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Quality Management in improving the process of Ready Mix Concrete production

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Alaa AL-Saedi

Table of content

Abstract

Zarządzanie projektem wyraża się w takim wykorzystaniu wiedzy, umiejętności praktycznych, narzędzi i technik, aby odpowiednio planować kolejne krok realizacji określonych przedsięwięć. Jego stosowanie przynosi ze sobą wiele korzyści, między innymi obiżoną liczbę remontów, wzrastającą wydajność, redukcję kosztów, wzrost satysfakcji klienta, wreszczie podniesienie dochodowości. Trzon pracy tworzą analizy optymalizacji procesów zarządzania jakością, stosowanego w fabryce produkującej beton Ready Mix Concrete (RMC). Badaniu poddano wpływ najpierw kontroli jakości oraz zarządzania nią, a następnie wkład kompleksowego zarządzania jakością na proces produkcji. Wszystko to w perspektywie wprowadzania koniecznych ulepszeń w funkcjonowaniu systemu jakości umożliwiających wprowadzanie kolejnych usprawnień procesu produkcji. W celu zrealizowania celów i zadań dysetracji wyodrębnono trzy powiązane ze sobą obszary dokładniejszych analiz: zebranie informacji celem rozpoznania obecnego systemu jakości, rozpoznanie i analiza problemów, znalezienie rozwiazań, wywiedzionych z adekwatnych do danego problemu zasad zarządzania. Sporządzenie Adekwatnego opisu i eksplikacji procesu produkcji domagało się użycia wielu metod i instrumentów teorii zarządzania, takich jak:schemat blokowy procesu,diagramy Ishikawy pomocny w zdefiniowaniu siedmiu głównych grup problemów,rejestr występujących problemów umożliwiający analizy FMEA (analiza rodzajów i skutków możliwych błędów) w stosunku do 35 problemów i uszeregowania potencjalnych usterek w oparciu o ich występowanie, wykrywanie i wagę określonej usterki,metoda 5 Whys użyta w stosunku do trzech najważniejszych problemów i zaproponowanie strategicznych rozwiązań poprzez analizę związku przyczynowo,skutkowego pomiędzy zastosowanym rozwiązaniem a efektem dla wszystkich problemów w procesie,schemat blokowy dla procesu, po zastosowaniu zapewnienia i kontroli jakości w procesie,matryca odpowiedzialności w zarządzniu zasobami ludzkimi,diagramy Ishikawy dla ryzyka, analiza ryzyka i diagram, strategia zapobiegania ryzyku i podejmowane działania,struktura podziału pracy (jako technika zarządzania przedsięwzięciami) . Matryca powiązania, ma wykazać zaangażowanie po zmianach w strukturze firmy, PDCA, aby ulepszyć i rozwinąć proces całkowitego zarządzania jakością.Przeprowadzone eksploracje wykazały brak odpowiedniej organizacji procesem zarządzania w firmie. Spośród najważniejszych powodów takiego stanu rzeczy braku należy wymienić następujące: brak doświadczenia w zarządzaniu, brak umiejętności nawiązywani ipodtrzymywania, brak zainteresowania ogólnym zarządzaniem jakością w organizacji całości procesu produkcyjnego, co stanowi przejaw systemowych zaniedbań (struktury, procedury, zasoby). Badanie ukazało także ograniczenia procesu produkcyjnego. Stanowią one skutek nieadekwatnego wykorzystywania metodologicznych

założeń i pryncypiów nauki o zarządzaniu. W celu skutecznego przeciwdziałania zaobserwowanym ograniczeniom procesu produkcji konieczne jest stworzenie metodycznie uporządkowanego planu kolejnych faz przedsięwzięcia. Mogłoby to dokonać się w oparciu o „Guide of Project Management Body of Knowledge 5th edition”, który dostarcza niezbędnej wiedzy odnoszącej się do skutecznego zarządzania procesem produkcji betonu.

Abstract

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the requirements. The welfare of conference quality requirements contains higher productivity, lower costs, less rework, increased customer satisfaction, and increased profitability. This study investigated using of Quality management to optimization the process of the company to produce Ready Mix Concrete (RMC) in the batching plant and studied the impact of Quality Control, Quality Assurance, and Total Quality Management on the company by making improvements to current Quality system and makes it continuous improvements.

To achieve that the thesis investigated three main points: the first is gathering information to identify the current quality system, the second is identifying and analyzing these problems and the third is finding solutions based on the principles of management.

To manage the process of production the researcher used many techniques and tools for Management such as a Flow Chart for the process of the company, Ishikawa diagrams to define seven main groups of problems, a Check Sheet to record the number of occurrences of problems, then use it in FMEA Analysis for thirty-five problems to prioritize potential defects based on their Detection, Occurrence and Severity, 5 Whys for the most important three problems, then propose strategic solutions by solution effect analysis for all process problems, the Flow Chart for the process after applying Quality control, Quality assurance in process, the Responsibility matrix for the Human Resource Management, Ishikawa diagram for Risks, Risk analysis and diagram, Risk prevention strategy and action steps, and the Work Breakdown Structure for the procurements.

Relationship Matrix to show involvement after changes in the structure of the company, PDCA to make the improvements and updating process continuous to reach Total Quality Management.One of the most important results from this study is the main reason for the absence of management methodology in the company is a defect in the Quality system (structure of company,procedure, and resources), lack of management experience, and lack of

interest in Total Quality Management in management methodology.

The researcher found a lack of thoughtful scientific methodology for the management in the process of production, therefore the developing of the system of production in the RMC plant is to build a methodology based on a guide of Project Management Body of Knowledge 5th edition because of the maturity level of the project management knowledge areas.

CHAPTER ONE

INTRODUCTION

1.1 General

Concrete is one of the main constituents of the construction, predominantly of most multi-storied concrete constructions. It is the most general of all the structure materials, it is regularly considered as the most economical one and it is a durable and strong material.

The quality of concrete products has also an actual straight effect on the strength and durability of the construction as an entire. Therefore, there is an advantage to producing concrete in a Ready Mix Concrete batching plant. The gears of sand, gravel, cement (usually Portland type), and maybe extra additives necessity are delivered to the construction site as one material called concrete. Also, a source of spotless water is essential for the concrete batching process. Also after totally the heavy and dusty materials have been put into the hopper even one minor mistake inthe ratio of wet/dry materials can make the whole concrete product unusable.

The Quality of concrete products is below threat for several causes resulting in poor quality oruseless products. Many codes of practice provide procedures for execution standards and tests for approval. Product sampling and testing are the main componentsof quality control. Similarly, sampling and testing of raw and fabricated materials are essential. We can describe Ready Mixed Concrete (RMC) as a type of concrete delivered in a plastic state and needing no more treatments before actuality being placed on the work site where it is to be set andstrengthened. RMC is a particular material in which the sand, cement, aggregate (gravel), andperhaps extra additives are evaluated at a plant and mixed in a batching station or mixture truckbefore delivery to the construction site. Therefore, the concrete is readymade in a manufactory and transported within the expected journey time.

Fresh concrete is produced under plant circumstances and authorities control the entire process of production and transportation of concrete owing to its strength, lower cost and it is the ability to be modified for dissimilar applications. At present, the concrete is ordered in quantities of cubic meters units. The usage of the RMC is likewise simplified by a boom placer mounted on a truck which can push the concrete at multi-storied or ordinary constructionsites. The key benefits from RMC are good quality, lower Life cycle cost, speed of work, and friendliness of the environment are more than the site mixed concrete.

1.2 Problem description

After 2014, the problem of stalled construction projects in Iraq emerged. These problems are the lack of the number of these projects and the lack of completion of these projects within the planned time, allocated budget, and required quality makes the need for Ready Mix Concrete less than before and that makes the companies of Ready Mix Concrete so competitive to keep its position in the market by focusing on quality management. The researchers focused on adapting modern principles to management. Famous methodologies have been applied extensively in many parts of the world and the most famous are the American project management Institute methodology (PMI) and PRINCE2 methodology in British. However, that does not mean that compliance with these methodologies or other well-known methodologies. Because of the experience of the researcher in the construction sector and direct contact with company's managers through deals, meetings, and personal interviews, the research problem can be summarized in the lack of Iraqi Read Mix Concrete companies to clear the Quality Management system for these companies.

In our case study and from the data that we got from Al-Senaf Company for the productionof Ready Mix Concrete (RMC) and interviews with the head of the company, the employees responsible for the production process, and the field visits to the plant work site. The researcher noticed that in the past two years:

1. Production rates have been reduced from 1000 to 200-100 cubic meters per day as a result the company began to lose skilled employees.
2. The company deals with several reliable contractors, the foreign and localcompanies and government departments have begun to lose them.
3. It's begun to lose money on maintenance of the parts of the manufactory and equipment thattransport concrete to the work site.
4. Lose money due to materials and fuel losses because equipment aged.
5. The fore there is a need to predict the expected problems or failures in the process basedon actual information from this company to analysis it and find solutions.

1.3 Research Hypothesis

The following points can describe the research hypothesis:

1. There is no clear Quality Management system in the company.
2. There are problems in the processes of production.
3. The concrete production process needs continuous improvements and updating processes.
4. Total Quality Management can make the company a strong competitive in the market.

1.4 Research Objectives

The problem description in the previous section reveals that this research has an extensive area of interest. The main objectives of this study are:

1. Exploring and identifying the problems and obstacles in the process of production of Ready Mix Concrete.
2. A thorough analysis and diagnosis of the problems in the process and what is the effect of this failure on the results of the process the biggest problem and the roots of the causes.
3. Propose solutions to the problems to eliminate the wastes in cost, materials, equipment, fuel, and any other resources to a minimum extent.
4. Apply Quality control and Quality assurance in the process to provide Ready Mix Concrete with consideration of the best degree of homogeneity and reliability to match market requirements.
5. Develop the system of production of the company and contribute to the application of the management principles by managing another area of knowledge.
6. Using Total Quality Management methodology to involve everyone in the process and to make improvements to the Quality system of the company and make it as cycle of continuous improvements and updating processes to meet customer satisfaction.

To achieve the aims of the study the following subjects have been identified as shown in the figure below.

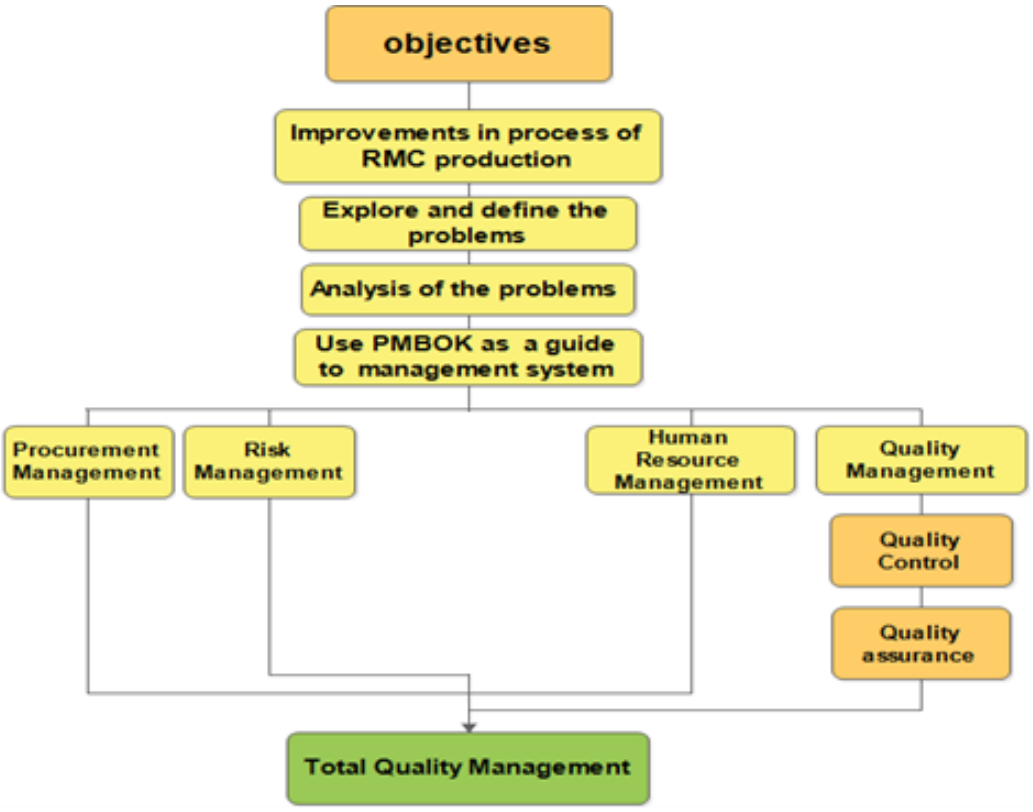

Fig. 1. Research objectives *(Researcher).*

1.5 Research importance

The importance of this study as a new added to the fields of knowledge as it can be beneficial for researchers in the academic field and engineers in the practical field. The researcher aspires from his research to be a research example for the development of Ready Mix Concrete producing companies in Iraq according to quality management principles.

1.6 Research Methodology

To achieve the study objects required, the researcher depends on the following methodology asshown in the figure below:

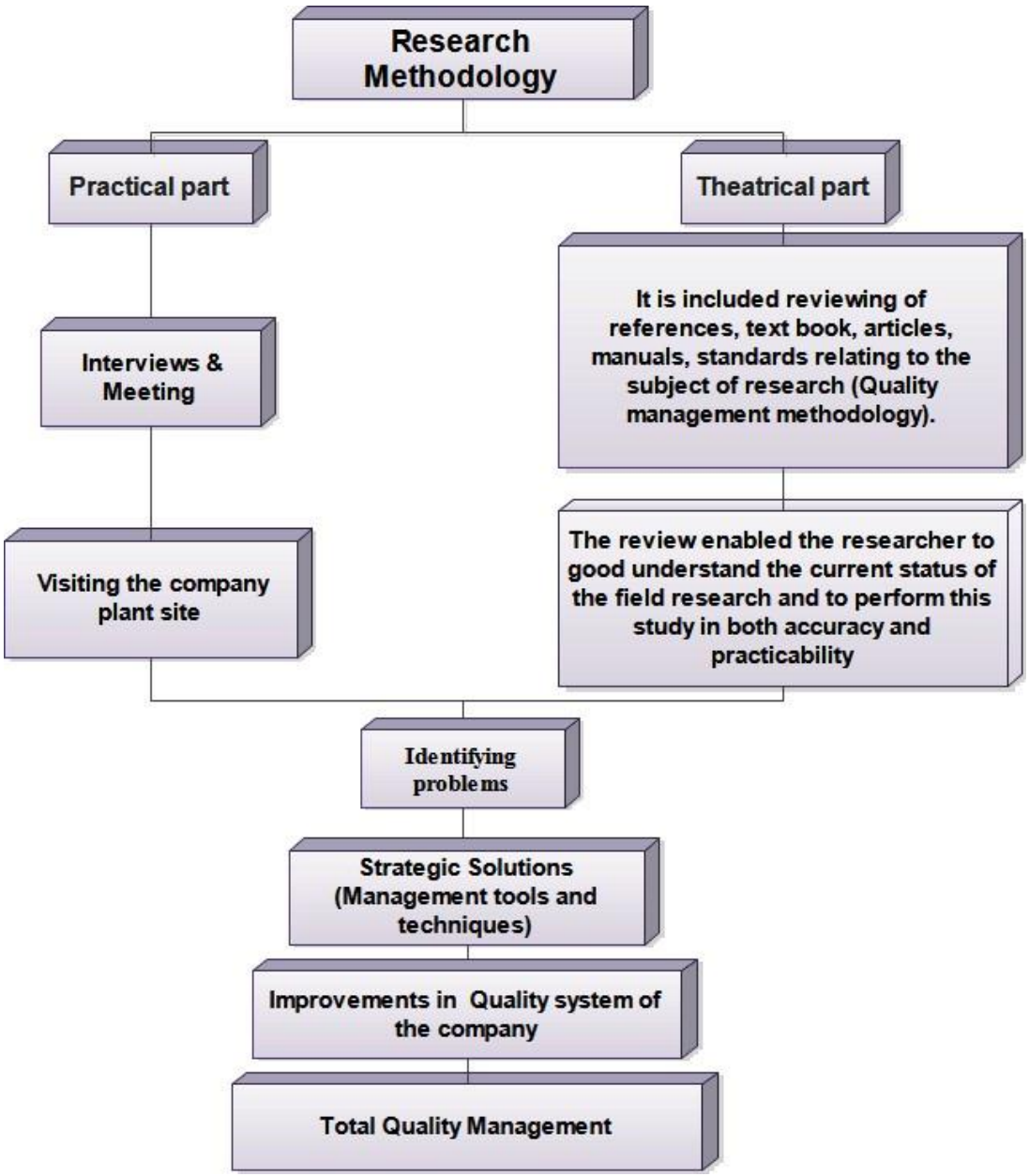

Fig. 2. Research Methodology *(Researcher)*.

1.7 Structure of the thesis

The structure of the thesis was as follows:

1. Chapter One: Introduction

   The first chapter provides an introduction to the whole thesis, including a general introduction to the subject of the research. Also, it defines the research problem, hypothesis, objectives,methodology, and structure in addition to the literature overview.

2. Chapter two: Definition and Concepts

   The second chapter provides definitions for the terms and concepts that are used in the whole thesis and explains the most important terms related to quality and management tools and techniques used.

3. Chapter three: Process Description

   The third chapter provides a comprehensive and accurate description of process production through manufacturer description, product description, manufacturing process description, and problems description.

4. Chapter Four: Processes Management

   The fourth chapter identifies and analyzes problems in the company and clarifies the group to which they belong, then analyzes to find out the root causes and determines the most influential in the process to find the main reason, then propose solutions for all problems and execute these solutions by applying Quality Control and Quality assurance in the process by managing the knowledge areas where problems exist to reach the Total Quality Management.

5. Chapter five: Conclusions

   Provides conclusions of the work carried out in research and further research.

1.8 Previous studies

In this part, we will review examples of study about RMC and management as follows:

1. M. Alhozaimy and A. Al-Negheimis.: *Introducing and Managing Quality Scheme for RMC Industry in Saudi Arabia*. September,2014.
2. A.Momani, and Others.: *Costing of the Production and Delivery of Ready Mix Concrete*. April 2012.
3. William C. Twitty, Jr., P.E and Others.: *Quality Management System for Ready Mixed Concrete Companies.* February, 2008.
4. H. Naiknavare, S. Deshpande, and R.Padhye.: *Model Chart of Quality Control Process for Ready Mixed Concrete Plants*.

CHAPTER TWO

DEFINITION AND CONCEPTS

2.1 Definitions and Concepts of Quality management

2.1.1 Overview of Quality Management

Quality management can be traced back to Walter Shewhart who while working at Bell Lab in the 20s developed concepts of process control and process improvement [1].

Shewhart is credited as being the inventor of the control chart and the Plan, Do, Check and Act(PDCA) cycle Edwards Deming and Joseph Juran taught the Japanese in the 50s how to execute these ideas of process control and process improvements [2].

W. Edwards Deming remained the world-class management consultant who helped Japan industries learn new principles of management which revolutionized their quality and productivity [3].

Faithfully followed his doctrine that "quality should be aimed at the needs of the customer", his experience as a consultant in statistical methods is summarized in perfect 14 principles of management which are the basis of what is now called Total Quality Management and Joseph Juran who developed many of the management tools and concepts [2].

Quality management is the implementation of the concept of a process which its customers and suppliers. A process is probably thought of as a set of activities organized to achieve some objective. In manufacturing, it is the series of activities necessary to turn raw materials into objects which can be mixed for delivery to some customers or it is the set of activities necessary to turn a concept into an executing application. The set of activities may be very rudimentary or may be very complex, the maturity of the process and the kinds of activities included in theprocess can have an enormous bearing on the resultant quality of the product, the establishing such structures of activities naturally creates by Marcel Dekker who found an opportunity to establish feedback loops both internal and external around each process in an organization. These feedback loops help identify opportunities for improvements and provide information for controlling processes. Both the control and improvement of processes rely on the use of statistical methodology. Deming and Juran are mentioned in most management textbooks and Quality has become recognized as a major strategic dimension by modern enterprises that are forced to keep up with rapid changes and world competition [2].

2.1.2 Quality Definition

The search for a universal definition of quality has yielded inconsistent results a global definition does not exist rather different definitions of quality are appropriate under different circumstances [4].

The Quality has various definitions for each person. American Society of Quality (ASQ) defines it as “a subjective concept for which every person has his or her definition”. In technical use quality may have two definitions [5]:

1. The features of a product or service that afford on its capacity to satisfy specified or initial requirements.
2. A product or service Free of shortcomings.

International Organization of Standardization (ISO,1994) defines quality as “the totality of features of an existence that afford on its capacity to satisfy stated or required needs” [6].

Pyzdek in 1994 shows that there is no generally single accepted definition of quality [7].

He produced five principal procedures for defining quality which have been viewed by Garvin as follows [5]:

1) Transcendent “Quantity cannot be defined, but you can find a way to know what it is”.
2) Product “based on Differences in quality, amount located to differences in the quantity of desired products or attribute”.
3) User "based on the Quality contains the ability to meet needs".
4) Manufacturing "based on Quality tools to meet requirements" [8].
5) Value "based on Quality is the degree of excellence at the most acceptable price and the control of variability at cost". Quality means the best conditions for customers, such as the selling price of products and actual usage [9].

The definitions of quality above can be summarized below the names of the contributors to the quality effective whose tools, methods, and philosophies have been proved essential in quality. They are called the “quality Geniuses”. Their definitions of quality are:

a) W.E.Deming “Quality should be designed into both product and the process, it is the expected degree of homogeneity and reliability at the lowest possible cost and matched to market requirements” [5].
b) Joseph Juran “Quality is fitness for use, or it is the usefulness of product and service” [10].
c) John S. Oakland “Quality is conformance to the requirements of customer” [5].
d) Kaoru Ishikawa “Quality of the product as well as services after sales, quality of management of the company and the human” [5].

