, or you do not have enough reason to do it, it will be very difficult for you to get the job done. Choose something that you have a strong reason to do. If you are unable to complete the activity, stop doing it and start something else (for which the reasons are stronger and clearer).

L) Write down your objectives.

Write down your purpose for doing the activity, then stick it on the wall, your computer, or a mirror. During your day, review your work steps and this awareness makes it easier for you to continue.

M) Act with a positive outlook to get the job done (strive for positive thinking).

Learn to think positively and to get negative thoughts out of your head before they get in your way. We may not all always be able to think positively; we believe that we can strengthen this feeling in ourselves and help us to work harder.

N) Divide your work schedule up into several smaller plans.

If you have a large project in hand, divide it up into several smaller sections. Start by focusing on the first section of the work and when this section is done, start on the next one. The small successes you achieve in doing these initial parts will increase your motivation and prevent discouragement. If you follow this method, you will be amazed at the result.

O) Review the available information.

Having the necessary information at the beginning of any piece of work is essential, but sometimes the media conveys information that is negative. To evaluate your mental archives, eliminate negative points and use useful and positive information to achieve your objective according to your insight.

P) Use your creativity.

Take a piece of paper and write the objective you would like to achieve on it. Now write 20 ways, ideas, or views about this objective. Try adding 10 more ideas to your list; of course, not all of these ideas will be useful or good. Use your creativity and find ideas that will help you reach your

objective. You will not only use your creativity, but also come to realize how creative you are. In doing this, you will increase your motivation to do the work and provide yourself with suitable spiritual conditions.

Q) Listen to wise sayings.

Set up a small library for yourself. Write or record sentences that lead to personal growth and motivation. Listen to them while riding the bus or subway, driving, cycling, running, or walking, and read your notes.

R) Think beyond your living environment and ability.

Do not think that your future is only focused on your current abilities and what you have now; the world is not limited and your abilities are far greater than you think. Plan for a future where there are fewer constraints, using the experience you have gained so far and where you are now, i.e. broaden your horizons.

S) Consider time.

Life is short, so focus on today and do what you want. Tomorrow there will be other work to do.

References

The author's experiences and research.

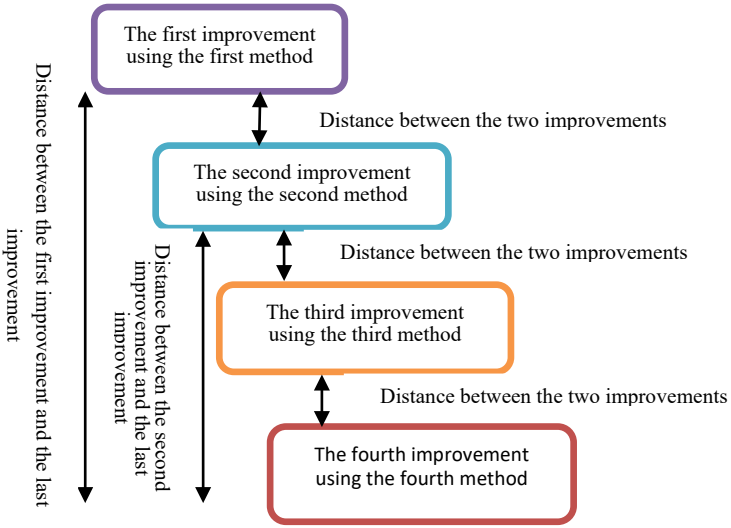
CHAPTER TWO

CAPACITY MATURITY MODEL INTEGRATION (CMMI)

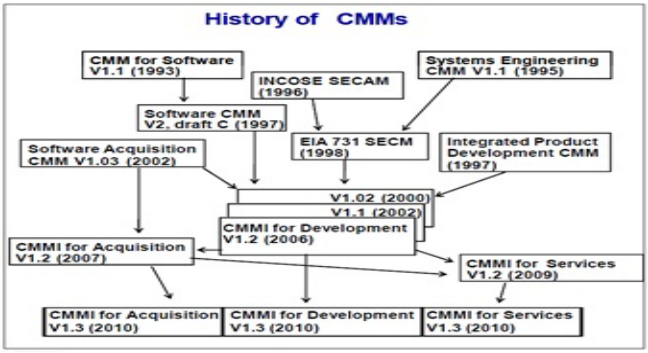
Now more than ever, organizations need to deliver better, faster, and cheaper products and services. On the other hand, with advances in technology, almost all organizations are increasingly realizing that manufacturing and producing products and services is very complex because complex product and service components cannot be produced and developed within a single organization. As such, it is common to make several components within an organization to provide several suppliers; finally, all the varied components have to be assembled and integrated into the final product.