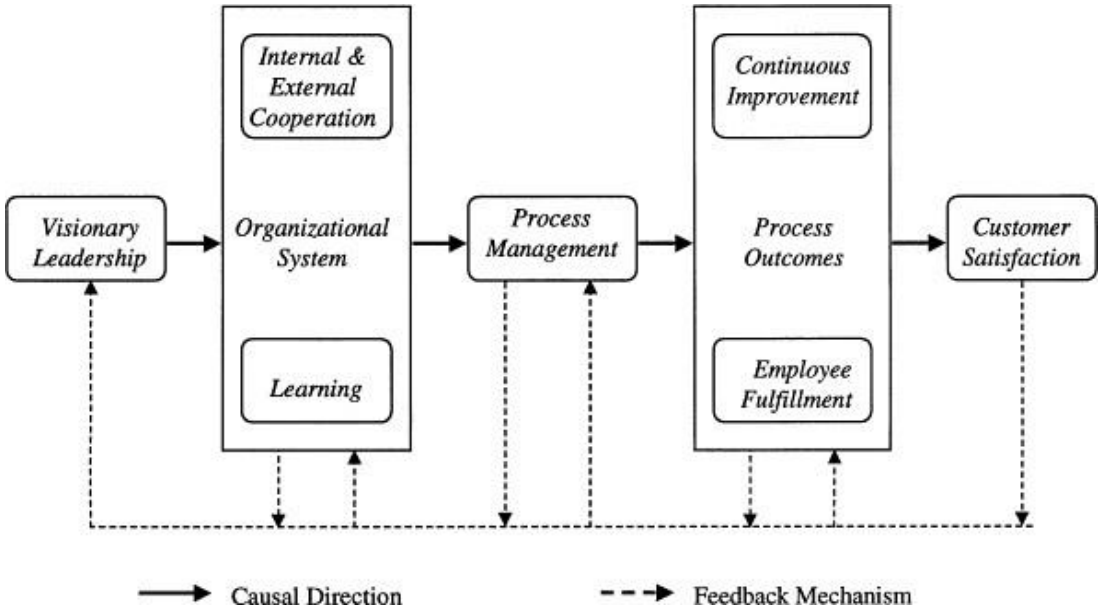

Fig. 3. The theory of quality management underlies the Deming Management Method [11].

e) Philip B. Crosby "meeting the requirements not as elegance or goodness" [12].

2.1.3 Process

Set of interrelated resources and activities that transform inputs into outputs, resources may include personnel, finance, facilities, equipment, techniques, and methods [6].

2.1.4 Product

Result of the activities or processes (product may include service, hardware, processed, materials, software, or a combination thereof). The term product is used throughout this International Standard. It can be tangible or intangible or a combination thereof [6].

2.1.5 Cost of Quality

It is a methodology that allows an organization to determine the extent to which its resources are used for activities that prevent poor quality, that appraise the quality of the organization's products or services, and that result from internal and external failures [13].

Quality-related activities that incur costs may be divided into prevention costs, appraisal costs, and external and internal costs of failure [13].

The quality cost includes the entire cost throughout the product life by investment money in preventing non-conformance actions, appraising the service or product for meeting the requirements, and failing to conform to requirements or rework [14].

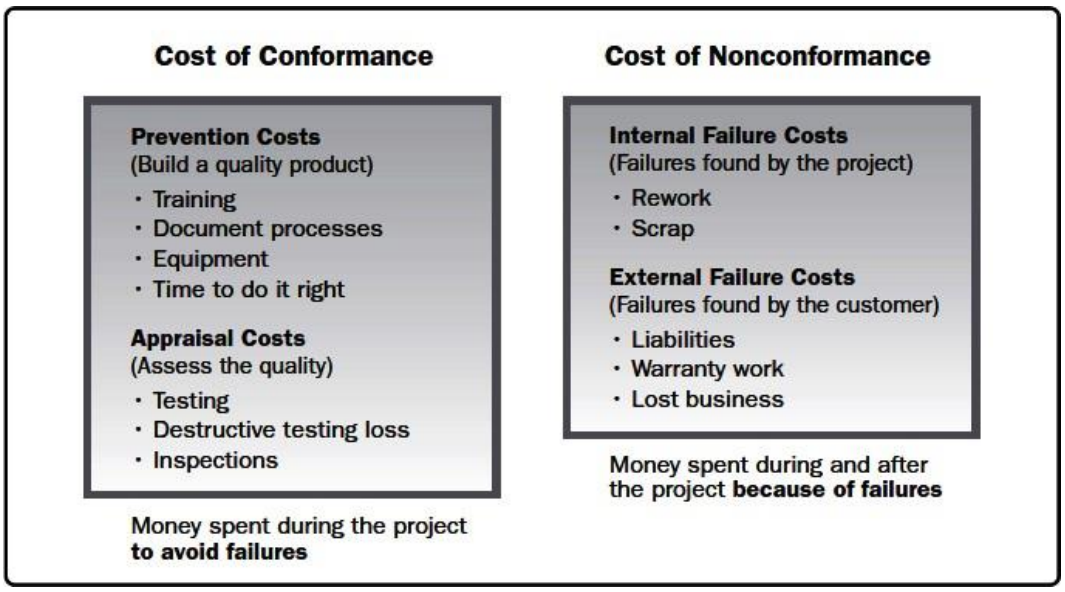

Fig. 4. Cost of quality [14].

Failure costs are classified into internal which is found by the project and external which is found by the customer [14]. It is the costs incurred to ensure quality. The cost of quality includes quality planning, quality assurance, quality control, and rework [15].

2.1.6 Quality Assurance

The process of guessing the whole process performance on a good basis gives confidence that the process will satisfy the suitable standards of quality, it's the organizational unit that is assigned responsibility for quality assurance [15]. Quality assurance plays an important role in the maintenance of quality processed products at levels and tolerances acceptable to the consumer. It also ensures meeting government regulations, reducing the probability of spoilage, minimizing the cost of production, and raising the product value [16]. ISO: 9000 describes the key concepts of quality assurance which include the objectives and responsibilities for quality, stakeholder expectations, the concept of a process and its role in a quality system, the roles of documentation and training, and the application of other standards. ISO 9001 certification gives the company Quality systems that will provide the foundation for better customer satisfaction, staff motivation, and continual improvement. ISO 9004 on the other hand guides the development and execution of a quality system. The latest revision to the ISO standards, which is currently known as ISO 9001:2008, where the ISO 9001:2015 has just been launched, replacing the previous version provides a recognized international quality standard that businesses can follow [3].

2.1.7 Quality Control

Monitoring and inspection of the process results to evaluate if they are meeting associable standards of quality and define ways to remove causes of non-conformance performance, it's the organizational unit that is assigned responsibility for quality control [15].

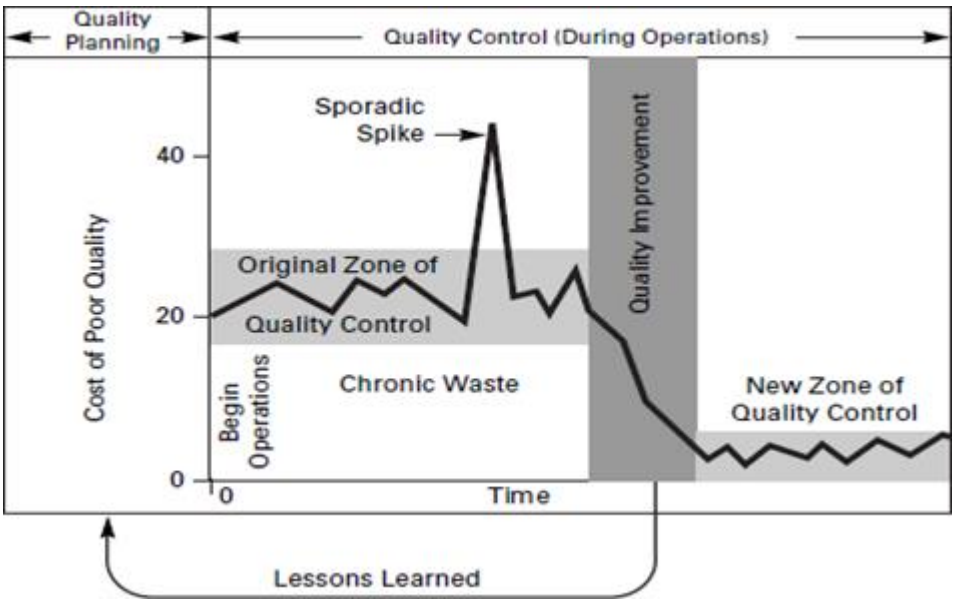

Fig. 5. Juran trilogy diagram [10].

Quality control is one of the three basic managerial processes through which quality can be managed; the others are quality planning and quality improvement. The Juran trilogy diagram figure below shows the interrelation of these processes [10].

2.1.8 Quality System

Quality system is the Organization structure, procedures, responsibilities, and causes of the quality management execution. It is a method of maintaining consistent quality in producing products or providing services that will meet or exceed customer's implied or state needs [17].

2.1.9 Quality improvement

The quality improvement process rests on a base of certain fundamental concepts. For most companies and managers, annual quality improvement is not only a new responsibility; also, it is a radical change in the style of management and a change in company culture. Therefore, it is important to grasp the basic concepts before getting into the improvement process itself. The huge number of projects carried out demonstrated that quality improvement applies to service industries, manufacturing, business processes, processes, support activities as well as operations software and hardware [10].

The construction industry is that sphere of the economy that presents enormous possibilities for improvement in quality management. like the activities that should be considered, handicrafts of industry processes, restrictions on automation and robotics, strong impact of the environment and fragmentation of processes, as well as the predominant criterion of cost minimization in contracting construction works [18].

2.1.10 Total Quality Management

A different definition of the TQM has been viewed over the years till the present day [19]. Levitation competitiveness in the world markets has resulted in the requirement to address quality management in all aspects of business, including customers and suppliers.

Total means that everyone in the value chain is involved in the process, including employees, customers, and suppliers. Quality means products and services must meet the customer's needs. Management means management must be fully committed and encourage everyone else to become quality-conscious [20].

It is a collective approach to the execution of a quality improvement process within the process ofthe organization [15].

It's the management of quality at every stage of operations, from planning and design through self- inspection to continual process monitoring for improvement opportunities [21].

The concepts of the TQM can be modified into two wide categories or dimensions: social or the easy and the technical TQM. The social TQM is designed for human resource management and establishment training leadership, employee involvement, and teamwork. The technical reflects the direction toward optimization production operations methods and establishment of good processes and procedures to be able to do constant improvement of products and services. The management of social or technical TQM cannot be treated in isolation. Social and technical issues should be interrelated mutually and support each other reflecting the holistic concept of what to expect will be results from it is initiative. It provides superior value to the customer by identifying customers' needs and expressed, responsiveness to market changes, as well as improving the effectiveness of the processesof the company that produces the service or products [20].

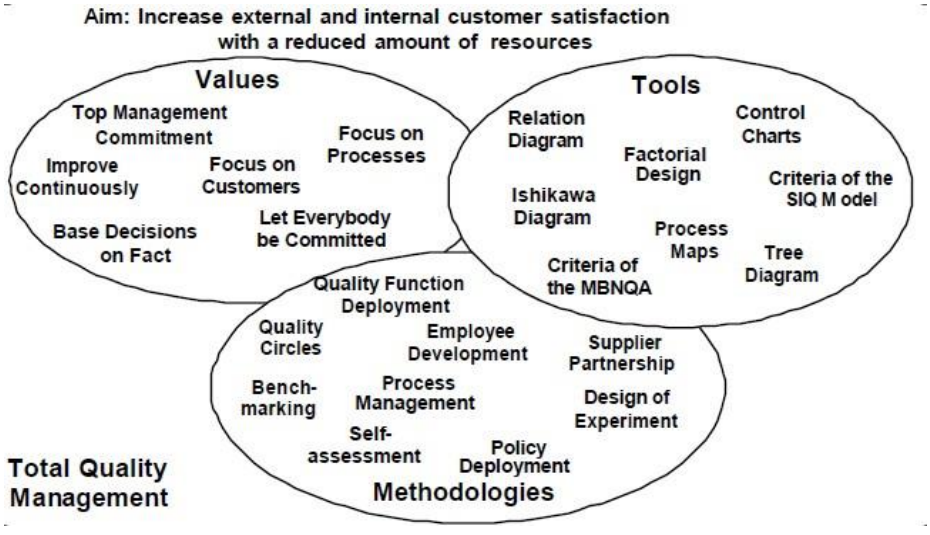

Fig. 6. Total Quality Management (TQM), the values, methodologies, and tools example [19].

2.1.11 Flow Chart

It is a type of diagram that represents an algorithm workflow or process showing the steps as boxes of various kinds and their order by connecting them with arrows. This diagrammatic representation illustrates a solution model to a given problem. It's used in analyzing, designing documenting, or managing a process in various fields [19].

2.1.12 Fishbone or Cause- effect tool

The fishbone or the cause-and-effect chain tool is also sometimes called Ishikawa or root cause analysis which provides a visual map of the factors or the causes that contribute to a particular problem (effect) and is best used while exploring a given problem at an early stage or during the analysis phase to dig deeper. It helps to identify, explore, and display a possible cause related to a problem and to similarly discover the root causes and show dependencies amongst causes and underlying drivers. In other words, it is the graphic illustration of the relationship between a problem or goal or the effect and its underlying contributors the root causes [14].

2.1.13 Check List

The checklist is a structured way containing specific instructions used to substantiate that a setof steps has been completed based on the process requirements and practices [14].

2.1.14 Failure Modes and Effects Analysis (FMEA)

FMEA is a systematic tabular way for access and reporting, the causes and effects of known types of constituent failures. It includes a quantitative estimate of the significance of the consequences of a failure mode [14].

All the problems and barriers will be analyzed in terms of probability of occurrence, ease of detection, and the importance and impact on the functioning of the entire company. The Risk Priority Number (RPN) factor will be calculated by multiplying detection by occurrence by Severity of the problem. The higher the RPN is the more important issue is for the company [22].

2.1.15 5 Whys

An effective technique when you want a systematic way to lead a group to understand the actual reasons why a problem is/has occurred. It could also be an essential tool in all your information-gathering activities that require a deeper understanding [23].

2.1.16 Solution- effect analysis

An inversion of the fishbone is the solution-effect analysis where you place the possible solution in a box on the left, and draw a horizontal line from it towards the right, with further linesleading from this to display possible consequences and effects [23].

2.1.17 The Plan- Do- Check- Act cycle

Deming emphasizes continuous improvement and believes that management must constantly and forever improve the system of production and service. The concept of improvement ongoing is illustrated through the Shewhart cycle or the Plan, Do, Check and Act (PDCA) continuous improvements cycle [14].

2.2 Definitions and Concepts of PMBOK Guide

2.2.1 The Project Management Body of Knowledge (PMBOK Guide)

A guide to the Project Management Body of Knowledge (PMBOK Guide) provides the best guidelines for managing individual projects and defines project management-related concepts. It also describes the project management life cycle and its related processes, in addition to the project life cycle. The PMBOK Guide provides and promotes a common good vocabulary within the project management profession for using and applying project management concepts. It provides also the foundational professional vocabulary that can be consistently used by projects, programs, process managers, and other stakeholders. A commonly practiced vocabulary is an essential component of a professional discipline [14].

2.2.2 The contents of the PMBOK Guide

The PMBOK Guide contains the globally recognized standard and guide for the project management profession. The first two sections of the PMBOK Guide introduce key concepts in the project management field. Section 3 summarizes the Process Groups and provides an overview of process interactions among the ten Knowledge Areas and five Process Groups. Sections 4 through 13 are the guide to the project management body of the knowledge. These sections expand on the information in the standard by describing the inputs and outputs, as well as tools and techniques used in managing the process [14].

2.2.3 Purpose of the PMBOK Guide

The acceptance of project management as a profession indicates that the application of knowledge, processes, skills, tools, and techniques can have a significant impact on project success. The PMBOK Guide identifies that subset of the project management body of the knowledge that is generally recognized as worthy practice. Usually recognized means of the knowledge and practices described apply to most projects most of the time and there is consensus about their value and usefulness. Good practice means there is general agreement that the application of knowledge, skills, tools, and techniques can enhance the chances of success over many projects. The PMBOK Guide in addition to the standards that establish the guidelines for the project management processes such as the Project Management Institute

The Code of Ethics Professional Conduct guides practitioners of the profession and describes the expectations that the practitioners should hold for themselves and others. The Project Management Institute Code of Ethics and Professional Conduct is specific about the basic obligation of responsibility, respect, justice, and honesty. It requires that practitioners demonstrate a commitment to ethical and conduct of professional. It carries the obligation to comply with laws, regulations, and organizational and professional policies. Practitioners come from diverse backgrounds and cultures, and the Project Management Institute Code of Ethics Professional way applies globally. When interacting with any stakeholder, practitioners should be committed to honest, responsible, fair practices, and respectful dealings. Acceptanceof the code is essential for project managers and is a requirement for the following exams [14]:

- Certified associate in project management (CAPM).
- Project Management Professional (PMP).
- Program Management Professional (PgMP).
- PMI Agile Certified Practitioner (PMI-ACP).
- PMI Risk Management Professional (PMI-RMP).
- PMI Scheduling Professional (PMI-SP).

2.2.4 Why PMBOK Guide?

We used the PMBOK Guide for the system of the company for the following reasons [14]:

1) The PMBOK Guide contains the standard for managing the best projects most of the timethrough various types of industries.
2) The PMBOK Guide describes the project management processes used to managea project or the procedure of the industry toward a more successful outcome.
3) The PMBOK Guide defines the project management processes, although product-orientedprocesses should not be unnoticed by the project manager and process team, processes management and product-oriented processes join and interact through the life cycle of a process.
4) The PMBOK Guide describes the environment of process management in terms of the incorporation between the processes their interfaces and the purposes of their work.
5) This standard is unique to the project management field and has interrelationships with otherproject management disciplines such as program management.

2.2.5 The standard

A standard is a formal document that describes established norms, methods, processes, andpractices. As with other professions, the knowledge contained in the standard has evolved

from the recognized good practices of project management practitioners who have contributed to the development of this standard [14].

2.2.6 Functional managers

Functional managers are key individuals who can play a management role in a functional area of the business, the administrative also human resources roles, finance, account, or procurement [14].

2.2.7 Employees Involvement Matrix

Also called a matrix chart, it is mainly useful in making clear the roles and responsibilitiesin cross-functional departmental processes [24].

2.2.8 Manufacturing Defect

An imperfection that causes a product to fail to meet the manufacturer’s specifications. Manufacturing defects occur when the raw materials or components used in making the product contain unacceptable flaws, or there are assembly mistakes [17].

2.3 Relationship between Quality Management and PMBOK Guide

The researcher found and adopted in his research the relationship between PMBOK Guide and Quality Management by combining them in one process to achieve the best results in the minimum time possible, addressing the company's problems and achieving it to reach Total Quality Management through the guidelines and instructions of PMBOK Guide and the principles, tools, and techniques of Quality Management.

CHAPTER THREE
ORGANIZATION DESCRIPTION
CASE OF STUDY

3.1 Background

Ready Mix Concrete (RMC) is the type of concrete that is made in the RMC batching plant according to a set formula and then transported to the construction site by a truck mixer mounted in transit mixers. This results in the exact mixture permitting field of the concrete mixtures to be advanced and applied in the construction site. The first Ready Mix Concrete batching plant was built in the 1930s in the United States [25].

The first mobile batch plant was made in 1956 by Vince Hagan designs manufacture and patents. The design finds the ability to transport concrete batching plant to work sites and allows the owners to transport the plant anywhere maybe in a few hours. After that the design became an industry icon and it is still copied today but indeed the industry started to expand clearly until the 1960s. Then in the 1980s, the In-Truss Dust Collector design used a dust Collector on its batch plants that assurances load for one time and propose to be mobile for the plantand dust control unit. The first horizontal shaft mixer was made in at1982. Then the dual lane Wet or Dry batch plant in 1983, this design allowed dry materials to be held in a hopper for high-speed batching. The first self-erect mobile concrete batch plant design and produces was in 1988, this design eliminates the cost of cranes to establish and set up the plant. Then the Jet Pulse Dust Control design in 1991, this design was an affordable jet pulse system of dust collection for the concrete production process. The first Containerized Batch Plant was designed in 2007. This design saves the cost of shipping batch plants by designing a total concrete batch plant that is fit in containers of freight. In 2011 there were 2,223 companies to produce RMC just in the United States and the process continues to the present day in continuous development. RMC is often favored more than on-site concrete mixing becauseof the accuracy of the mixture and reduced work site mistakes.

3.2 Manufacturer Description

Al-Senaf Company is one of the oldest companies in the Iraqi market in the south regions of Iraq to produce Ready-Mix Concrete (RMC). Al-Senaf Company was founded in 1972, and it is a company established under the laws and regulations of Iraq, registered with the Ministry of Industrial under the Reg. No. 4469 with a commercial registration

ID.No.10111 with a long-standing and established reputation for servicing the construction sector of Iraq through its long experience in RMC production.

The company has been providing services to the construction sector of Iraq in the region for over 45 years hence today. The experience absorbed over these years enabled the company to earn many contracts with many projects in Iraq. It has been working with many governmental, private, local, and international organizations (Turkish, Chinese, and Korean companies and also works for the US Army Corps of Engineers in Iraq).

Through the information collected from the company, interviews with the company's chief, those responsible for the production process, the company's employees, and the field visits to the plant's work site.

The researcher found that the company established one production unit type Dry Batching Plant in the 1990s for producing Ready Mix Concrete until 2009 the company added two production units, and the number became three units of production because of the increasing demand for RMC because of the company's contract with more than one organization for to provide large quantities of concrete (one unit is not enough).

The company consists of the following departments:

1) Design and planning department.
2) Materials storage department.
3) Inspection and testing department.
4) Production department.
5) Product service department.
6) Marketing department.
7) Procurement department.
8) Services department.

Fig. 7. AL-Senaf Ready Mix Concrete batching plant *(Researcher).*

The plant is a mix of Chinese and locally made (some parts made in China and others in Iraq). Its copy was taken from MB-100W Stationary Concrete Batching Plant from the Turkish company Meka Concrete Batching Plants, the picture below shows the parts that are locally made.