Organizations must be able to manage and control this supply chain complexity. They need a **comprehensive and integrated approach** to develop their products and services and achieve their business objectives.

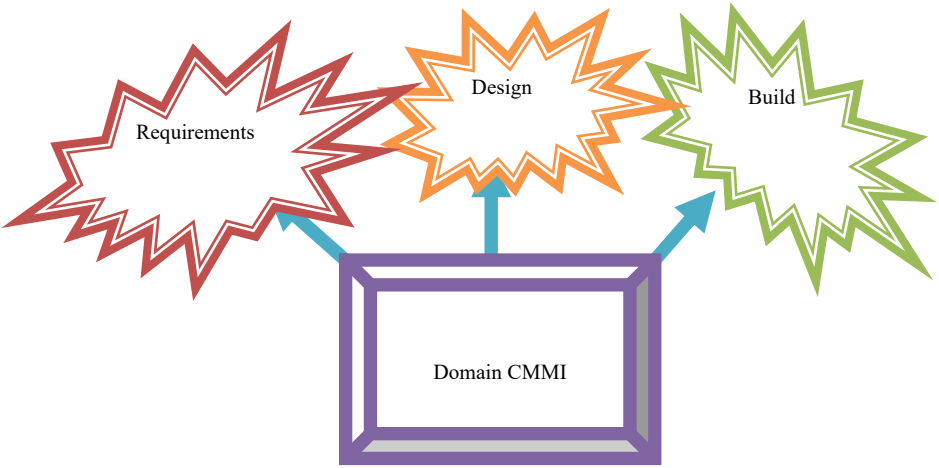
In today's understanding, there are a number of ways (including models, standards, and guidelines) to help an organization's progress. However, many of these improvement methods focus on a specific part of the business. They do not provide a systematic approach to the problems that organizations face and, therefore, the intractable obstacles that exist in the organization continue.



In this regard, maturity models have been proposed to help reduce and remove obstacles (intervals) to organizational improvement. These models eventually led to the development of Capacity Maturity Model Integration (CMMI).



As mentioned, the Capacity Maturity Model Integration for Development (CMMI-Dev) provides an opportunity to prevent or eliminate obstacles/barriers. This model includes a number of *best practices* and recommended *measures/actions to develop* products and services. These methods cover all steps of the product life cycle—from receipt to storage. The emphasis in this model is on what is necessary to build and maintain the product.



The CMMI model is a combination of two structures. The first structure is made up of **capacity levels and maturity levels**. The second structure is made up of **process areas.**[4] In the following, explaining and

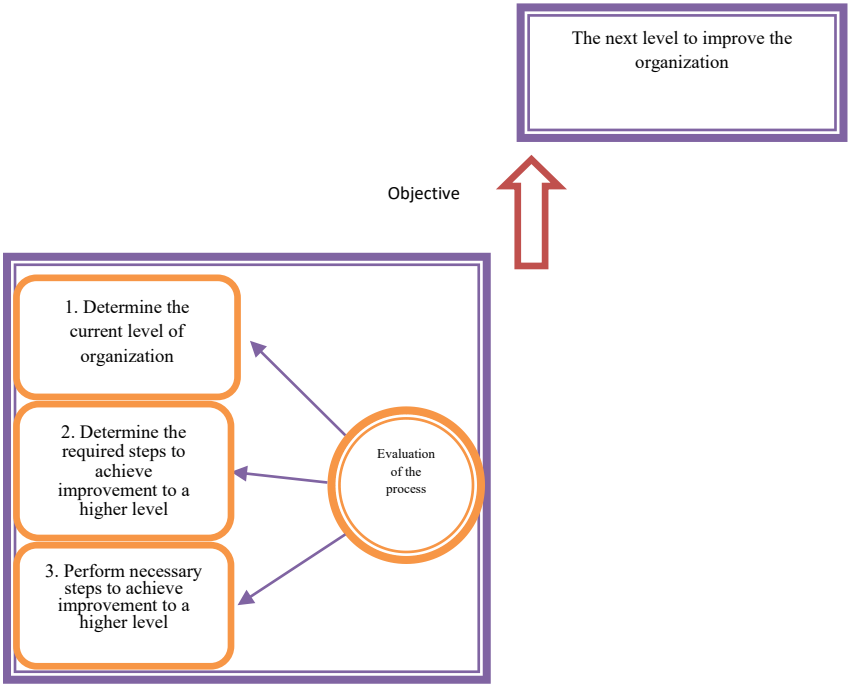
[4] Achieving any level of maturity/capability requires the implementation of process areas.

combining these two structures is discussed. It is worth noting that the CMMI approach and the quality approach, in general, constitute a ***process approach***, because the mutual interaction of processes (process balance) is considered.

Capacity levels and maturity levels

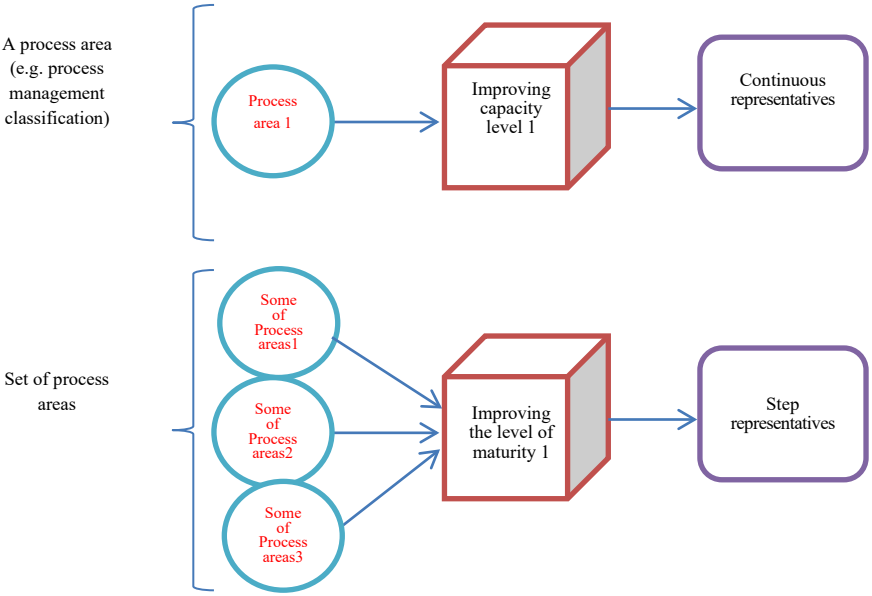
The CMMI model introduces levels of process maturity/capability to define an "improvement path" using an incremental (step-by-step) and continuous process and with a large number of small steps. These steps are based on the concepts and philosophies of Schwartz, Deming, Juran, and Crosby. These levels make it possible for the organization to assess the current levels of these processes. These levels help to prioritize the actions needed for progress (to achieve higher levels and further improvement).

Note:
Levels provide a recommendation (guidance) of the organization's evolutionary path to improve its processes and develop products or services.



Therefore, in the CMMI-Dev model, levels are introduced to ***determine the current situation of the organization*** and ***move towards improvement***. As such, the organization can move from its current situation to continuous optimization. Alternatively, the organization can start from a zero-level and move towards improvement.

The capacity maturity model integration (CMMI) supports two pathways of improvement. One path empowers the organization to increase process improvements associated with a ***specific process area*** (or group of selected processes) (***capacity levels***).[5] The other path enables the organization to improve a set of processes, including success in ***a set of process areas*** (***maturity levels***).[6]



[5] In the following, four classifications will be introduced (having 22 process areas). These four classifications are continuous representatives (i.e. capacity levels).

[6] As mentioned, four classifications are used for capacity levels (continuous representatives). But for maturity levels, a combination of 22 process areas can be used (step representatives), regardless of the four classifications.

To achieve a particular level, the organization must meet all the objectives of a process area (capacity level) or set of process areas (maturity level) to improve, regardless of whether it is a capacity level or a maturity level. ***Both provide ways to improve processes to achieve business objectives.***

Note:
Process: a set of activities that have one or more inputs; by processing the inputs, one or more outputs are obtained that create value for the process customer.
Process area: implement a set of related actions in an area to meet important