Fig. 8. The parts that it is made locally *(Researcher).*

From the data provided by Al-Senaf company, interviews with the company's head, and interviews with employees responsible for the production process the researcher found that the type of stationary concrete batching plant is a Dry mix system, and the technical information is as shown in the table below.

Table 1. Technical information of concrete batching plant *(Researcher).*

No	***Technical Data***	***Value***	***Unit***
1	*Capacity*	*80*	*m^3 /hr*
2	*Mix Type*	*DRY*	*--*
3	*Mix Capacity*	*1.5*	*m^3/min*
4	*Aggregate Compartments*	*4*	*Quantity*
5	*Aggregate Weighing Conveyor*	*800x14.350*	*mm*
6	*Mixer Feeding Conveyor*	*800x29.000*	*mm*
7	*Aggregate Weighing Capacity*	*2.200*	*kg*
8	*Cement Weighing Capacity*	*500*	*kg*
9	*Water Weighing Capacity*	*250*	*kg*
10	*Additives Weighing Capacity*	*20*	*kg*
11	*Cement Screw Conveyor*	*3*	*No*
12	*Cement Silo*	*3*	*No*
13	*Cement Silo Capacity*	*100*	*Ton*

The RMC Batching Plant's main parts:

1. Aggregate and gravel stocks.
2. Batching station.
3. Conveyor belt.
4. Admixtures tank and scale.
5. Storage bucket and discharge gate.
6. Cement silo and cement scale.
7. Water tank and water scale.
8. Control center.

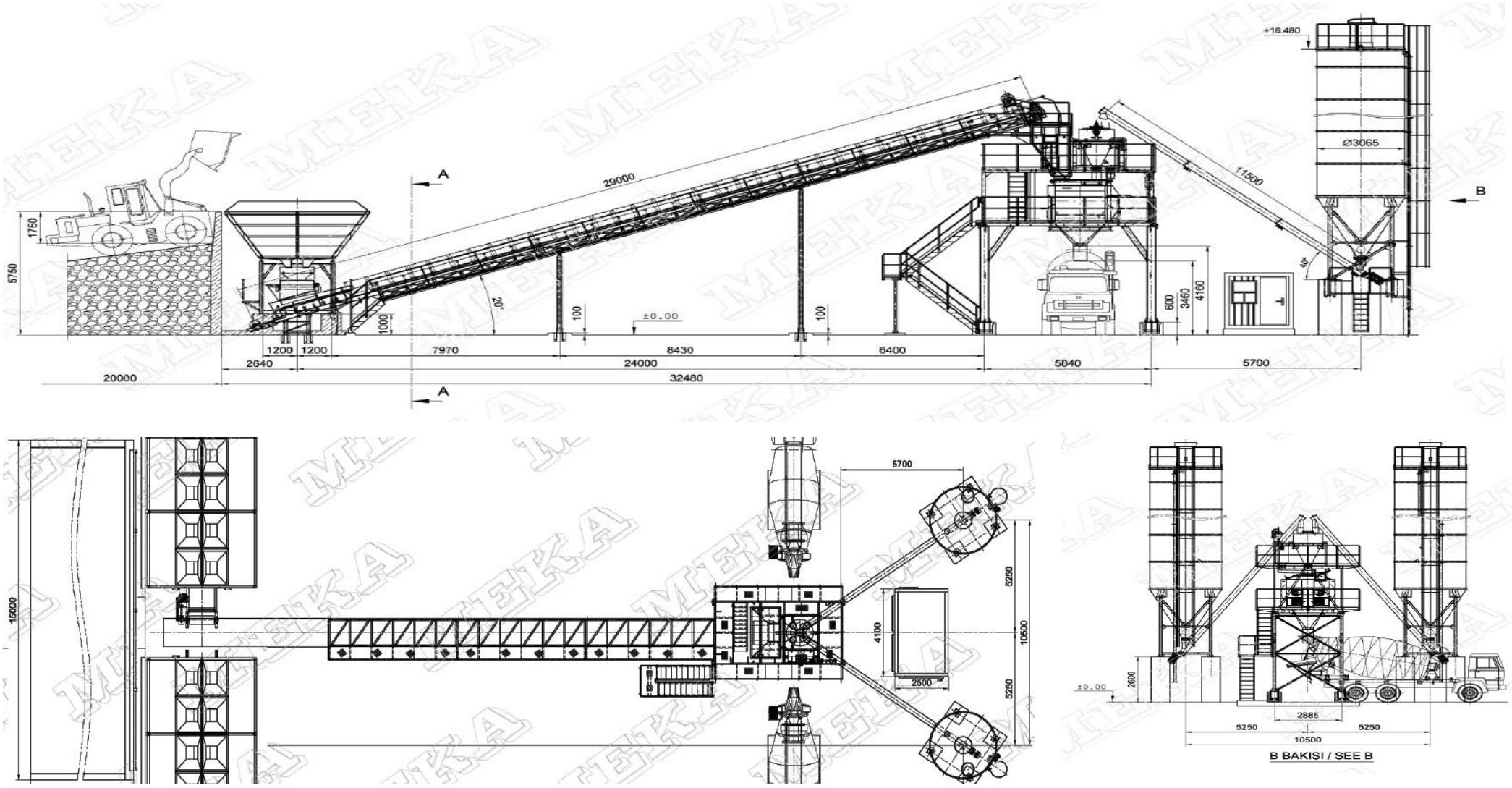

Fig. 9. The measurements of the stationary Concrete Batching Plant which is the plant copy of it [26].

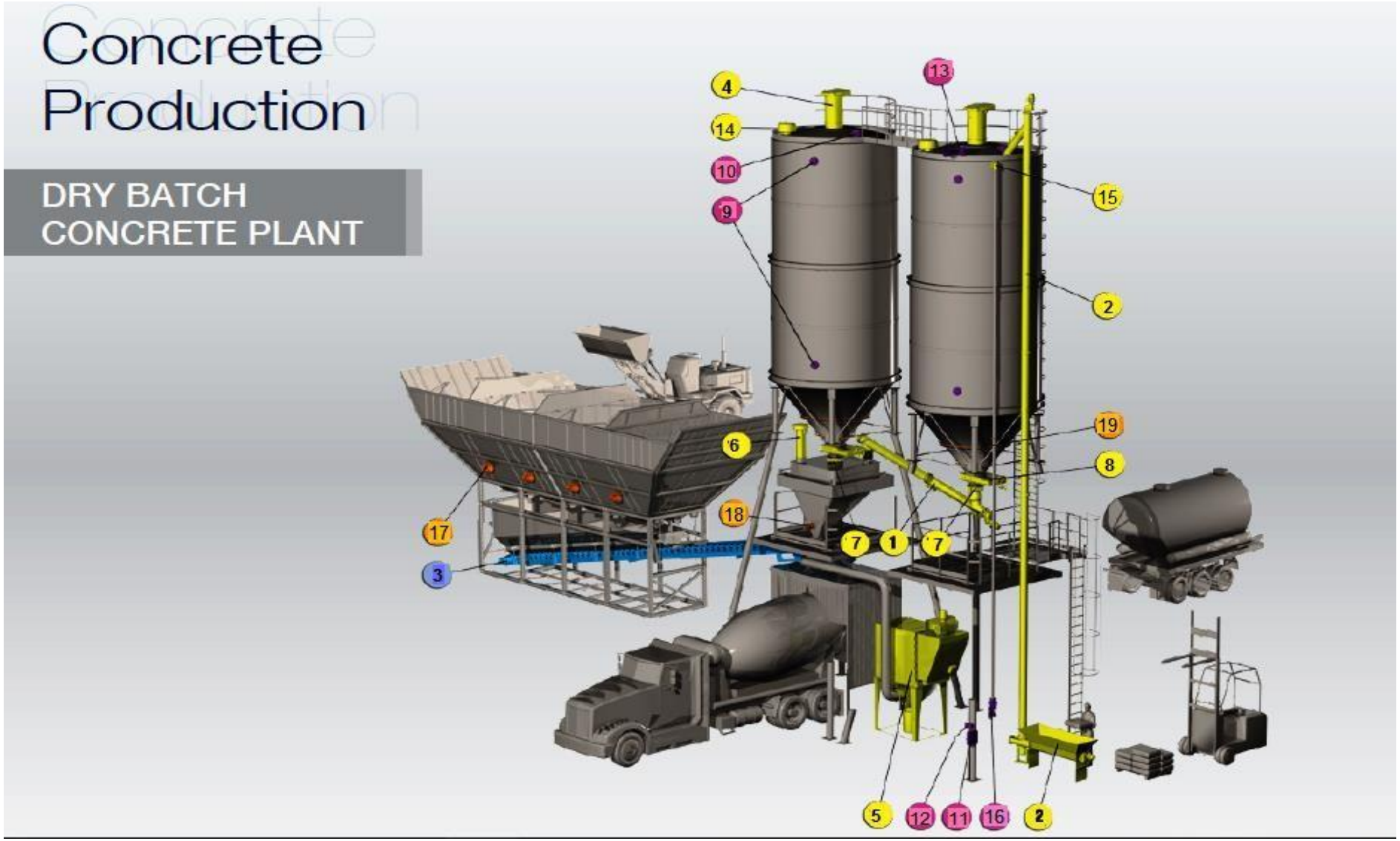

Fig. 10. The stationary Concrete Batching Plant (type dry batch) components[27].

Fig. 11. The descriptions (names and pictures) of the additional components [27].

The company structure consists of an engineer, technician, machines, supervisor,lawyer, accountant, administrative teams, and workers as shown in the table below.

Table 2. The employees of the company *(Researcher).*

No	*Employee*	*Numbers*
1	*Civil Engineer*	*2*
2	*Water Treatment Plant Engineer*	*1*
3	*Mechanical Engineer*	*1*
4	*Refrigeration and Air Conditioning Engineer*	*1*
5	*Mechanical Technicians*	*20*
6	*Electrical Technicians*	*5*
7	*Supervisor*	*6*
8	*consultative lawyer*	*1*
9	*consultative Accountant*	*1*
10	*Hygiene worker*	*1*
11	*Officials' administration*	*4*
12	*Guardian man*	*2*

The company has several pieces of equipment that are needed in the process of production of RMCsome of it has been purchased recently and some old examples are not all shown in the table below.

Table 3. Equipment descriptions *(Researcher).*

No	*Equipment*	*Quantity*
1	*Shovel loader*	*2*
2.	*Grader*	*1*
3.	*Finisher + Loader + Steel roller*	*3*
4.	*Crane*	*2*
5	*Compressor 20 bar.*	*2*
6	*Concrete truck mixers 6 m3*	*5*
7	*Vibrator and Damper*	*4, 10*
8	*Aggregate sieve analysis and Sand washer*	*1, 2*
9	*Steel and wood form 3000m*	*2*
10	*Compactor 10 Ton*	*5*
11	*Welding machine*	*8*
12	*Cutting machine*	*2*
13	*Bending machine*	*4*
14	*Generator 150 KVA*	*1*
15	*Water pump*	*5*
16	*Concrete batch plant 80 m3 /h*	*3*
17	*Crasher 50 T/h*	*5*
18	*Concrete mixer 1 bag*	*5*
19	*Cement pump(track)*	*1*
20	*Jack hammer*	*8*

3.3 Product Description

Ready Mix Concrete (RMC) is mass-produced under precise processes, transported, and placed at the work site using complex equipment and methods. Concrete is a tough construction material made by joining a chemical aggregate such as sand gravel and crushed stone with synthetic cement, water, and chemical additives. Though persons usually usage the word cement as a substitute for concrete, indeed indicates dissimilar materials: cement, which includes a wide variation of finely crushed powders that coarsen after mixed with water, characterizes single one of numerous components in concrete. As concrete desiccates, it gets a stone-like constancy that makes it ideal for constructing water supply, bridges, roads and sewage systems, railroads, waterways, airports, and other structures. Different types of concrete are manufactured nowadays that are appropriate for different needs and applications.

The formulas and ingredients in different types of concrete vary to suit the conditions preferences and requirements for specific construction designs [28].

Fig. 12. Materials used to make RMC [29].

The company product all types of concrete, high strength concrete, air-entrained concrete, high-performance concrete, lightweight concrete, self-compacting concrete, roller-compacted concrete, or any type of concrete according to orders because the type of selling in the company is sold according to orders. But here the question is what motivates companies to prefer RMC compared to the conventional type of concrete. The answer here is that the RMC has better features which are:

1. Better quality concrete is produced.

2. Elimination of storage space for materials.
3. Elimination of plant and machinery.
4. Wastage of basic materials is avoided.
5. Labor associated with the production of concrete is eliminated.
6. The time required is greatly reduced.
7. Reduced noise and dust pollution at the site.
8. There are no losses on the site and Environment friendly.

3.4 The Manufacturing Process Description

The manufacture of RMC concrete is simple, firstly the cement is prepared. Next, the other materials chemical admixture additives, aggregates sand or gravel, elements, fibers or any necessary elements, and clean water are mixed with the cement to produce the concrete. After that, the concrete is transported to the construction site. Before describing the process inthe stationary concrete batching Plant, we must explain the types of systems that work inside the process, which in total make the system of production.

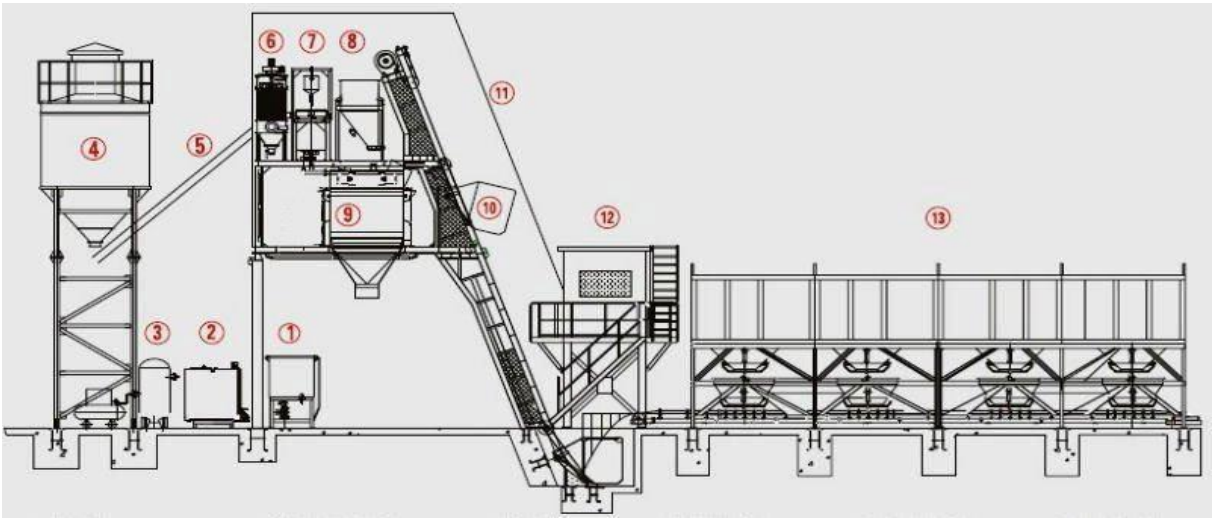

Fig. 13. The type of systems in process production [30].

The type of systems inside the process of production:

1. Water supply system.
2. Additive supply system.
3. Air supply system.
4. Powder material storage system.
5. Powder material conveys system.
6. Powder material batching system.
7. Liquid material batching system.
8. Dust cleaning system.
9. Concrete hoper system.
10. Aggregate feeding system.
11. Protective cover of equipment.
12. Control system.
13. Aggregate storing and batching system.

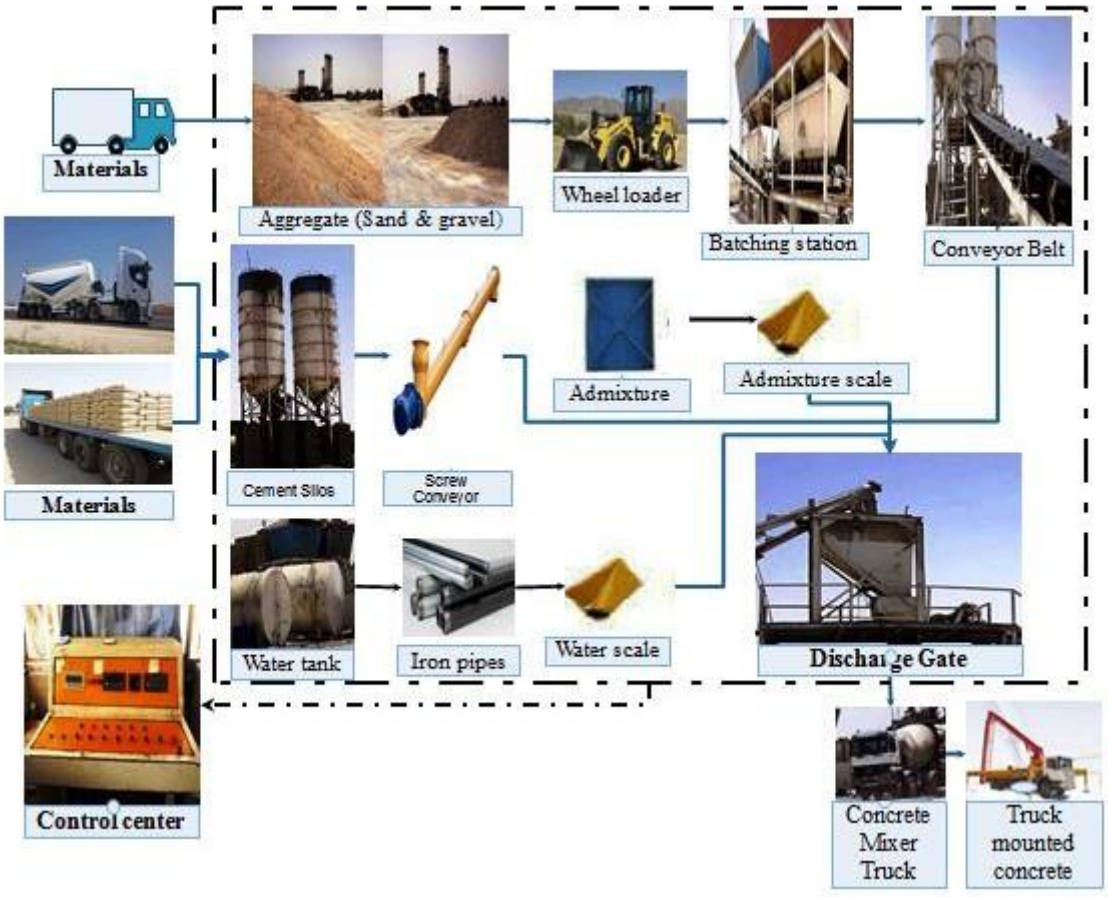

Fig. 14. Flow of process in the production of ready mix concrete *(Researcher).*

The production begins with searching for suppliers of materials, but we speak in case the plant is ready for production and there is no problem in the process, it is agreed with the other companies and contractors to provide the materials that are used in Ready Mix Concrete as we mentioned in the product description. Of course, quality, price, time, and quantity are considered when we make a contract with these companies, according to the information obtained from the company and interviews with the company chief and employees during the personal visits. Then the materials are received and entered the company's work site and placed on the ground in the shape of stocks for aggregate sand and gravel, for cement is placed in the silos designated for that. Then the materials are transported from the work site to the unit of production, gravel, and sand to the batching stations by wheel loader, we can control the quantity of aggregate by discharge gates under batching stations according to formula design then by conveyor belt transport to the storage bucket. For cement it transports by screw feederto the same storage bucket, for water it is transported by iron pipes and for the admixture, it transports to scale then the storage bucket has a discharge gate, then to the concrete mixture truck to transport it to the construction site.

3.5 Problems description

Based on data gathered from Al-Senaf Company about the entire process of producing Ready Mix Concrete (RMC) in manufacturing, meetings and personal visiting to the company work site, the problems were as follows:

1) Defect in the Quality system.
2) Defect in the Structure of the company.
3) Bad communications.
4) Lack of awareness of management.
5) Lack of updates for the system.
6) There is no system of Human resources management.
7) There is no system of Risk management.
8) Cost loss because reject return or rework.
9) Prices are not stable in the market for materials, fuel, services, and products.
10) Loss due to waste materials and fuel.
11) Services (Electricity and water) and taxes are expensive.
12) Bad Marketing and service after sale.
13) Lake of qualifications of teamwork.
14) Loss of skilled employees.
15) Teamwork number is not enough for the process of production.
16) The existence of barriers between the departments.
17) Employee's Lack of awareness of responsibilities and duties.
18) Old technology and old control systems.
19) The defect is because the plant is locally made.
20) Defect in equipment transport concrete.
21) High temperatures because of the weather and equipment working for a long time.
22) The service department is indifferent to the hygiene of the site
23) There is no alarm system for safety
24) Absence of a procedure to prevent defective before it occurs.
25) Losses due to defects in the process.
26) There is no schedule for each step of the process.
27) Unreliable suppliers.
28) Provide poor-quality materials.
29) Delayed delivery of materials or full quantity.
30) Additional costs such as transportation and loading costs.

31) Wrong orders because of bad communications.
32) There is no clear project manager and depend only on engineers to manage processes.
33) Pollution of the plant environment due to concrete wastes and washing of the vehicle transporting concrete inside the site.
34) The faults stop the plant during production, especially in large quantities then causea delay
35) Problems in station batching gates and conveyor causes changes in formula design and quality of products.

It is worth mentioning that the company has a time and cost management system and does not have problems with these systems.