Capacity level

- Level zero

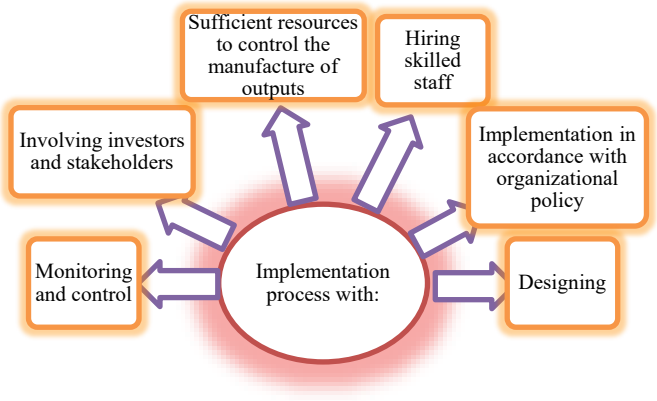
An *incomplete process* is a process that has not been done, or has been done only partially. One or more specific objectives from the process area are unsatisfactory and *there are* ***no general objectives*** *for this level* because there is no reason to create and execute the process partially.

- Capacity level 1: implemented (ongoing)

The indexing process at this level is the *implementation process.* The implementation process is the process that enables and supports work requirements to produce work products. At this level, process area-specific objectives are satisfactory. The result of capacity level 1 is significant improvements; however, if these improvements are not maintained, then they can be lost at any time.

- Capacity level 2: Managed

A capacity level 2 process is a *management process.* A management process is an implementation process that has *the basic infrastructure to support the process*. In fact, capacity level 2 (management process) is a combination of capacity level 1 (implementation process) and the following elements: *design; implementation under organizational policy; hiring skilled employees; sufficient resources to control the manufacture of outputs; involving relevant investors; and monitoring and control.*



- Capacity level 3: defined

Capacity level 3 is determined by the *definition process*. The definition process is a management process that is based on a set of *standard organizational processes* under the appropriate guidelines for the organization.

A special score between levels 2 and 3 concerns the standards, process descriptions, and methods. This is because, at capacity level 2, the standards, process descriptions, and methods can be quite different for each specific instance of the process (such as a particular project). However, at capacity level 3, standards, process descriptions, and methods are based on a set of organizational standard processes that are appropriate for a particular project or organizational unit and are therefore more robust (except for the differences permitted by the appropriate guidelines).

Another critical advantage of capacity level 3 processes is that they give a *more accurate description* than those at capacity level 2. A clearly defined process describes the following: *purpose; inputs; input measures; actions; roles; measurements; validation steps; outputs; and output measures.*

The distinction between level 3 capacity and level 2 capacity:

A) Defining and describing *standards, processes, and methods.*

B) Determining and describing *purpose, inputs, input criteria, actions, roles, measurements, verification steps, outputs, and output criteria.*

- Capacity level 4: Quantitatively managed

Capacity level 4 is described as the *quantitative management process*. The quantitative management process is based on a defined process that controls the use of quantitative and statistical techniques. Quantitative

objectives should be set for the implementation of a process and its quality, and used as criteria for process management.

Achieving capacity level 4 indicates that this area of the process is a *key driver of the business* and the organization wishes to achieve control through quantitative and statistical techniques. This analysis gives more insight into the implementation of selected sub-processes that ensure a competitive advantage in the market.

- Capacity level 5: optimization

Capacity level 5 is described as the *optimization process*. An optimization process is a quantitative management process based on the common concept of intrinsic causes of change and instability in the process. The focus of the optimization process is continuous improvement, enhancing improvement and innovation.

Reaching capacity level 5, selected sub-processes can be implemented consistently and continuously, and common causes of change and instability can be reduced.

Note:
Remember that "change" is an inherent cause in every process, and, while it is possible to improve all processes, this may not be affordable. **It is better to focus on those processes that help us achieve our business objectives.**

Comparison between capacity levels and maturity levels

Level of capability	Description	Indicator process	Level of maturity
Level Zero: Incomplete	The process is not done or only superficially done	Incomplete process	**Level one: initial**
Level one: performed	Processes performed as usual	Performed process	
Level two: managed	At this level, the implementation of the CMMI model begins; planning, organizing, directing and monitoring related resources and investors (including customers, stakeholders, suppliers, etc.) to achieve the objectives of the organization	Managed process	**Level two: managed**
Level three: defined	Process definition is performed under set standards	Defined process	**Level three: defined**
Level four: Quantitative managed	Use of quantitative and statistical techniques to perform and control the process	Quantitatively managed process	**Level four: quantitatively managed**
Level Five: Optimized	Determining the intrinsic causes of change and instability in the process for correction and improvement	Optimized process	**Level Five: optimized**