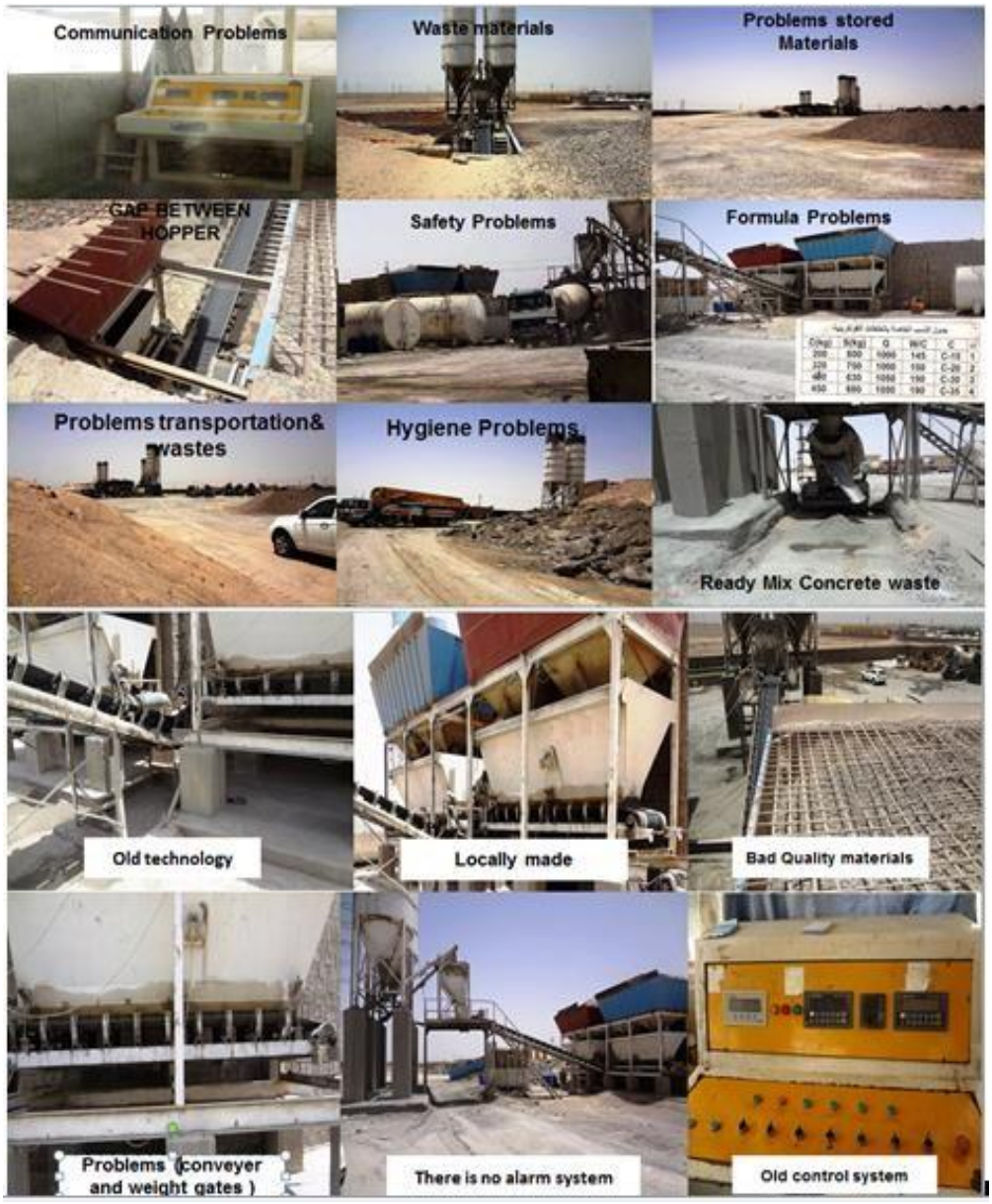

Fig. 15. The Problems in AL-Senaf Concrete Batching Plant *(Researcher).*

CHAPTER FOUR

PROCESS MANAGEMENT

4.1 General

Process management is the application of knowledge tools, skills, and techniques to process actions to meet the process necessities. This application of knowledge requires the effective management of the process of production.

A process is a set of consistent activities and actions executed to produce a specified product, service, or result.

The batching plant processes are attained by the process team with stakeholder collaboration and usually drop into one of two main categories:

1. Project Management Processes: It guarantees the operative flow of the process through the life cycle of the process and includes the tools and techniques involved in the skills and abilities labeled in the knowledge areas.
2. Product-oriented processes: It stipulates and makes the product. It is usually defined bythe product life cycle, it differs by plan area and the phase of the product life cycle [14].

It is known that if we want to make improvements or updates to the quality system of any organization, we will need the tools, techniques, and principles of Quality Management to find, detect, analyze, and understand the problems and know the main and secondary causes that led to occurrence and knowledge of root causes and of course, we also need an outline, a directive, a parser, a debugger, and a guide to the path of the management process therefor the researcher choose PMBOK guide to be as a guide to the management process.

The researcher based his research on the idea of combining quality management with a PMBOK guide in one process to reach the best results, quick and strategic solutions for the problems of the organization, and achieve the best results for access to Total Quality Management.

So the researcher used the framework of the process and the instructions from the Project Management Body of Knowledge (PMBOK guide), then used principles, tools, and quality management techniques to solve problems in the quality system of the company and problems in other knowledge area, where the researcher used many tools and techniques of management as required by the need and as required by the implementation process as we will explain in the next pages.

4.2 Quality Management

Quality Management includes the processes and actions of the company performance that define quality rules, aims, and responsibilities so that the process will fulfill the needs for which it was undertaken. Quality Management uses rules and procedures to carry out within the process setting, the quality management system of the company as suitable for continuous improvement to process activities as undertaken on behalf of the performing organization. Quality Management works to guarantee that the process desires including product needs are met and validated [14].

According to the PMBOK Guide the Quality Management processes, are as follows:

1. Plan Quality Management.
2. Perform Quality.
3. Control Quality.

4.2.1 Plan Quality Management

It is the process of recognizing quality necessities or standards for the process deliverables and detailing how the process will validate acquiescence with quality requirements to deliver supervision and coordinate how quality will be achieved and confirmed through the process [14].

The quality standard of our plan of management is the PMBOK Guide (the fifth edition). The plan will start with identify the producer of production by using Flow Chart diagram, then define and displaying the problems or failures in process by gathering data about the whole process of production Ready Mix Concrete and clarify it by using Cause and Effect diagramor Ishikawa diagram to locate point of cause, then we will identify the occurrence of problemsby check sheet for thirty days, after that we will analyse these problems by FMEA analysis (detection, occurrence, severity and risk priority) and 5whys analysis for the most three problems important, then propose solutions for all problems by an inversion of the Ishikawa diagram which called the solution effect analysis, then apply QC and QA and Flow Chart after apply them in process of production, then change the structure of company, the type of organization and use Employees Involvement Matrix to define the employees involvements, improve quality system to make it continuous improvements and updating process by PDCA to compliance with Total Quality Management requirements and we will draw the whole process after applying QC, QA and TQM in the process. Finally, for the Quality management monitoring, we will use Check List as shown in the figure below:

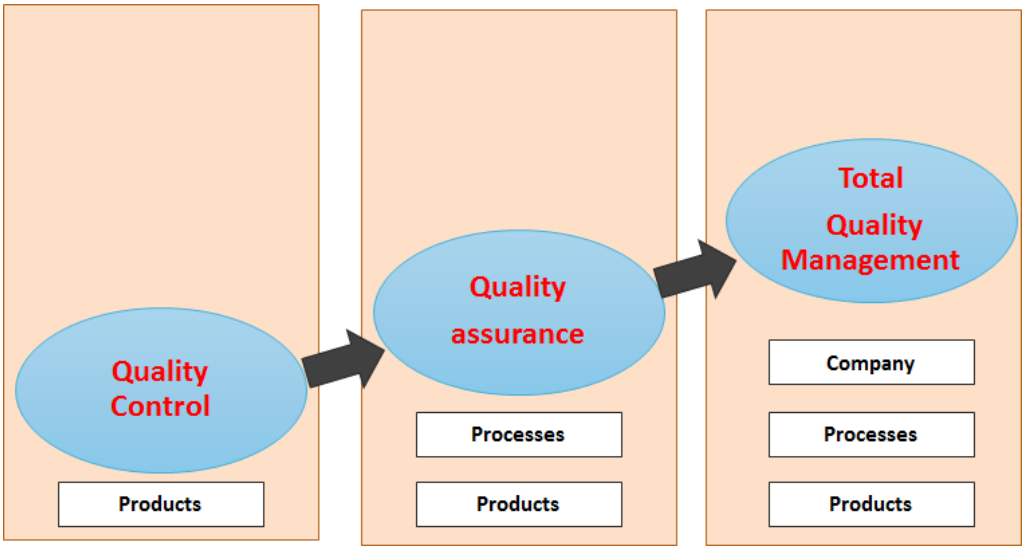

Fig. 16. Quality control, Quality assurance, and total quality management [31].

4.2.2 Perform Quality

To know the performance of Quality we must identify the current Quality system so we will start with the structure of the company where the company structure is the classic functional organization type. It is a hierarchy where each employee has only one clear supervisor. Members of teamwork are collected by specialty persons, such as engineering, accounting, production, and marketing.

Specialties are subdivided into focused functional units, such as mechanical and electrical engineering where each department in AL-Senaf Company does its work independently of otherdepartments as shown in the figure below:

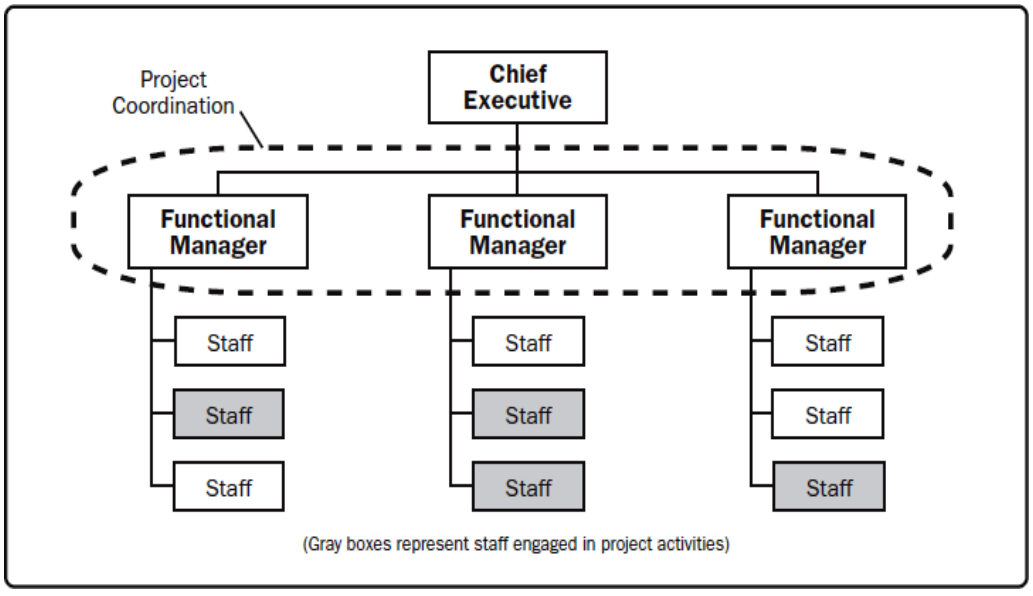

Fig. 17. Functional organization [14].

1) Flow chart of process

The process usually begins with specifying specifications and requirements for materials and services that we would like to purchase from outside the company, first of all, bring offers from companies, organizations, and suppliers then check these offers agree with the specifications that previously identified if it is not meet our specifications the company will bring other offers and exclude nonmatching offers. Then negotiate whether the price of transportation is included with the price of materials or not but it is not mandatory to accept the offer in most cases, the company pays the cost of transportation.

The standard to accept the offer for the company is price is not quality) if there is interest in quality it will be secondary (The company then selects the best offer and contacts the suppliers after ascertaining the quantity required by the engineers and the orders are processed. After that, the suppliers will load the materials into trucks to transport to the plant and when they arrive they will be received without inspection just to check whether the quantity is complete or not, if there is a shortage of quantity the owner will communicate with the supplier to complete it) always delivered late and poor quality(. After completing the quantity, the materials will go into the company's stores (placed in open places in the form of stocks in a plant). The paperwork is then completed and notified to the financial manager to pay to suppliers.

On the other hand, the design and planning department will perform the mixing formula forthe concrete after taking the judgment of the engineers into account. Then they practically test the formula if its success will be used directly in production.

Then the mixing phase with the main parts of the plant where the inputs will be the materials from stores, additives materials, water, and the mixing formula from the design and planning department, and the output is Ready Mix Concrete as a product.

The process begins with the transport and loading of the materials from the stores to the mixing stations, notice that material losses are big on the ground. Then make sure that the team of work is ready to work as well as communications. Then the gates will open to the stations andthe materials falling with the effect of it is weight then transported by conveyor belts to scaleand cement transport by a screw feeder to the same scale to discharge gate to the mixture trucks to the customers.

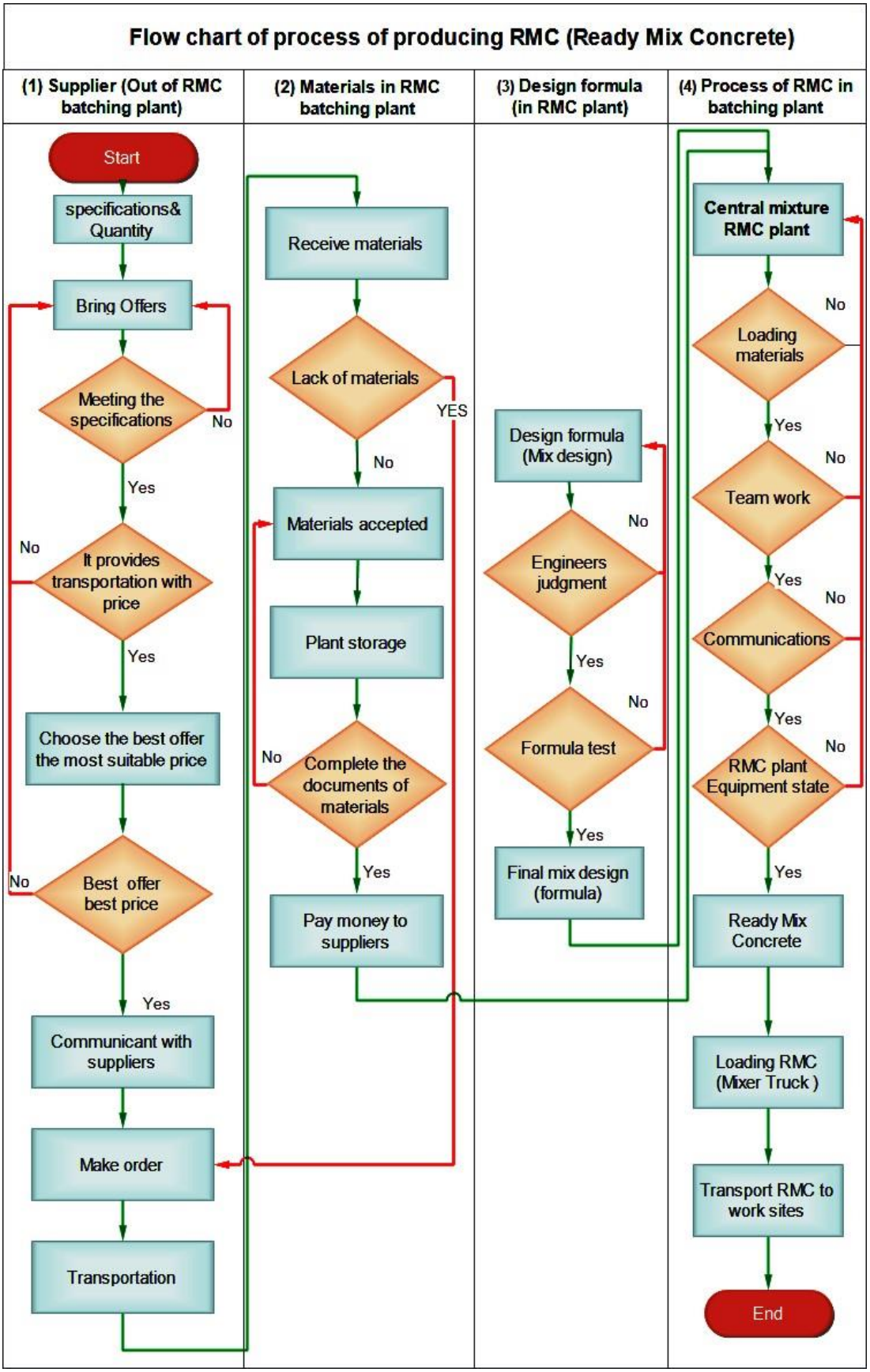

Fig. 18. The Flow chart of stationary batching Ready Mix Concrete plant *(Researcher)*.

2) Ishikawa diagram

The researcher used the Ishikawa diagram to identify, explore, and display all possible causes related to a problem and to furthermore discover the root causes and show dependencies amongst causes and underlying drivers the main categories of problems were: Management, People, Procedure, Financial, Machines, Suppliers and Environment as shown in the figure below.

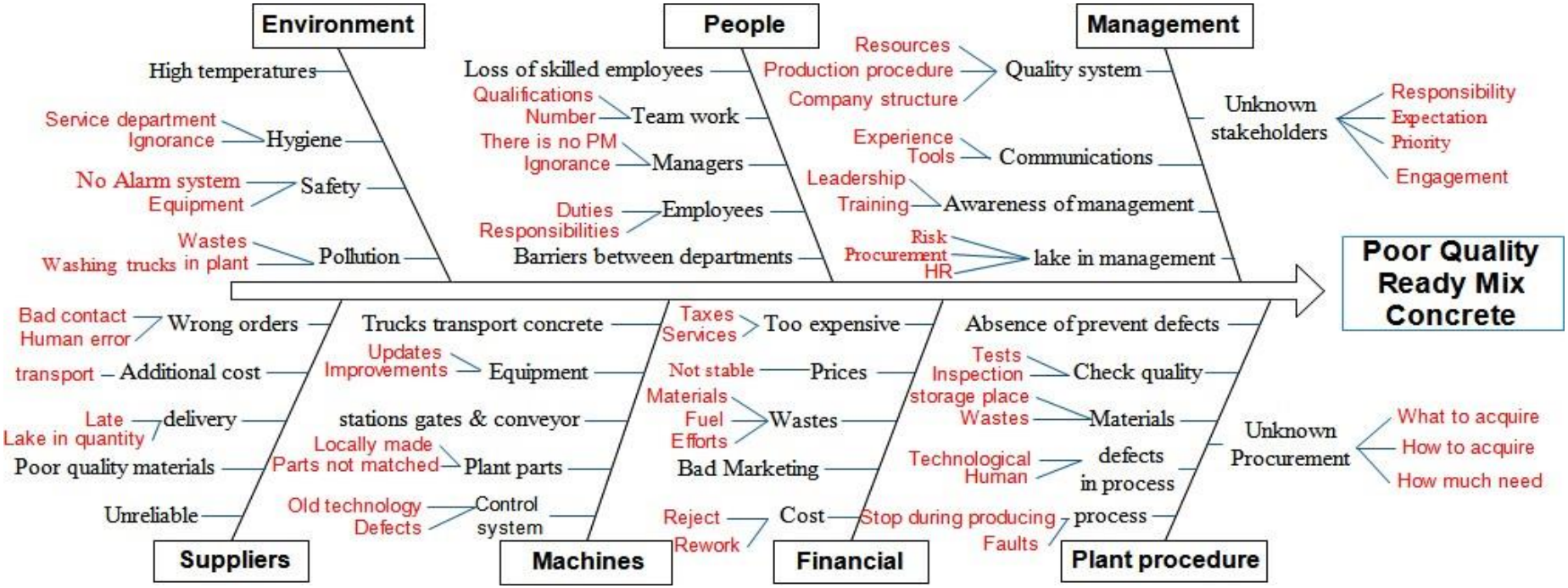

Fig. 19. Ishikawa diagram indicates the problems *(Researcher).*

Figure (19) shows the all causes related to the problems of the company which they identified and displayed by the main 7 categories which are related to 34 secondary causes and the associated causes are 1- 4 for each one of the 34 causes.

3) Check-sheet

To record the number of occurrences of problems the researcher used the Check sheet table for thirty days, not all problems due to some of them cannot be measured like the Quality System, where the biggest occurrence number the faults or stops the plant during production and Bad communications and awareness of management as shown in the table below.

Table 4. Check-sheet for AL-Senaf Ready Mix Concrete plant for 30 days *(Researcher).*

No	*Defect type*	*10 days*	*10 days*	*10 days*	*Total count*
1.	*Late delivery of materials or full quantity.*	|	|	||	*4*
2.	*Additional cost (transportation & loading cost).*	||	|	|	*4*
3.	*Wrong orders due to bad communications or human error.*	|	|		*2*
4.	*Provide poor-quality materials.*	|	||	|	*4*
5.	*The faults stop the plant during production, especiallyin large quantities then cause a delay*	||	|||	||	*7*
6.	*Wastes of materials and fuel*	||	|	|||	*6*
7.	*Materials place storage*		|	|||	*4*
8.	*Defects in Test & Inspection*	||	|	|	*4*
9.	*Problems in station batching gates and conveyors causes changes in the formula and quality of a product.*	|	|	|	*3*
10.	*Equipment transport concrete.*			|||	*3*
11.	*Bad communications*	||	|||	||	*7*
12.	*Lack of awareness of management*	||	||	||	*6*
13.	*Loss skilled employees*		||	|	*3*
14.	*Lake of numbers of Team Work*	||	||	||	*6*
15.	*Lake of Qualifications of Team Work*	|	|	||	*4*
16.	*Employee's awareness of responsibilities &duties.*	|	|	||	*4*
17.	*Bad Marketing and service after sale.*	|	|	||	*4*
18.	*Cost loss because of rejection return or rework.*	|||	|||	|||	*3*
19.	*Prices not stable (materials, fuel, and products)*	|	|	||	*4*
20.	*Services (Electricity & water) & taxes (expensive)*			|||	*3*
21.	*High temperatures*	||	||	||	*6*
22.	*Problems in the environment due to the waste & washing of the Mixer trucks inside the plant.*	|	|	|||	*5*

4) FMEA ANALYSIS

The researcher uses FMEA Analysis to prioritize potential defects based on their detection, occurrence, and severity management of the problems. We can account Risk priority number by multiplying detection by occurrence by severity. Problem and the scale number will be from 1 to 10 where 10 is the biggest Priority or impact. The probability of detection measures the actual chance of you catching the defect before escaping (1 means you have extensive controls on catching the defect). The probability of occurrence measures the actual chance the failure mode appears (a higher number means a higher chance). Severity measures the possible damage that could occur to the product, process,and human using the item if a failure occurs (a higher number means more possible loss).

Table 5.FMEA analysis for Ready Mix Concrete *(Researcher).*

No	Subject	Problem	A) Detection Rate 1-10 10 =lowest Probability	B) Occurrence Rate 1-10 10=highest Probability	C)Severity Rate 1-10 10=most Sever	Risk Priority A×B×C
1	Management	Defects in the Quality System	9	9	9	729
2		Unknown stakeholders	5	5	5	125
3		Lack of awareness of QM	8	6	6	288
4		Experience & Communications	7	7	9	441
5		HR management	6	5	5	150
6		Risk management	8	5	5	200
7	Financial	Wastes due to defects	9	6	3	162
8		Bad Marketing	8	4	5	160
9		Reject or Rework.	4	3	5	60
10		Prices not stable	7	4	3	84
11		Services & taxes	3	3	3	27
12	People	Loss skilled employees	8	3	5	120
13		Qualifications of Team Work	6	4	4	96
14		Barriers between departments	4	3	5	60
15		Numbers of Team Work	5	6	6	180
16		Responsibilities & Duties	6	5	4	120
17	Machines	Old technology & C. S	7	4	6	168
18		The Plant locally made	4	3	5	60
19		Station batching gates & conveyor defects.	8	3	5	120
20		Updates of process	2	3	4	24
21		Equipment Transport cocrete.	3	3	3	27
22	Procedure	Defect of stopping the plant during production	9	7	8	504
23		Wastes of materials and fuel	7	6	5	210
24		Materials place storage	6	4	5	120
25		Defects in Test & Inspection	6	4	8	192
26		Absence of a procedure to prevent defect	7	3	5	105
27	Suppliers	Unreliable	4	4	6	96
28		Poor quality materials	7	4	8	242
29		Late delivery&quantity	6	4	8	192
30		Additional cost	4	4	3	48
31		Wrong orders	3	2	7	42
32	Environment	High temperatures	3	6	3	54
33		Hygiene	3	4	4	48
34		Safety (no alarm system)	5	3	8	120
35		washing of Mixture truck inside the site.	4	5	3	60

In Table (5) after we used the number of occurrences of problems from check sheet results and multiplied it by detection and severity to give risk priority number of the results the biggest numbers were for the defects in the quality system (729), then defect and stop the plant during production (504), then the lack in Experience & Communications (441) and so on for the rest problems.

5) 5 Whys

It is an effective technique that helps get to the source of a problem in minimum time. The researcher uses it as a systematic way to understand the real reasons why problems have occurred in the plant for the most important three points based on the results of FMEA Analysis which was the defect in a Quality system where the researcher used why 5 times to find the source of a problem and the sources was as shown in the figure below:

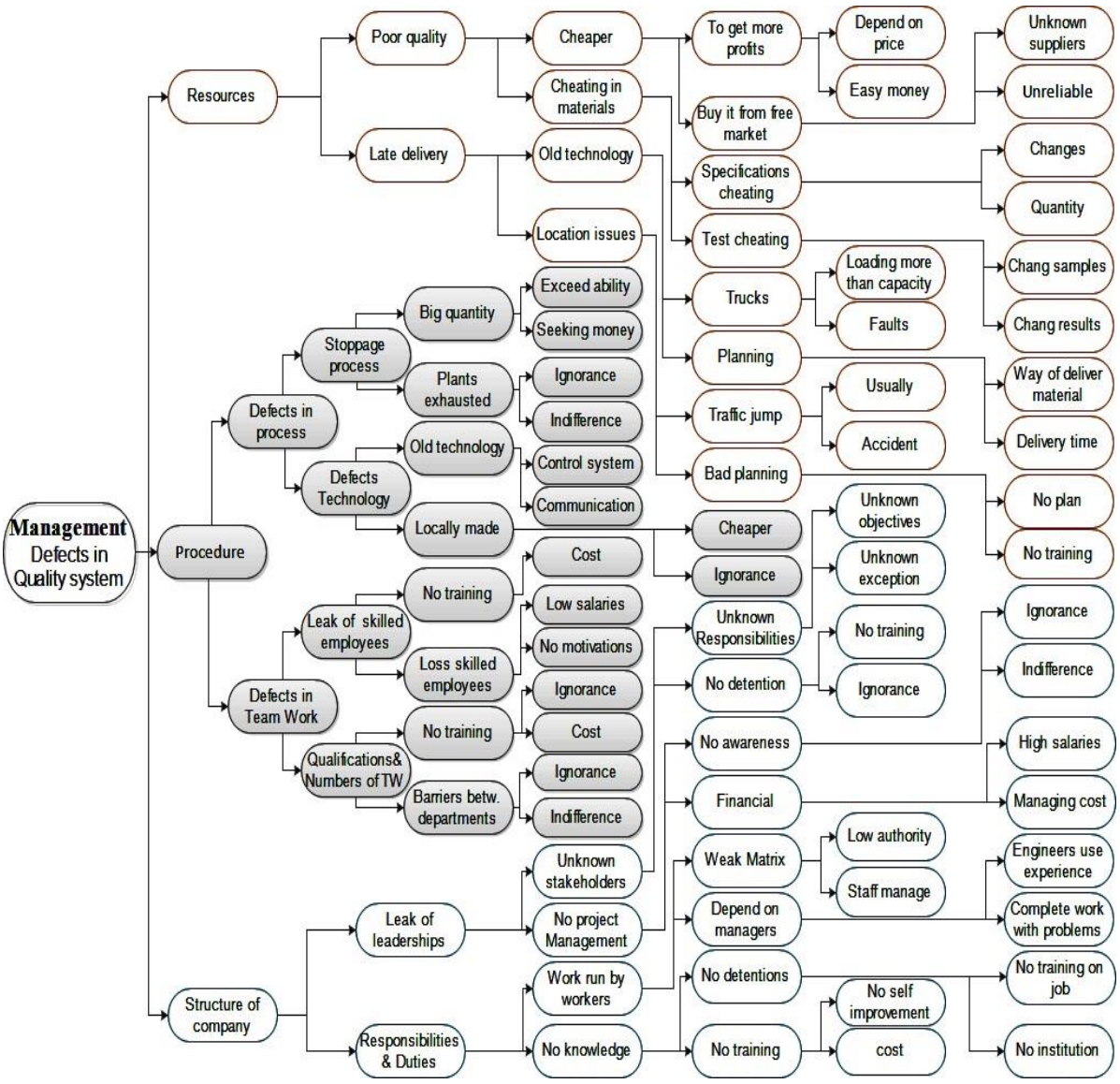

Fig. 20. The 5 Why for Management /Defects in Quality System *(Researcher).*

Figure 20 shows the results of the analysis by 5 why for managing defects inQuality system of the company where the sources of problem were unreliable and unknown suppliers, deception and change in specifications and quality, manipulation of samples and results of tests, errors in planning to the way of delivery of products, errors in plan of delivery time, lack in training and development plan, ignorance, loss of skilled staff due to low salaries or cost, there is no project manager, producing with errors, defect in the company structure, low authority, lack of leadership and training programs on job.

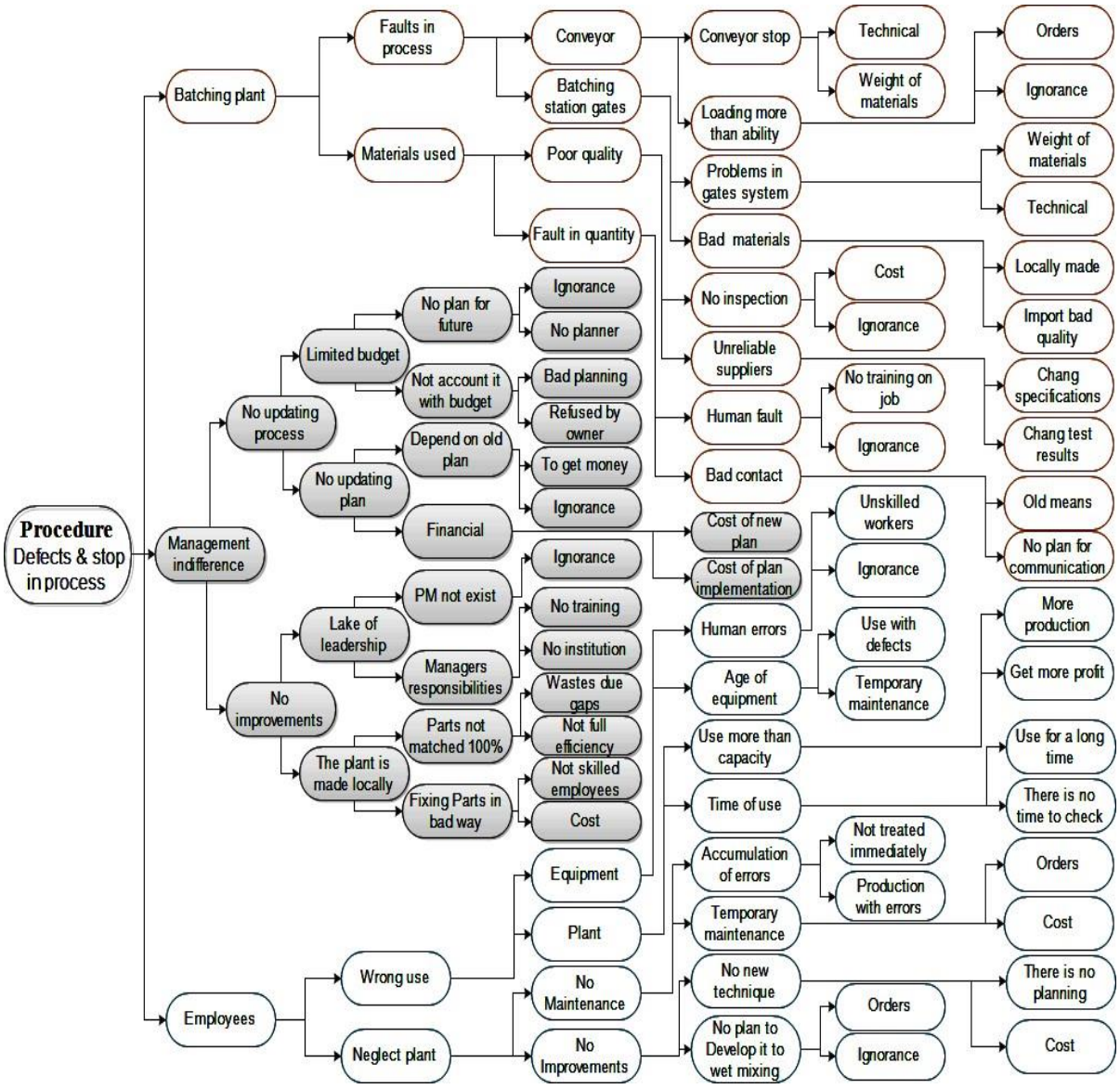

Fig. 21. The 5whys for Procedure /defect and stop the plant during production *(Researcher).*

Figure 21 shows the analysis by 5 why for Procedure the problem of defect and stop the plant during production where the researcher found that the sources of the problem are mistakes in orders, ignorance, overloading materials, technical errors, malfunction in locally made parts, poor quality materials, cheating in specifications, manipulation test results, lack

of a communication plan, producing more than plant capacity, greed, long-term use, lack of periodic inspection, and lack of periodic maintenance only when the problem occurs and the process stops.

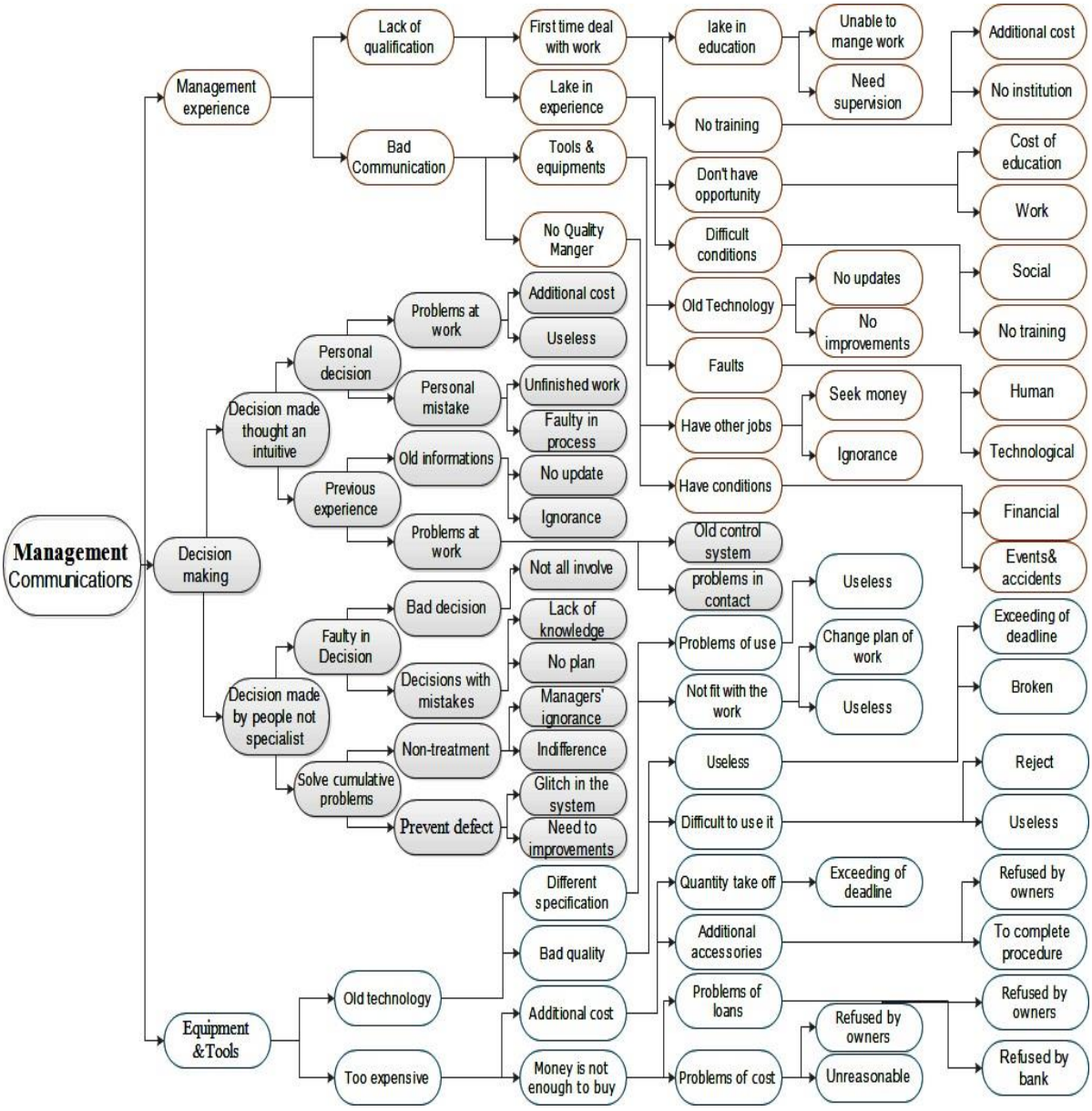

Fig. 22. The 5whys for Management /communications *(Researcher).*

Figure 22 shows us the results of the analysis by 5 why management the problem of communications of the company where the source or causes of the problems were defects in experience and management, decision making, equipment, and tools because of lake of qualifications, no training, financial reasons, lack in experience due to cost of education, ignorance because of social reasons, human and technical errors, additional cost due to reject product or rework, developing cost refused by the owners, the cost of new technology which is refused by owner.

4.2.3 Control Quality

The benefits of it include less rework, higher productivity, lower costs, stakeholder satisfaction, and increased profitability.

1. Solutions

An inversion of the Ishikawa diagram is the solution-effect analysis. The researcher uses it to display the solution for each problem.

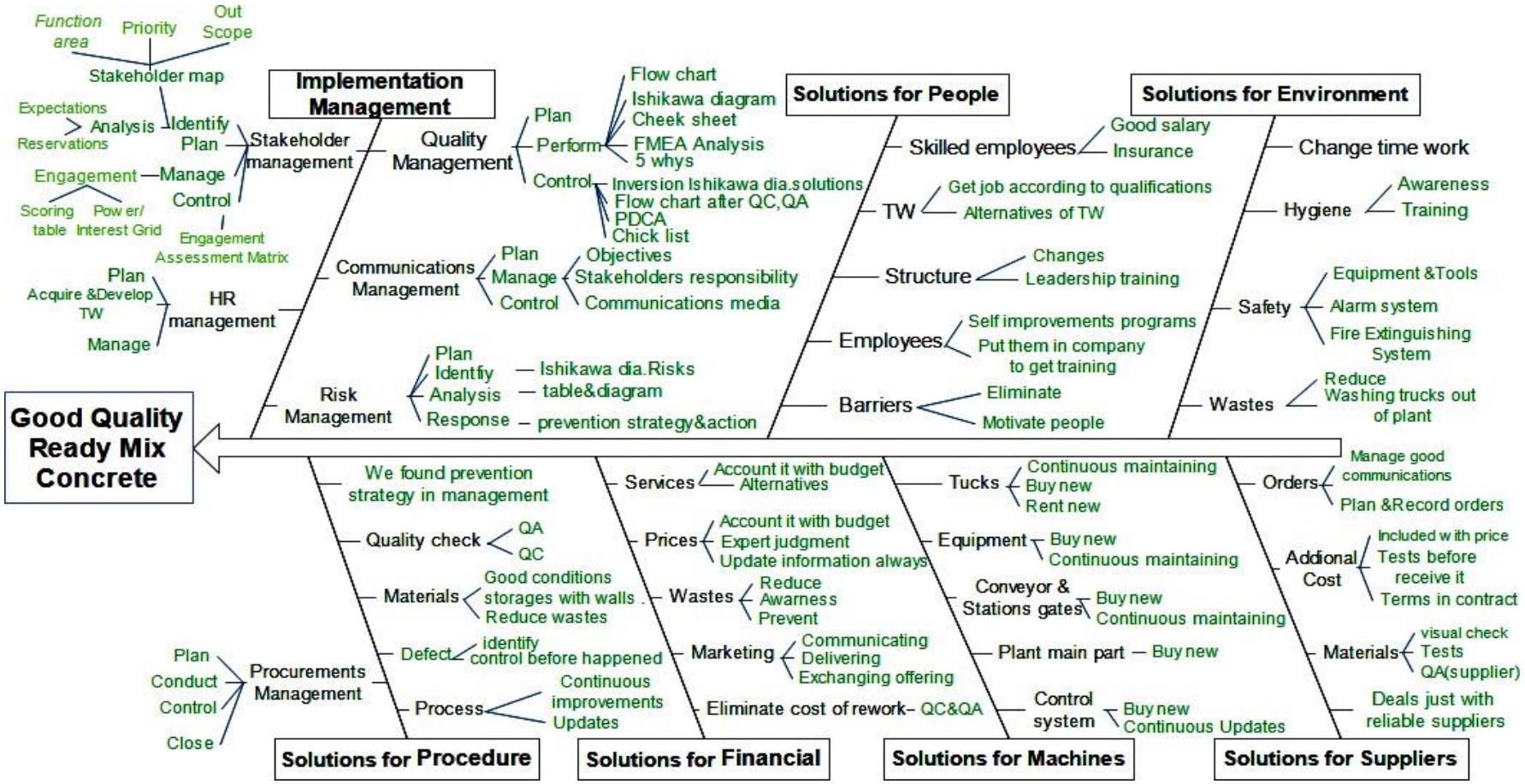

Fig. 23. The solution-effect analysis *(Researcher).*

Figure (23) shows what the researcher proposed as solutions to all problems in the company. The researcher suggested (1-4) solutions for each problem, some of them will be applied through Quality Control and Quality Assurance. Others we will use several tools and techniques to implement when managing the other knowledge of areas like Human Resources, Communications, Procurement, Risk, and Stakeholders to reach Total Quality Management.

2. Quality Control in the process

As we mentioned before Quality Control is the process of monitoring specific projectresults to determine if they comply with relevant quality standards and define ways to eliminate causes of unsatisfactory performance, it's the organizational unit that is assigned responsibility for quality control. It deals with products therefore when the researcher applies Quality control he found:

The product enters the Inspection and testing department to the quality control team where the results of this process are three cases:

- The first is a mandatory report on the quality control and production process.
- The second is product conforms to the specifications then delivery.
- The third is product not conforming to specifications thus resulting in four cases:

a) Accepted with permission then accept request and report.
b) Repair then repair request and report then return to process again.
c) Type change then change request and report then return to process again.
d) Reject products then reject report then disposal of the products.

3. Quality Assurance

The defect prevention in quality assurance is different from the defect detection and rejection in quality control and has been referred to as a shift left as it focuses on quality earlier in the process. It deals with processes and products in our case as follows:

a) From the beginning the materials must be of good quality, in complete quantity, and delivered on time, also price includes the price of transportation and loading (all these topics must be established as terms in the contract with the suppliers).
b) The basic criterion for accepting the offer must be quality not price and quality assurance of the material by the supplier.
c) Put monitors production and Quality monitors in process and take into account many other factors (team of work, communications, equipment, and quality and production reports) as shown in a flow chart and figure below.

d) Inspection and test the materials' arrival at the plant a prerequisite for acceptance, complete paperwork, and pay the money.

e) Use expert judgment in the mixing formula then test it practically, approved by authority, and establish QA and QS Lab in plant to test formula and products.

f) Receive production and Quality Control reports to make final inspections and test or focus on stakeholder expectations, documentation, and training. All these changes(boxes with red borders are changes) are shown in Figure (24).

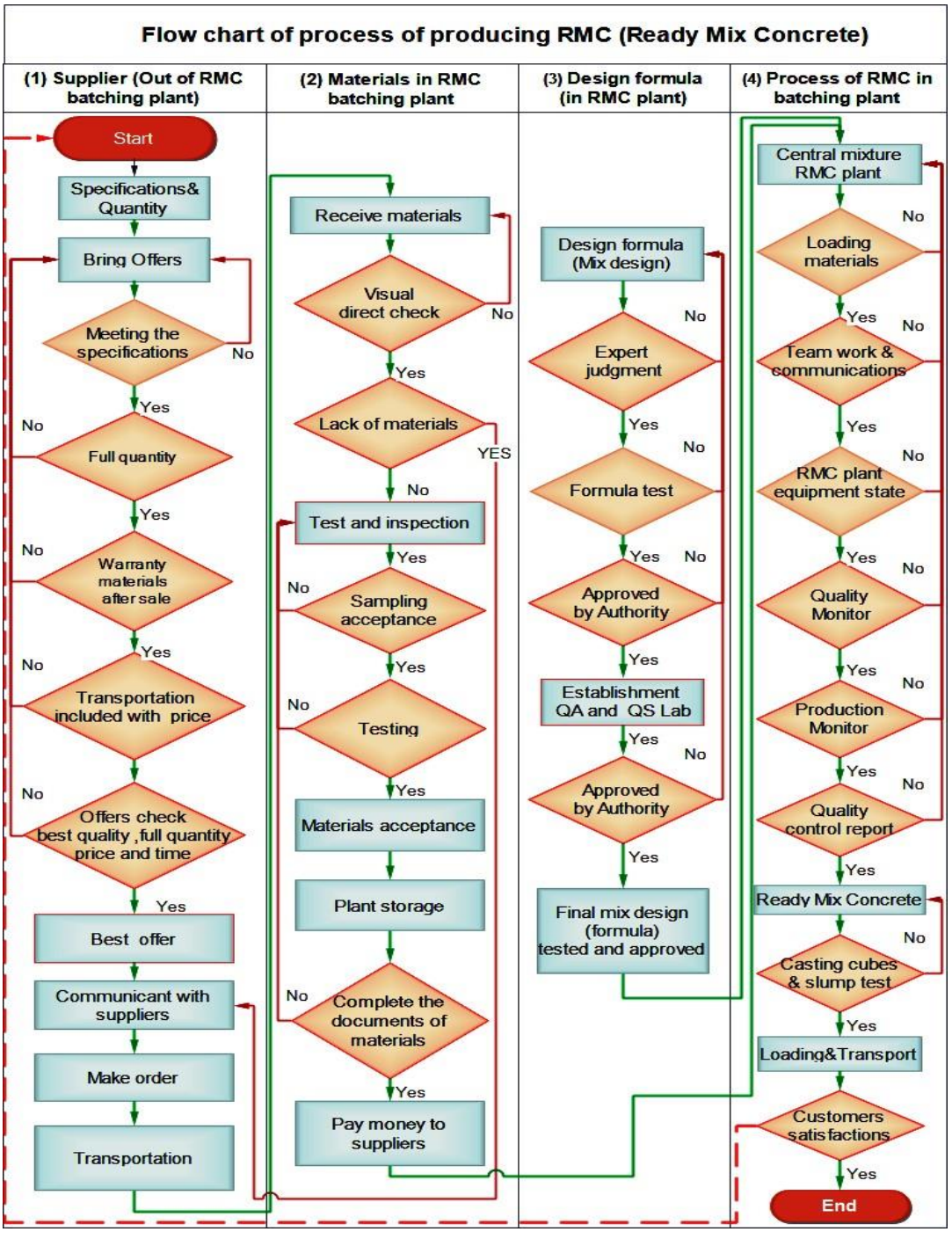

Fig. 24. Flow chart of the Ready Mix Concrete plant after applying QC and QA *(Researcher).*

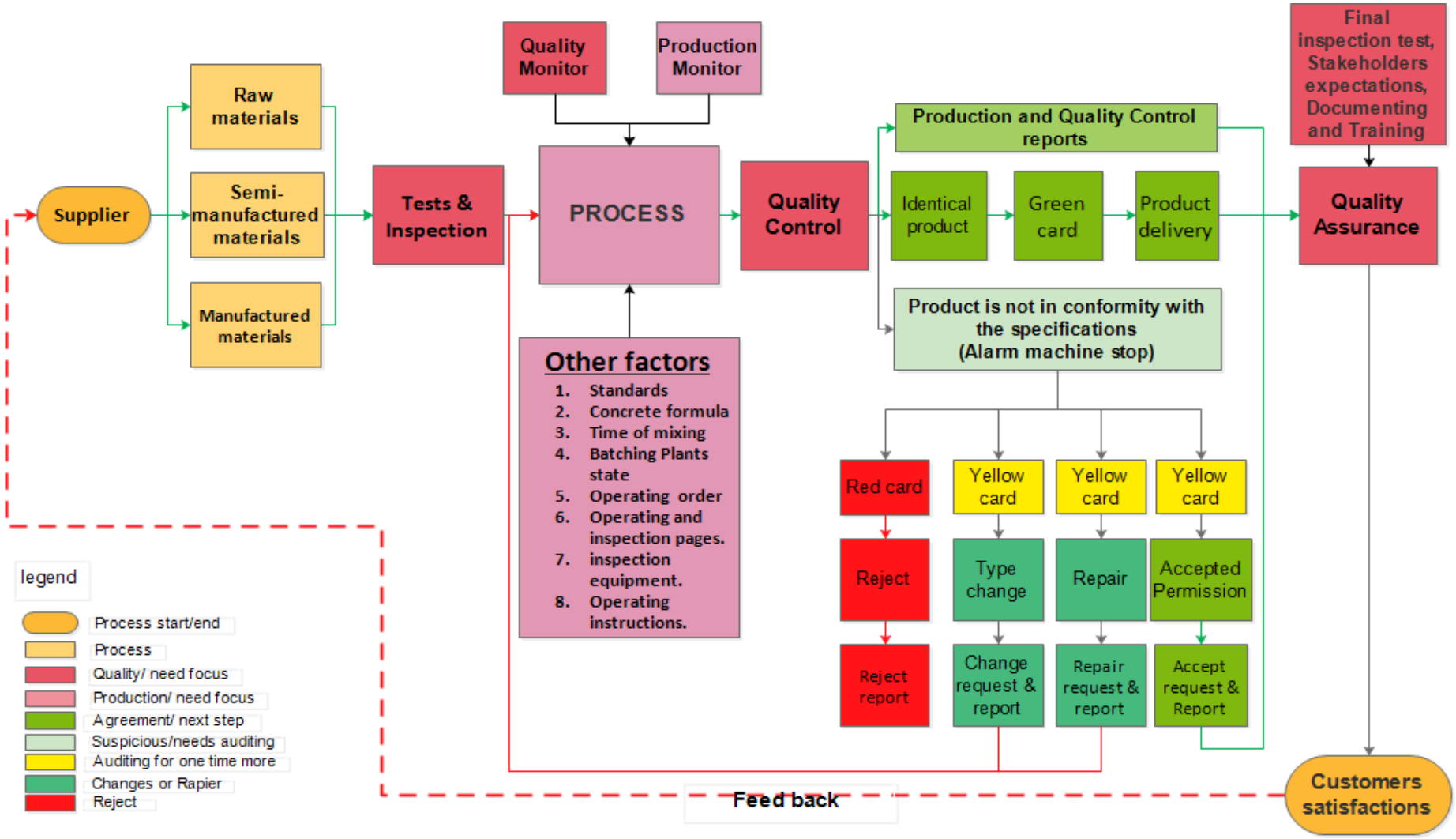

Fig. 25. The QC and QA in the process *(Researcher)*.

The figure (25) shows a detailed outline of the process with full details about the all process from suppliers to deliver the product to customers and the service after that, where we note changes in the process after introducing Quality Control into the process, where its dealing with products by classifying the output from the production process to: acceptable deliver to customers, rejected being thrown out of the process as wastes , need to be reformed by repaid to materials of process and enter the process again from beginning, need of partial or minor changes and is returned to the process in partial to make changes but not from the beginning such as the adding more ratios of materials and the last one is accept with permission discount at the price or change the specification like if the customer order concrete (25MPa) but the result of process of production after testing was concrete (24MPa) at the same time customer need to concrete type (20MPa) also, so we contact with customer to deal about discount the price to make order as concrete (20MPa).

Then the role of quality assurance comes, where its dealing with process and products, so it enters the process and makes main changes to the process from the beginning as we explained in figure (24) it regulates the relationship, the conditions and requirements with suppliers to achieve good quality materials, quantity and suitable price through the inspection and test the quality of materials, type and quantity that arrive to the plant before reception and entry to the stores, then changes in the process through the introduction of monitors for the quality and production process to provide periodic reports on both and also require the assurance quality process taking into account several factors that help, correct and direction the process such as specifications, compliance with the mixing formula, mixing time, plant state, orders quantity and precise instructions for the quality of the work, then periodic reports about production and the Quality Control results, then how to deal with the re-work or rejection and make suitable adjustments to minimize them as well as ensure quality of the product to meet specifications through the services of after-sales which is allow customers to talk with the company to get customers satisfaction for service and quality, otherwise we will re-evaluate the process from beginning by feedback to make any necessary adjustments to meet customers satisfaction.

As a summary, figure (25) shows the complete process and the role of Quality Control and Quality Assurance by showing the outcome of each of them, their impact, and how they work. The rest problems in Figure (23) the researcher will address each problem individually in the other knowledge areas to reach Total Quality Management at the end.

4. Checklist

The checklist is used to monitor and record the results of implementing quality activities to assess performance and recommend necessary changes. It helps to ensure consistency and completeness in carrying out a task. The table below examples of subjects that need to be monitored and checked always but not all.

Table 6. Check List for RMC batching plant *(Researcher).*

No	***Checklist***
	Quality (test and inspection)
1	*Requirement for laboratory*
2	*Procedure for scheduling testing personal/strength test*
3	*Concrete sampling and testing*
4	*Sampling frequency*
5	*Sampling location, Number and point of placement, and agreement*
6	*Tests performed on each sample*
7	*Type of test) slump, air content, compressive strength, and flexural strength(*
8	*Shape of sampling (cylinder, beams, and cube)*
9	*Who has the authority to accept or reject concrete delivery?*
10	*What criteria will be used to concrete*
11	*Are re-tests allowed before reject*
	Orders
12	*A person responsible for ordering contact*
13	*Define large and specialty orders*
14	*Minimum specifications required for materials quality*
15	*Contact with suppliers /type of communications*
16	*Procedure for handling revised orders*
17	*The person on the job site responsible for visual checking and reviewing delivery*
18	*Delivery schedule (location, quantity, type, and state delivery)*
19	*Acceptance /rejection responsibility*
20	*Any traffic restrictions at or near to job site*
21	*Number of trucks interval schedule*
	Safety
22	*Personal protective equipment required*
23	*Hard hat, Safety boots, Eye protection & Safety vest*
24	*Specific protective clothing &respirators*
25	*Who responsible for safety meetings, fall protection, and safety inspection*
26	*Emergency contacts*
	Environment
27	*The Person who is Responsible for a time of work*
28	*Department Responsible for awareness and training on hygiene*
29	*Responsible for cleanup and the wash trucks out area of the plant*
30	*On-site emergency contact person*

Table (6) shows the checklist of the Ready Made Concrete batching plant, what can be inspected, monitored, and documented, the type of questions that can be asked and monitored regularly such as an inspection and test of what the process needs, and the timetables, type of tests, location, number of tests, the shape of sample for test, what is used in the test and re-test is allowed before reject or not and so on for the rest like orders, safety and environment.

4.3 Human Resource Management

Human Resource Management contains the procedures that organize, manage, and lead the process team. The process team contains the people with allocated roles and tasks to finish the process. The involvement of team members in process preparation and decision-making is helpful. The contribution of members during preparation increases their knowledge of the process and supports their commitment to the process [14].

According to the PMBOK Guide the Communications Management processes, are as follows:

1. Plan Human Resource Management.
2. Acquire and Develop a Process Team.
3. Manage Process Team.

4.3.1 Plan Human Resource Management

It is the process of finding and detailing roles, responsibilities, and skills required, relationshipsrecording, and making a team management plan.

The researcher used a Responsibility Chart or matrix for responsibilities and to document team member roles. It is a suitable tool for administering authority and responsibilities. Where the Matrix Responsibility chart is distributed into:

1. The Rows: It refers to responsibilities, activities, and authority.
2. Columns: This refers to the position of process participants.
3. The Numbers: It refers to the degree of authority-responsibility connecting between the rows and columns. It can be any symbol.
4. Symbols/ Codes where :

a) The number (1) refers to actual responsibility.
b) The number (2) refers to general responsibility or general Supervision.
c) The number (3) refers to most being consulted.
d) The number (4) refers to maybe consulted.
e) The number (5) refers to must be notified.
f) The number (6) refers to must approve.

Where the sales services and products manager should cooperate with the production manager to develop, maintain, and improve the quality level and cost efficiency of making and monitor their implementation. Also, Quality control activities are coordinated with our production and sales departments. Quality control depends on this information which shows the relationship between the authority and the responsibilities as shown in table (7) the

actual responsibilities were on Project Management inspection then design planningand production.

Table 7. Responsibility Matrix for AL-Senaf company *(Researcher).*

No	*Activity/Responsibly*	*The owner*	*Project Manager*	*Engineers*	*Design and Planning*	*Production*	*Legal*	*Financial*	*Marketing*	*Sales Service*	*Inspection*	*Human resource*	*Services*	*Supervisors*	*Technicians*	*Administrators*	*Workers*
1	*Objectives &Policies*	*1*	*1*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*4*	*4*	*5*	*5*
2	*Process direction*	*4*	*1*	*3*	*1*	*2*	*3*	*3*	*3*	*3*	*3*	*4*	*3*	*5*	*5*	*6*	*6*
3	*Planning*	*4*	*1*	*3*	*1*	*4*	*4*	*4*	*4*	*4*	*1*	*4*	*4*	*5*	*5*	*5*	*5*
4	*Design*	*2*	*3*	*4*	*1*	*4*	*4*	*3*	*6*	*6*	*4*	*5*	*4*	*6*	*6*	*6*	*6*
5	*Production*	*3*	*2*	*4*	*4*	*1*	*5*	*4*	*5*	*4*	*2*	*5*	*4*	*5*	*5*	*5*	*5*
6	*Funding*	*2*	*4*	*4*	*3*	*4*	*5*	*1*	*5*	*5*	*5*	*6*	*5*	*6*	*6*	*6*	*6*
7	*Tests &Inspection*	*5*	*2*	*4*	*4*	*3*	*6*	*3*	*5*	*5*	*1*	*5*	*5*	*5*	*6*	*6*	*6*
8	*Quality control*	*4*	*4*	*2*	*3*	*1*	*6*	*3*	*6*	*2*	*1*	*5*	*4*	*5*	*5*	*5*	*5*
9	*Quality assurance*	*4*	*2*	*3*	*3*	*1*	*4*	*3*	*5*	*1*	*1*	*5*	*4*	*5*	*5*	*6*	*6*
10	*Process conflict resolution*	*3*	*1*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
11	*Process update/continues*	*2*	*1*	*3*	*2*	*3*	*5*	*3*	*4*	*4*	*3*	*3*	*4*	*5*	*5*	*5*	*5*
12	*Improve product &Services*	*2*	*1*	*3*	*1*	*2*	*4*	*3*	*3*	*2*	*1*	*3*	*4*	*4*	*4*	*5*	*5*
13	*Marketing*	*4*	*3*	*4*	*3*	*4*	*6*	*3*	*1*	*2*	*5*	*5*	*6*	*6*	*6*	*6*	*6*
14	*Advertisings*	*4*	*2*	*4*	*4*	*4*	*6*	*2*	*1*	*3*	*3*	*6*	*6*	*6*	*6*	*6*	*6*
15	*Training on job*	*4*	*2*	*3*	*3*	*3*	*3*	*6*	*4*	*4*	*3*	*1*	*5*	*4*	*4*	*5*	*6*
16	*Self-improvement program*	*4*	*2*	*3*	*3*	*6*	*3*	*6*	*4*	*4*	*3*	*1*	*5*	*4*	*4*	*5*	*5*

4.3.2 Acquire and Develop Process Team

It includes the process of confirming human resource availability and obtaining the necessary team to finish process activities to ensure that all employees are aware of and achieve quality standards and communication with each employee's initial training and continues through their employment. Employee awareness consists of:

1) Every employee understands the company's intention to produce, deliver, and service.
2) Quality-ready mixed concrete by continuously educating and training the employees on theirrole in maintaining the quality.
3) Management System by creating customer awareness of the standards of quality, and detailsof the process of communicating awareness internally in the company.
4) Training: begins with the interview process and make it continues. The following outline provides an overview of the training process.

a) Interview Process.
b) Introductory Training: All new employees receive introductory training once.

c) On-the-job Training: On completion of introductory training, each employee meets with his or her immediate supervisor to begin their on-the-job training. This training may be conducted by the supervisor or by a qualified individual designated by the supervisor.

Training is specific to the position being filled the following items are shared with all positions:

1. Safety: Review general safety information (building exits, fire extinguisher locations, and emergency numbers) and specific hazards to the job.
2. Quality: Review specific processes of quality and some applicable publications that relate to the performance of the position being filled.
3. Work procedures: The sequence and performance of each task in the work process, each employee is informed about how the quality of their work impacts the product quality (quality is everyone's responsibility).
4. Job-specific responsibilities: the equipment operation, batching procedures, and proceduresof reporting sales.
5. Continuing Education: all the employees receive ongoing training in the numerous aspects of the company business.

The types of training received are dependent on the position held by the employee. Examples of continuing education and training include:

1) Weekly toolbox safety and quality meetings for all production personnel.
2) Weekly quality meetings for supervisory personnel.
3) First aid training for designated supervisory and production personnel.
4) Mandatory annual safety training for all Company personnel.
5) Professional training for management or leadership training (administrative personnel).
6) Certifications: All employees are encouraged to obtain available national or state industry certifications that are pertinent to their job functions.

The company should facilitate their pre-course training and fund their attendance to industry courses and certification programs that will improve their ability to understand their jobs better. These industry certifications are important to establish the knowledge base and quality focus of the company in the eyes of the customers. The certificates of completion for outside training are turned in by employees to the personnel department. The company should believe in the continued growth of the organization process and employees [32].

4.3.3 Manage Process Team

The process management team monitors progress toward deliverables accomplishments that are a source of pride for team members and interpersonal issues.

The personnel affecting product quality and conformity shall be competent based on appropriate education, training, skills, and experience. The level of knowledge and skill required to operate the quality system effectively shall be identified and documented.

Where required by these regulations personnel responsible for specific activities shall be identified Competence, monitor awareness, and training of the company shall be:

1) Ensure that relevant staff are competent to perform their functions and are aware of the effects of those functions on quality.
2) Ensure that personnel have been adequately trained in the use of procedures for the activities for which they have responsibility and authority so that the quality objectives are understood, implemented, and maintained at all levels of the company.
3) Review the training requirements for staff particularly when procedures are updated.
4) Ensure that the testing of materials and control of concrete and their constituents are under the supervision of an experienced concrete.
5) Technologists who shall be trained to a standard
6) Maintain appropriate records of education, training, skills, and experience.

Improve communications are important when considering jobs with specifications. The figure (26) shows an example of human resources for communications and recording in the payroll process.

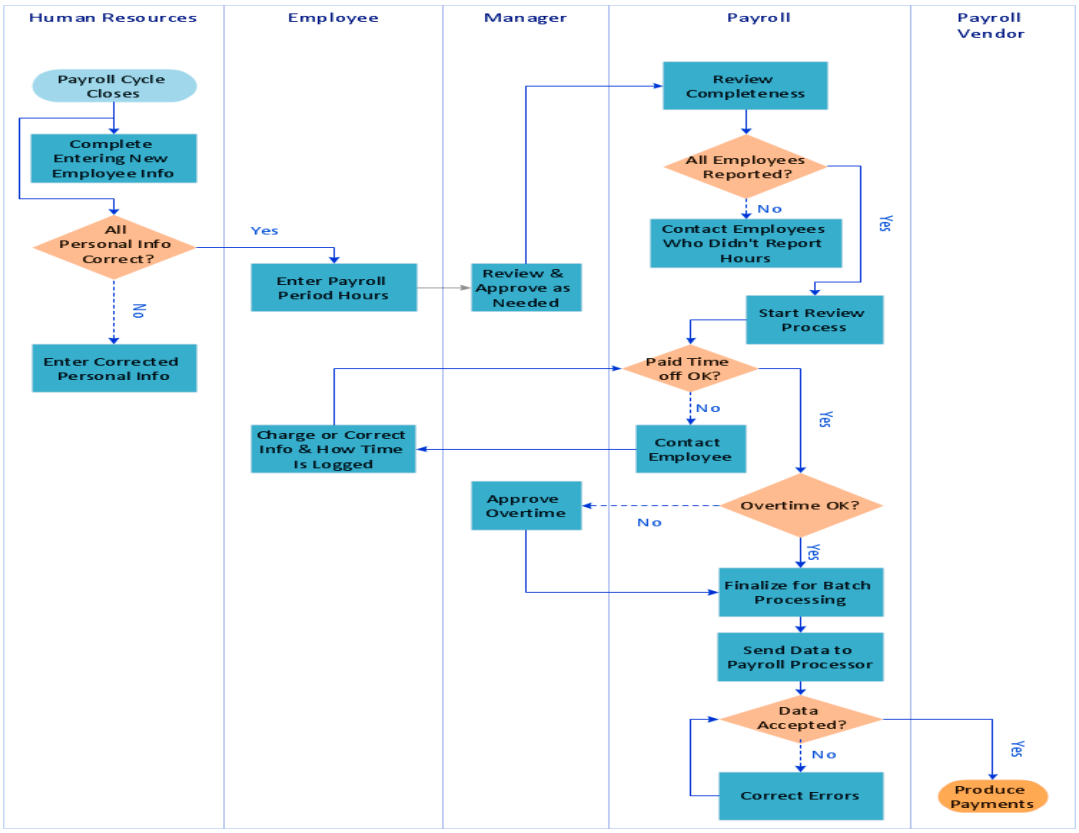

Fig. 26. Human Resources in the process of payroll [31].

4.4 Risk Management

Risk Management includes the process of identifying in what way to deportment risk management actions for the process. It includes the processes of directing risk management preparation, identification, analysis, response, controlling, and monitoring risk in a process. Risk management aims to raise the probability and impact of positive actions, and reduce the likelihood and impact of negative actions. The advantage of this process is guarantees that the degree, type, and prominence of risk management are equal to both the danger and the importance of the process to the company [14].

According to the PMBOK Guide, the overview of the Risk Management processes is as follows:

1. Plan Risk Management.
2. Identify Risks.
3. Risk Analysis.
4. Plan Risk Responses.
5. Control Risks (risk prevention strategy and action steps).

4.4.1 Plan Risk Management

A risk management plan is mainly to communicate with and get agreement and support from all together stakeholders to guarantee the risk management process is reinforced and achieved efficiently over the process life cycle. The risk management plan includes the following:

- Methodology: the researcher relied on the interviews and information obtained from the company during the visit to the company's work site, to indicate the risks by using a cause and effect diagram, then the risk analysis diagram for analysis and from the results of this diagram after draws it he indicates the recommended risk prevention.
- Roles and responsibilities: the roles for anticipating and identifying the risks lie with the Inspection and Auditing Department and the principal supervisor is the Project Manager, solutions are determined by them or by the experts. The responsibility to carry out the recommended risk prevention actions on all employees in the company.
- Budgeting and Timing: a financial allocation for risk management is included in the management plan from the beginning to ensure that the work is carried out within the budget and the time also should be included in the management plan.
- Risk categories to definitions of risk probability.

The main risk categories were: People, Process, Technology, Political, Social, Financial, and Environment.

4.4.2 Identify Risks

The organization to be successful should be committed to addressing risk management proactively and consistently throughout the production. A conscious choice should be made at all levels of the organization to actively identify and pursue effective risk management during the life ofthe project.

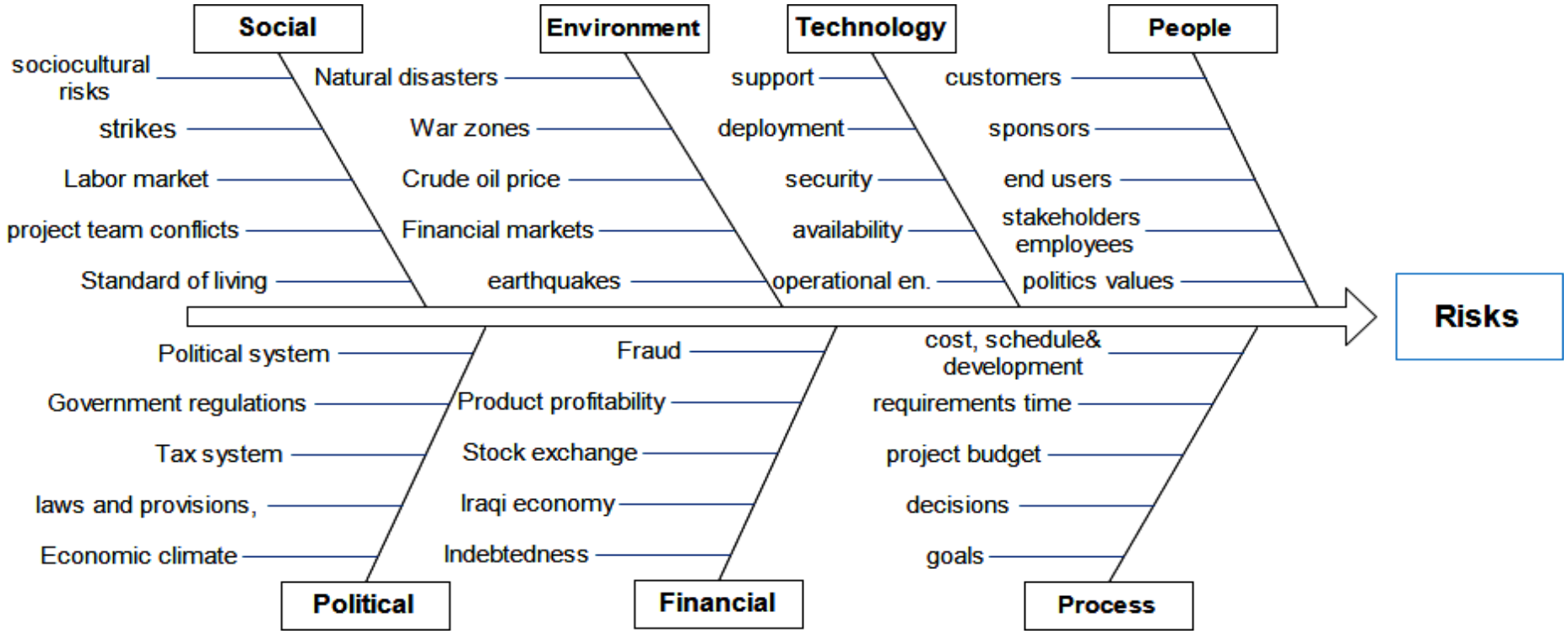

Fig. 28 . Ishikawa diagram indicates Risks *(Researcher).*

Figure (28) indicates all risks and shows all causes related to Risks for the company, where it is identified and displayed by the main 7categories of Risks which are: People, Process, Technology, Political, Social, Environment, and Financial, which are related to 35 causes.

4.4.3 Risk Analysis

The risk analysis is the tool that helps to identify, evaluate, and manage the risks. The Risks are documented according to impact and likelihood of occurrence (high, medium, and low). It depends on the combination of impact and likelihood.

Table 11. Risk analysis for ready mix concrete batching plant *(Researcher).*

Risk category	*No*	*Risks*	*Impact (H/M/L)*	*Likelihood (H/M/L)*
*1) **People** (customers, sponsors, end users, stakeholders' employees and politics)*	*1*	*Ineffective communication.*	*H*	*H*
	2	*Lack of understanding of the project is intended.*	*H*	*M*
	3	*Unknown stakeholders.*	*M*	*L*
	4	*Lack of qualifications.*	*H*	*H*
	5	*Lack of teamwork.*	*L*	*M*
*2) **Process** (goals, decisions, project budget, cost, schedule & development and time)*	*6*	*Process results unpredictable*	*M*	*L*
	7	*Lack of early obvious progress*	*L*	*L*
	8	*Unexpected problems.*	*H*	*M*
	9	*Executive turnover.*	*L*	*L*
	10	*Late delivery.*	*H*	*M*
*3) **Technology** (Support, deployment, security, availability and operational environment).*	*11*	*Old technology.*	*H*	*H*
	12	*Error Information Technology.*	*H*	*M*
	13	*Design risk.*	*M*	*M*
	14	*Budget risk.*	*H*	*M*
	15	*Poor quality data.*	*H*	*H*
*4) **Political** (Economic climate, laws and provisions, tax system government regulation)*	*16*	*Taxes*	*H*	*M*
	17	*Political Instability*	*M*	*M*
	18	*Economics*	*H*	*M*
	19	*Legislation*	*L*	*L*
	20	*Trade Barriers*	*M*	*L*
*5) **Social** (sociocultural risks, strikes, labor market, project team conflicts and Standard of living)*	*21*	*The team contributes to bad behavior*	*L*	*M*
	22	*External events (dead&sickness)*	*H*	*L*
	23	*Spiritual risks*	*M*	*L*
	24	*Culture traditions*	*L*	*L*
	25	*Language problem*	*L*	*L*
*6) **Environment** (Natural disasters, War zones, Crude oil prices, Financial markets and earthquakes)*	*26*	*Unexpected events*	*H*	*M*
	27	*Instability price market*	*H*	*M*
	28	*Natural hazards*	*L*	*L*
	29	*Competitive market*	*H*	*H*
	30	*Security, Safety & alarm system*	*M*	*L*
*7) **Financial** (Indebtedness, Economic, Product profitability and Fraud)*	*31*	*Tolerance in investing,*	*M*	*L*
	32	*Economic Risk of Lending Money*	*M*	*M*
	33	*Over budget (high cost)*	*H*	*H*
	34	*Maintaining cost*	*H*	*H*
	35	*Cost Escalation*	*H*	*L*

Table (11) shows us the Risk analysis by displaying the combination of the impact and likelihood where we will use the results in the Risk analysis diagram. The definition of what high, medium, and low would mean in our business is:

- **High**: The risks that will cause sufficient damage to the business to threaten its existence. The damage is generally beyond the ability of the business to manage. Recovery time: one month or greater.
- **Medium**: The risks that disable one or more parts of the business. The damage is generally manageable but may be irreparable, recovery time: is 72 hours to one week.
- **Low**: The risks that will disturb one or more parts of the business. The damage is confined to inconvenience, reduced morale, and delays. Recovery time 24 hours.

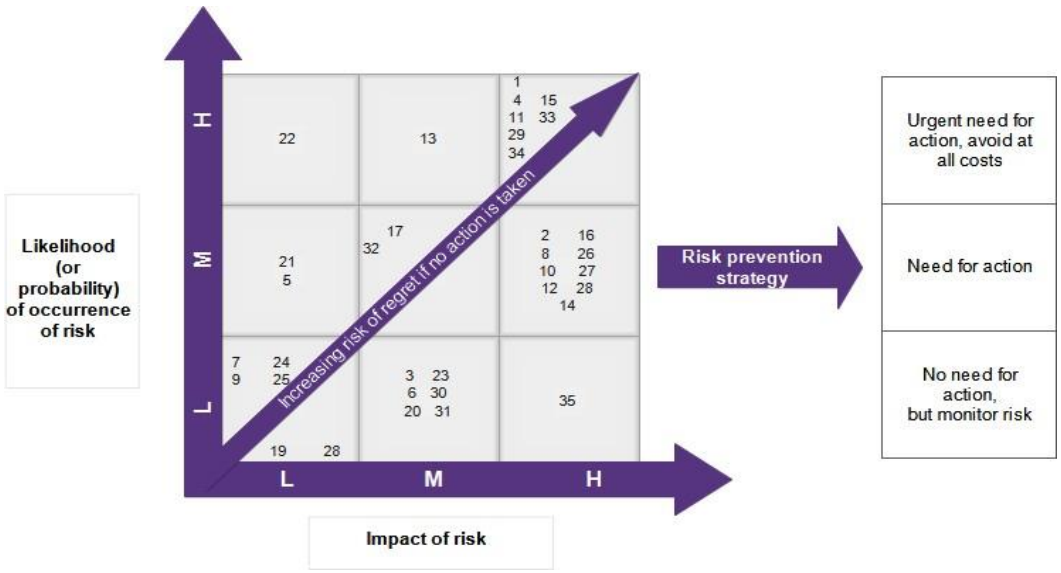

Fig. 29. Risk analysis diagram indicates the recommended risk prevention *(Researcher).*

4.4.4 Plan Risk Responses

Plan Risk Responses is the procedure of improving events and actions to increase opportunities and decrease threats to process aims. The advantage of this process is that it defines the risks and their priority, introducing activities and resources into the budget, schedule, and process management plan as requirements [14].

In our case the priority was for the technology was the poor quality of data and old technology, people were the ineffective communications and lack of qualifications. Environment and process were competitive markets and finances were maintaining cost and over budget or high cost, so we will focus on finding responses for it, but that does not ignore the other risks so we will find in the next step response for each risk to control it all.

4.4.5 Control Risks (risk prevention strategy and action steps)

Control risk is the procedure of implementing a response plan for risk by following identified risks, monitoring remaining risks, and recognizing new risks. The advantage of this procedure is to increase the effectiveness of the risk approach throughout the process of the life cycle to unceasingly improve risk responses.

Table 12. Risk prevention strategy and action steps *(Researcher).*

No	*Risks*	*Risk prevention strategy and action steps*
1	*Ineffective communication.*	*New system and a new communication plan.*
2	*Lack of understanding intended.*	*Training, meeting, and self-improvement programs*
3	*Unknown stakeholders.*	*Definition of stakeholders from the beginning*
4	*Lack of qualifications.*	*Get a job according to qualifications*
5	*Lack of teamwork.*	*Second team or alternative*
6	*Process results unpredictable*	*clear objectives and clear steps to reach it*
7	*Lack of early obvious process*	*Clear process made by expert and approved*
8	*Unexpected problems.*	*Continues improvement and updating process*
9	*Executive turnover.*	*Clear precise steps to the Executive process*
10	*Late delivery*	*Updating process to eliminate late delivery*
11	*Old technology.*	*New technology and keep updating the system*
12	*Error Information Technology.*	*Use skills IT qualifications employees*
13	*Design risk.*	*Check &examine the design before execution*
14	*Budget risk.*	*Ensure that we execute with schedules and budget*
15	*Poor quality data.*	*New steps to provide precise quality data*
16	*Taxes*	*Take into account the taxes with the total cost.*
17	*Political Instability*	*Identify general ideas about politics before start*
18	*Economics*	*Take into account the economic change*
19	*Legislation*	*Make steps in the management plan for Legislation*
20	*Trade Barriers*	*Identify these barriers and find solutions*
21	*The team contributes to bad behavior*	*self-improvement programs and motivate them*
22	*External events (death/sickness...)*	*Find alternatives like second team*
23	*Spiritual risks*	*Remove the barriers between departments*
24	*Culture traditions*	*Remove barriers robs people of pride in their work*
25	*Language problem*	*Training programs*
26	*Unexpected events*	*Drive out fear from workers so they can manage it*
27	*Instability price market*	*Assuming leadership for change*
28	*Natural hazards*	*Alarm system to predict hazards before happen*
29	*Competitive market*	*Awarding business on total cost &single suppliers*
30	*Security, Safety & alarm system*	*Make sure all staff for Security and safety are modern*
31	*Tolerance in investing*	*Looking for the ability to Tolerance in investing*
32	*Economic Risk Borrowing and lending money.*	*ability to join ventures with banks or other company*
33	*Over budget (high cost)*	*Execute according to plan, budget, and schedules*
34	*Maintaining cost*	*Control this cost or buy a new*
35	*Cost Escalation*	*Take into account this change in plan*

4.5 Procurement Management

Management is obtaining the procedure required to purchase the services, products, or results required from outside the process team. The company could be either the buyeror seller of the products, services, or results of the production process [14].

Al-Senaf Company is in contract with number of a reliable companies, institutions, and contractors to provide the company with the various materials, services, or results that are required to complete the process of production of Ready Mix Concrete. Also, it deals with several institutions for publicity or marketing for the products and quality and services after-sales of the company.

According to the PMBOK Guide, the overview of Procurement Management processes includes the following:

1. Plan Procurement Management.
2. Conduct Procurements.
3. Control Procurements.
4. Close Procurements.

4.5.1 Plan Procurement Management

The plan includes the process of detailing process procurement decisions, identifying the approach, and defining potential sellers. The advantage of this process is it defines whether to purchase from outside provision by answering these questions: What to purchase? How to purchase it? How much is required? When to purchase?

The Company purchases the following:

1) Raw materials such as sand and gravel.
2) Manufactured materials such as cement, additives, water, and others like fiber.
3) Services such as advertising, sales agents, and expert judgment.
4) Transportation such as transport of materials and products from- to the company.
5) Others such as spare parts for repairing parts of the factory.

The acceptance criterion of quality, cost, and time required to supply the full quantity of materials. All such information shall be documented in addition to other terms in the contract with the supplier but we should focus on:

a) Specifications and Quantity desired.
b) Quality levels and Performance data.
c) Period of performance and work location and other requirements.

parts of manufactory we can acquire it from any specialized company to product this kind of equipment also the same situation for cars.

The quantity of materials depends on the orders because our manufactory makes concrete according to orders but the quantity will meet our need per daybecause we need (1000 m3/day) so the quantity will be the quantity to produce 1000m3/day. The work breakdown structure (WBS) contains the components of work that may be resourced externally as shown in the figure below:

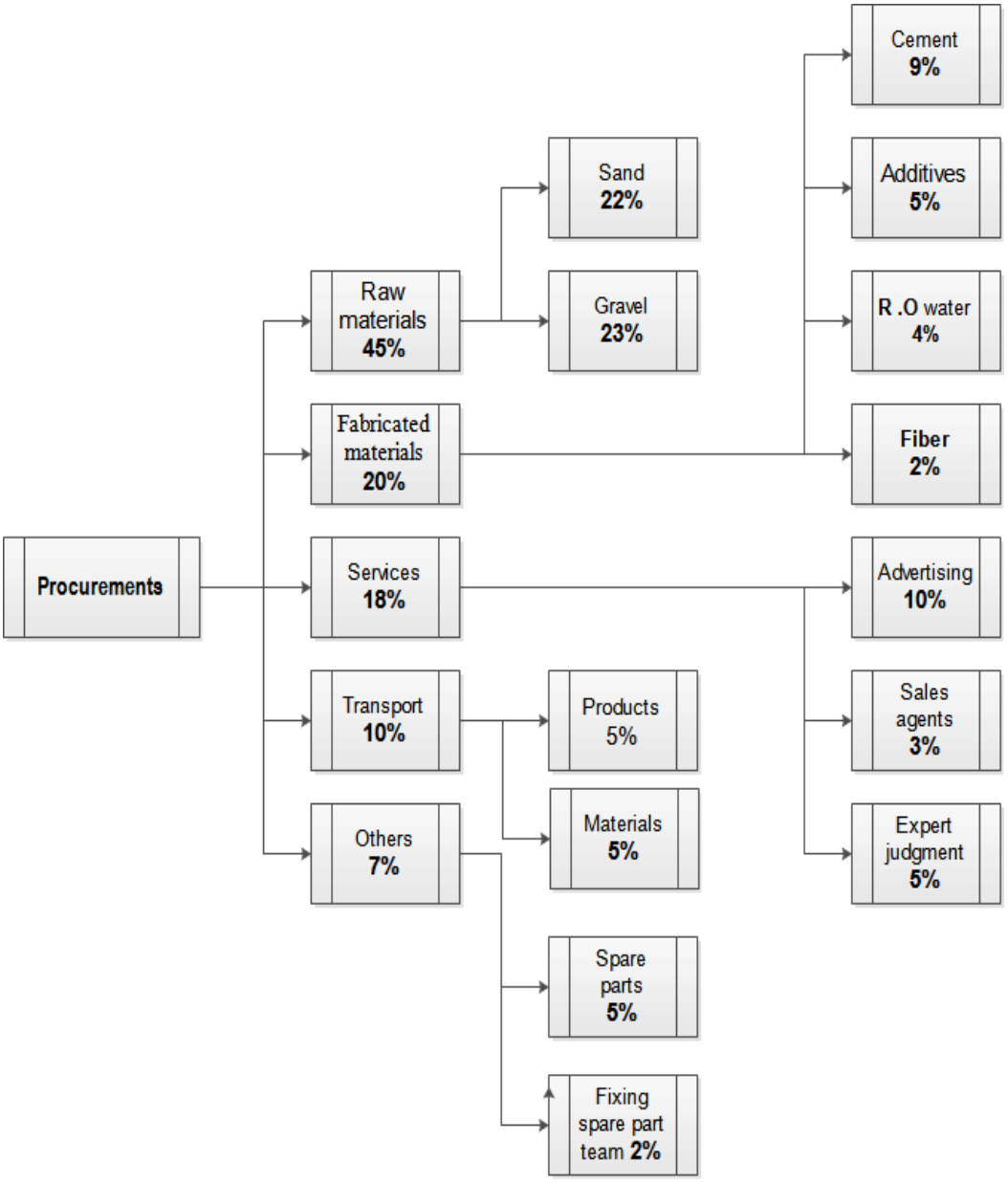

Fig. 30. Work breakdown structure (WBS) of Procurement of the company *(Researcher).*

Figure (30) shows the Work breakdown structure (WBS) of procurement where the researcher describes the services, products, or results required from outside the company with the percentage of priority of each one of them.

4.5.2 Conduct Procurements

Conduct is the process of obtaining sellers' replies, selecting a vendor, and signing acontract. The advantage of this process is that it delivers an arrangement of external and internal stakeholder expectations by recognized contracts [14].

We can find vendors by advertising where existing tilts of potential vendors often can be extended by placing advertisements in circulation publications such as select specialty in trade publications, newspapers, or expert judgment used in assessing sellersuggestions or independent assessments. The selected sellers are those who have been referred to as be inexpensive range built on the outcome of the suggestion and who have negotiated a draft of the contract which will be the actual contract when the decorationis made. The agreements include rapports, and circumstances and may incorporate other items that the buyer specifies regarding what the seller is to perform or provide for the company.

The resource calendars are the quantity and obtainability of resources and those dates on which exact resource or resource group can be vigorous or idle are recognized, also output from this stage change requests, management plan updates, and updates process documents.

4.5.3 Control Procurements

Control procurement includes the process of handling procurement relations, observing contract performance, and creating changes and improvements to contracts to guarantee that both the vendor and consumer performance meet procurement requirements according to the consideration of the legal agreement. A contract alteration control system describes the process by which the procurement can be adapted. It includes:

a. The administration and Tracing systems.
b. Arguments resolve procedures and Levels of authorizing changes.

4.5.4 Close Procurements

Close Procurement is a process of finishing each of the procurements to guarantee that it is document agreements and linked documentation for future situations. In this stage and based on the contract terms and conditions to close the contract all buyersand sellers had to sign the documents following the material and good quality

4.6 Total Quality Management

Total means that everyone in the value chain is involved in the process; it is including employees, customers, and suppliers. Quality means products and services must meet the customer's requirements. Management means you must be committed and encourage everyone else to become quality-conscious [20].

4.6.1 The structure of the company

All departments are responsible for product quality, so to get everyone involved in the process we have to deal with the structure of the company (there are problems and no project manager) first by providing the company what it needs as shown below.

Table 17. The company's employees description *(Researcher).*

No	*Employee*	*Number*
1	*Project Manager*	1
2	*Civil Engineer*	*2*
3	*Water Treatment Plant Engineer*	*1*
4	*Mechanical Engineer*	*1*
5	*Electrical Engineer*	*1*
6	*Mechanical Technicians*	*6*
7	*Electrical Technicians*	*6*
8	*Supervisor*	*6*
9	*consultative lawyer*	*1*
10	*consultative Accountant*	*1*
11	*Officials administration*	*3*
12	*Inspection and testing of employees (Manager and Employees)*	*3*
13	*Product service employee*	*1*
14	*Marketing employee*	*2*
15	*Store Employee*	*2*
16	*Worker (ordinary & Hygiene)*	6
17	*Guardian man*	*2*

The organizational knowledge base for storage and recovering databases covers information like the labor of one work shift and the time of shift eight hours. The organization structure could affect the resource's obtainability and how the process is conducted. Therefore we will change the structure of the company from a Functional organization to a Composite organization type which involves all structures at various levels.

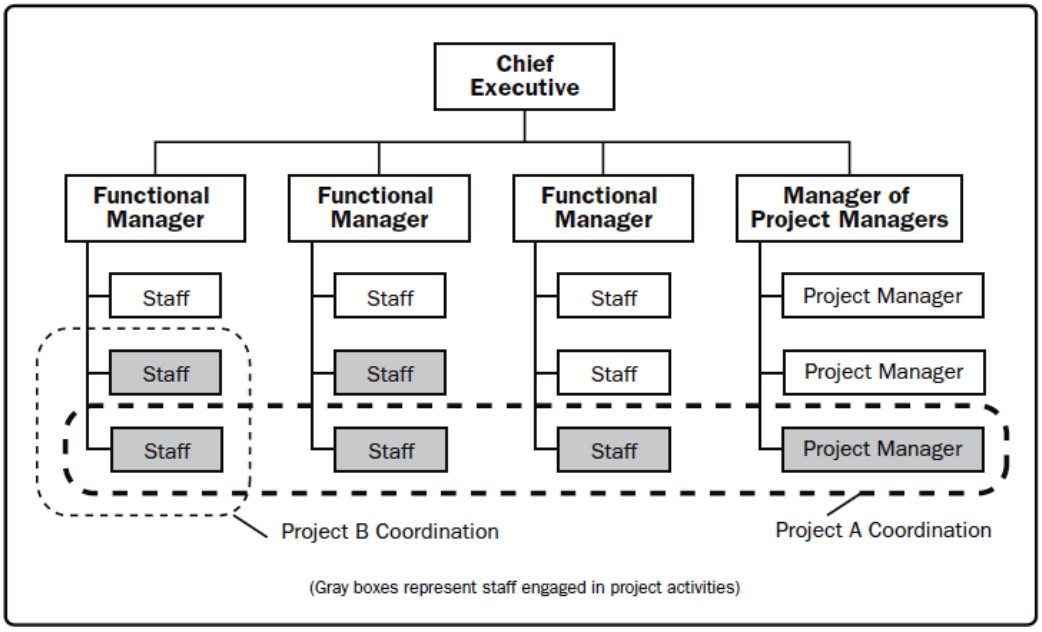

Fig. 32. Composite Organizational [14].

It means the organization may manage most of its process in a strong matrix but allow some work to be managed by functional. In a Composite organization, all the company's resources are involved in process work as shown in table (18).

The project manager has a great deal of independence and authority. The departments can report directly to project management or provide different products and services to the various projects also in some Composite organizations team members are regularly collocated, and virtual collaboration techniques are often used to accomplish the benefits of collocated teams.

Table 18. Influence of Organizational Structures from Functional to Composite [14].

No	*Project characteristics* / *Organization Structure*	*Functional*	→	*Composite*
1	*Project Manager's Authority*	*Little or None*	→	*High to Almost Total*
2	*Resource Availability*	*Little or None*	→	*High to Almost Total*
3	*Who manages the project budget*	*Functional Manager*	→	*Project Manager*
4	*Project Manager's Role*	*Part-time*	→	*Full-time*
5	*Project Management Administrative Staff*	*Part-time*	→	*Full-time*

4.6.2 Employees Involvement

The researcher used the employee involvement matrix to visualize and manage the employees of the company involvement as shown in the figure below.

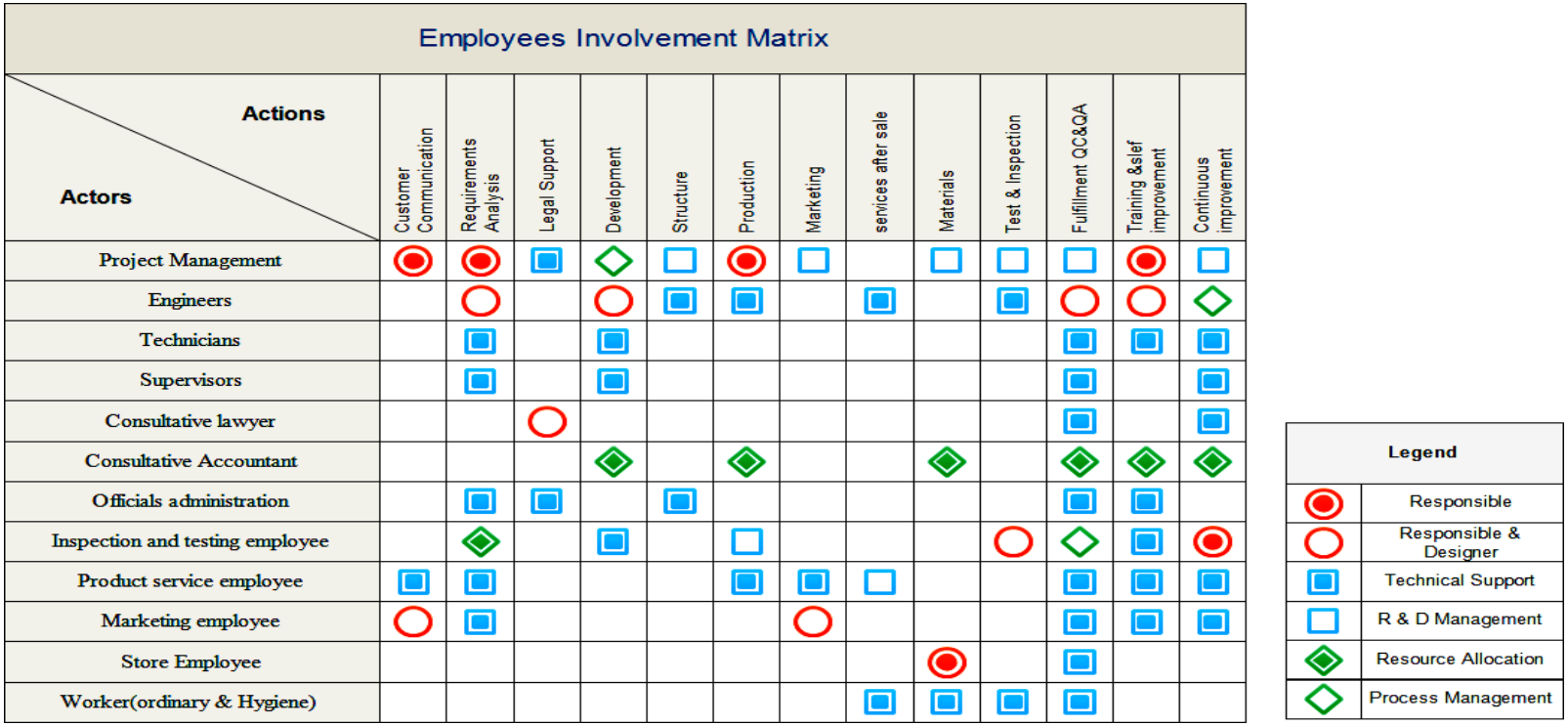

Fig. 33. The Employees Involvement or the relationship matrix *(Researcher).*

Figure (33) shows how each employee is involved in the process in the company, where the vertical direction refers to employees and the horizontal direction refers to actions, where the researcher noticed through the matrix that the Project Manager was the most responsible person and association with all the actions and employees and his role as an administrator, director and the workers were the least involvement.

4.6.3 PDCA (Plan, Do, Check and Act) Cycle

The researcher use PDCA to make improvements on the Quality system and update the process continuously for the most important problem which is the defect in the Quality system. In the same way, other solutions to problems are as follows:

1) Plan

1) Continuous improvement of Quality system and updating process of production.
2) Make all managers, employees, and customers are involved.
3) Improve plan of work and teamwork.
4) Improve the experience of employees.

2) Do

1) Managers, customers, and employees work together to define "Good".
2) Improve the plan of work by management learning what their responsibilities are and byassuming leadership for change.
3) Improve the experience and communications by organizing special training in a plant.

3) Check

1) Quality team working with employees to document how "Good" is measured.
2) The quality team teaches employees how to identify "Bad".
3) Quality team audits and analyses processes and results.
4) Assists employees in finding the root of the cause.
5) The quality team assists the process owner in identifying opportunities for improvement.

4) Act

1) Managers, employees, and Quality team implement solutions for quality improvement inpartnership
2) Processes observe, take photos, record, check data, and gain feedback.
3) Make adjustments to the original plan for continuous improvements and update process.

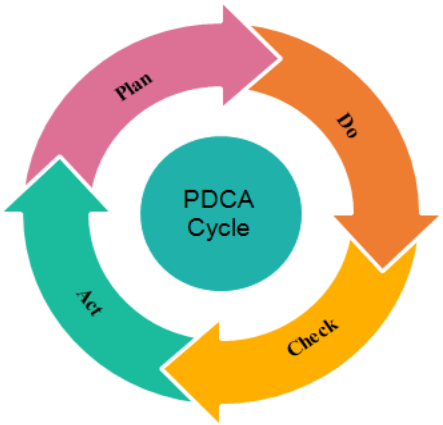

Fig. 34. The PDCA for quality system Ready Mix Concrete *(Researcher)*.

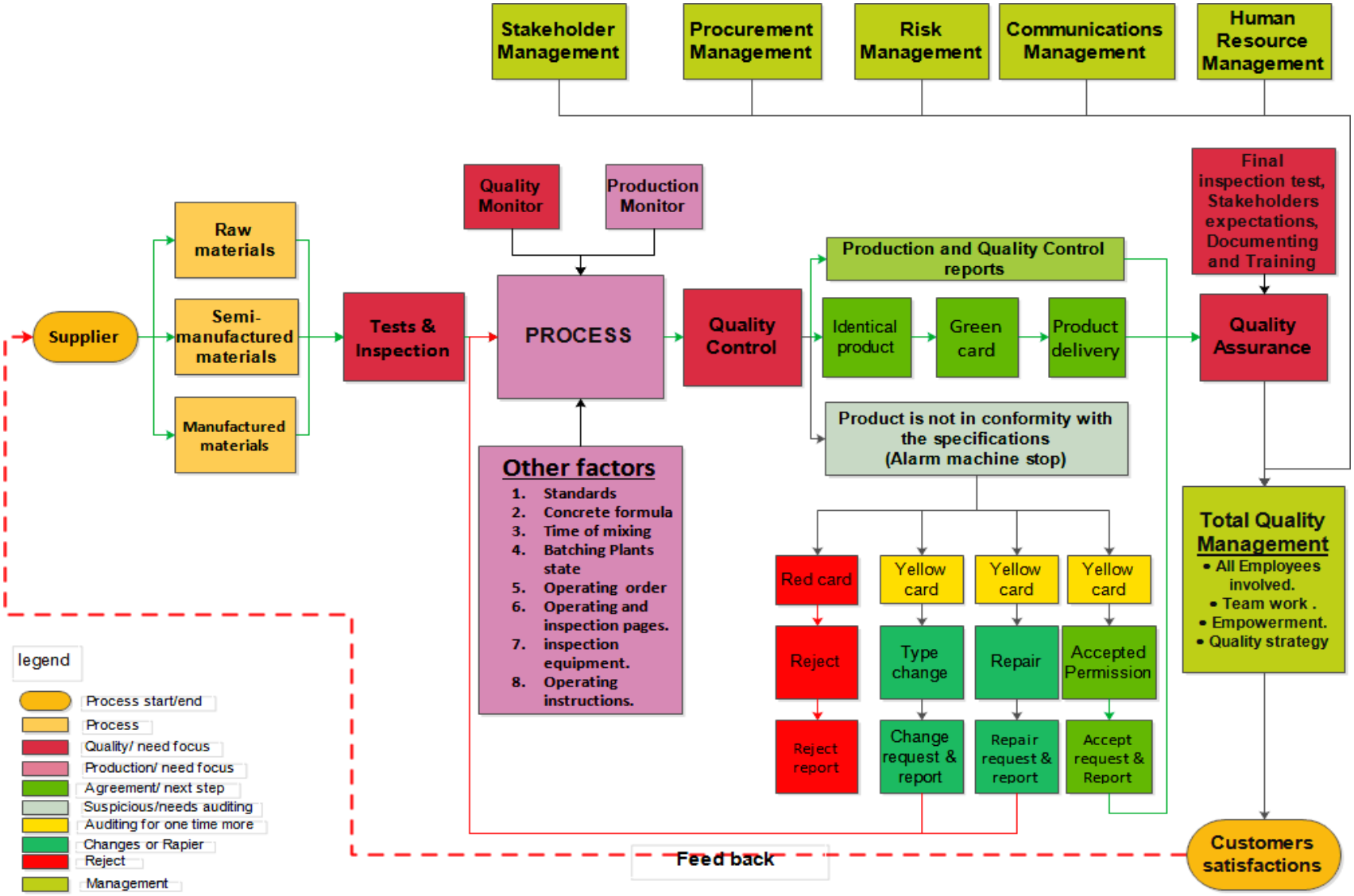

Fig. 35. QC, QA, and TQM in the process of production Ready Mix Concrete *(Researcher)*.

Figure (35) shows the final shape of the process after making adjustments, solving allthe problems of the company, and introducing Quality Control, Quality Assurance and reach Total Quality Management in the process after we described in detail the RMC batching plant and the location, type, number and frequency of occurrence of problems, then the analyzed of the problems by using quality management tools in a manner to explains the details of the mainly and secondary sources of cause or root of cause, found most three problems have biggest impact on the process and analyze it. Then propose strategic solutions to these problems by introducing quality control for the output from the production process where it deals with the product. Then introduced Quality Assurance in the process of dealing with the product and the process, where we made many changes in the process as explained in Flow Chart figure (24) to ensure the quality of the product and provide services tocustomers after sales to achieve customer satisfaction. Then the risk management can be accompanied by the process of finding a solution, wherethe researcher determines and clarifies it, explains the second causes associated with it, analyzes it, and identifies the most dangerous risks to the process, making a plan for responseand actions to prevent the risks from affecting on the process. After that solve the problem of procurement by identifying, planning, and determining the type of procurement, quantity, priority of any one of them when we buy from outside the company and then close it. The last area of knowledge that has a problem in the company where the stakeholdermanagement, where we solved this problem by defining them, identifying their priorities, their expectations, their impact, who is the most interesting, the most influence, the most impact, and the most support. Then we analyzed their current position and the desired positionto solve the problems of responsibilities and duties.

Finally, after all, previous modifications and solutions for the management areas, which used many management tools and techniques, are all in the direction of reaching Total Quality Management, so we changed the structure of the company and transformed the companyfrom Functional to Composite organization to give the project manager more authority and involve everyone in the process through the defined customer needs to meet their satisfaction by feedback and made the improvements and updates in process continues.

CHAPTER FIVE

CONCLUSIONS

5.1 General Conclusion

Through the research work, there are groups of conclusions that can be summarized by the following points:

1. The idea of a combination of the PMBOK guide and the Quality Management in one process was the better choice for the research because we got the best results to reach Total Quality Management by addressing the company's problems in good modality and almost solved it all through the guidelines and instructions of PMBOK guide and the principles, tools, and techniques of Quality management.
2. The entire results after all improvements in Quality and varied knowledge area for the system of the company does not mean that the knowledge described should always be applied uniformly to all processes of the company because it depends on people in the company, the costs, acceptance of owners, time of implement, understand the intent of the changes and support.
3. The most important results from this study are that the researcher found the main reason for the absence of management methodology in the company which is defects in the Quality system (structure of company, procedure, and resources), lack of management experience and communication, and lack of interest and the ignorance in management methodology.
4. Through the research, the researcher noticed that most of the problems originated from people and to a lesser extent other reasons.
5. The problem was hard and we could not solve it problem number (9) prices are not stable in the market because it depend on the uncontrollable market.
6. Application of the Deming PDCA cycle on the most important problem in the company was the best choice for Human resources, which resulted from everyone becoming involved (managers, employees, and customers) in the process of defining (Good). Working as a team involves the identification of leadership and definition of duties and responsibilities, finding the method of measuring ”Good” by the quality team, solutions by managers, quality team, and employees, and observing, recording, checking data, and gaining feedback.
7. The research objectives were achieved through the following tools and techniques:
   1) Ishikawa's diagram achieved the objective number (1).
   2) Check sheet, FMEA Analysis, 5 whys achieved the objective number (2).

3) The solution-effect analysis achieved objective number (3), where it proposes solutions for problems (1-35) except problem number (9) prices not stable in the market,which is uncontrollable.
4) Quality Control, Quality Assurance, and Checklist achieved the objective number (4).
5) The objective number (5) achieved by management of :
   a) Human Resources by responsibility matrix**,** training, and recording.
   b) Risks by Ishikawa diagram, Risk analysis table, Risk analysis diagram, and Riskprevention strategy and action steps table.
   c) Procurement by work breaks down structure (WBS) and finds what to purchase, how topurchase it, how much is required, and when to purchase it.

8. Objective number (6) was achieved by rearranging people (same number of employees with different specializations) inside the company by the company's employees table, changing the structure of the company from functional organization to composite, Employee'sInvolvement Matrix and PDCA (Plan, Do, Check and Act) Deming cycle as well as the results of all previous optimizations.

5.2 Particular Conclusion

The following conclusions can be withdrawn as a result of the work carried out in this research:

1. The researcher managed the exploring the problems by problem description based on the data obtained from the company and identifying the problems and obstacles in the process by using a Flow Chart for the process and an Ishikawa diagram to identify, explore, and display all possible causes related to a problem and discover the root of the cause and shows the dependencies among causes and underlying drivers, where main categories of problems were: management, people, procedure, financial, machines, suppliers and environment. Then the underlying drivers were 34 every one of them has 2 or 3 causes.

2. The researcher used to manage a thorough analysis Check sheet table to record or monitor the number of occurrence of problems for thirty days, then the researcher used the number of occurrences in FMEA Analysis which is used to prioritize potential defects based on

their detection, occurrence, and severity of problems where the results of the analysis are the most three important problems are: defect in quality system, defects and stopping the batch plant during production, and lack of experience and communications. Then to diagnose the problems we used 5whys to understand the real reasons why problems occur by using why 5 times to get the source of a problem (root causes) in minimum time.

3. The researcher used the solution effect analysis, which is an inversion of the Ishikawa diagram, to propose and display 2 or 3 or more 3 solutions to each problem to reduce the waste in cost, materials, equipment, fuel, and any other resources to a lesser extent.

4. The researcher solved the product quality problem by applying Quality Control in the process, where it is monitoring the result of the process to assess if they meetappropriate quality standards, and finding techniques to eliminate causes of unsatisfactory performance where the result of the process was three cases:

1) The first is a mandatory report on the quality control and production process.
2) The second is product conforms to the specifications then delivered to customers.
3) The third is product not conforming to specifications thus resulting in four cases:
   A. Accepted with Permission then accept request and report.
   B. Repair then repair request and report then return to process again.
   C. Type change then Change request and report then return to process again.
   D. Reject products then reject report then disposal of the products.

5. The researcher applies Quality Assurance in the process of production to manage defect prevention for products and processes by making changes in the whole process and the inspection and test to provide Ready Mix Concrete with consideration of the best degree of homogeneity and reliability to match to market requirements, we used Flow Chart to show the process changes.

6. The researcher develops the process of production of the company by using the application of PMBOK guide and Quality Management principle, tools, and techniques by:

A. Human Resource Management involves organizing, managing, and leading the processteam by three points:
   1) Plan Human Resource Management: we use the Responsibility Matrix to identify and document roles, responsibilities, skills required, and reporting relationships.
   2) Acquire and Develop the process team: by settling human resource availability and finding the team of work necessary to complete the process activities to ensure that all the employees are aware of the process and to fulfillment with quality standards and communication with employee training and continue by their employment.

3) Manage Process Team: by team monitors, record awareness, and training toward deliverables.

B. Risk Management activities for the process:

1) Plan Risk Management: methodology, roles and responsibilities, budgeting and Timing, and Risk categories
2) Identify Risks: Ishikawa diagram for Risks
3) Risk Analysis: Risk analysis tool and Risk analysis diagram.
4) Plan Risk Responses: report the risks by their priority and inserting resources.
5) Control Risks: Risk prevention strategy and action steps.

C. Procurement Management which is the process of purchasing services, products, or resultsrequired from outside the process team (outside the company):

1) Plan: define by finding what to purchase, how to purchase it, how much is required,when, and the Work Breakdown Structure (WBS) of procurements.
2) Conduct Procurements: selecting a seller, awarding a contract and agreements.
3) Control Procurements: monitoring contract performance.
4) Close Procurements: Complete each procurement and document agreement.

7. The researcher used the Total Quality Management methodology to involve everyone employees, customers, and suppliers in the process by:

a. Provide the company with what is needed (Project Manager and employees) by rearranging people inside the company (same number of employees but different specialization).

b. Change company structure from Functional organization to Composite organization type which involves all structures at various levels.

c. The Relationship matrix shows the employee's involvement.

8. The researcher used Total Quality Management to make continuous improvements on the Quality system and updating process of the company by using the PDCA (Plan, Do, Check, and Act) Deming cycle for defects in Quality system problem (the most important one) to meet with customer satisfaction, the result from that everyone become involve (managers,employees, and customers) in the process to define ”Good”. Working as a team work by identification of leadership, definitions of duties and responsibilities, finding the method of measuring ”Good” by the quality team only, solutions by managers, quality team, and employees, and observing, recording, checking data, and gaining feedback.

9. The objectives of the research were achieved by solving almost all problems of the company through Total Quality Management which resulted from introducing quality

control for the results of the process of production first, secondly using Quality Assurance by introducing modifications to the process from the beginning and insertion monitors of production and quality in the processes and thirdly managing the rest knowledge areas where the company has problems which were: Human Resource, Risk, and Procurement.

5.3 Further Research

- Meeting the requirements of the International Organization for Standardization (ISO) to get an ISO 9001 Quality Management Certificate for the company.
- Robotic.
- BIM.
- Industry 4.0.
- Made in China 2025.

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