

## The Application of DMAIC Six Sigma Methodology to Control the Quality of Internal Audit Performance: A case study

By

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### Abstract

The great changes in the business of economic units and the development of fraud and financial manipulation methods imposed on the internal audit great responsibilities and tasks of providing reliable information to the relevant parties with the speed and quality required, and this requires the development of this profession to keep pace with this development. Six Sigma is deemed as the most important methodology used to maintain quality and control performance. Hence, researchers have been deeply concerned with such subject which aims to identify the extent to which DMAIC Six Sigma Methodology can be applied to control the quality of internal audit performance. To attain such goal, the researchers applied realistic approach to accomplish this study. One of the more important results which have been concluded out of this study is that there is a manifest application of DMAIC methodology in Internal Audit Units through the application of the methodological stages (Define, Measurement, Analysis, Improvement and Control). Important recommendations were suggested in this respect the most important of which is that " High Management is taking pains to adopt the application of DMAIC SS methodology to attain performance quality especially in internal audit and support of work environment with quality concepts applied in the unit ".

**Key words:** Six Sigma, DMAIC Methodology, Internal auditing Quality.

### Introduction

DMAIC SS is a methodology which has a statistical base. It focuses on the removal of causes of differences or defects associated with main processes. It seeks to improve quality to 99,99966%. Therefore, it is deemed as a methodology seeking to identify and overcome the causes of errors, defects or defaults associated with processes through the focus on those outputs having material importance. Therefore, major companies have taken this methodology in consideration and started applying thereof to control performance and gain huge economic benefits. Consequently, this methodology shall be dealt with as follows:

### Methodology of Research

#### **Problem of Research:**

Problem of Research can be realized through the reply to the below question:-

To what extent Six Sigma methodology can be applied by internal audit units to control quality?

***Research Importance:***

Six Sigma Methodology is deemed as one of the means used to attain performance control and quality. The application of such methodology has been approved to be useful to applied in and has become some sort of an absolute necessity for internal audit units to adopt including the Internal Audit Department of the research sample.

***Research Objective:***

The main goal of this study can be identified as follows:

The extent to which Six Sigma methodology can be applied to control the quality of internal audit performance of the research sample and introduce the manner through which such methodology can be applied in the Internal Audit Units of Governmental Entities of the research sample.

***Research Hypothesis:***

Six Sigma methodology cannot be applied in the Internal Audit Units of the research sample.

***Research Sample:***

General Company for Ports of Iraq – Auditing and Internal Control Department.

## **Literature Review**

(AL Harbi, AL Sadiri, 2018) study entitled (The Application of Six Sigma standards to Improve the Quality of Internal Auditing at Commercial Banks in KSA). The said study confirmed that the Internal Audit Managements of Saudi Commercial Banks are ready to apply the standards of SS methodology through making available all important and basic elements and prerequisites required to apply such methodology whether financial or physical support or the attraction of human staffs specialized in the field of SS methodology.

(Costa et al, 2019) study entitled (Six Sigma application for Quality Improvement of the Pin Insertion Process). Through the application for such methodology in industrial units, this study could reduce the defected items from 3231 ppm to 312 ppm and increase Sigma level from 4,22 to 4,92 which resulted in huge savings amounting to around 122,000.00 Euro.

Researchers (Patidar & Rathore, 2021) through their study entitled (Implementation and Future Research Review of Six sigma DMAIC Methodology, Manufacturing Sector in the) have come to conclusion that research activities of SS methodology has been remarkably increased after 2005. SS researches have been widely widespread with a broader scope through various aspects and there was a significant participation within SS framework to widen the application of such methodology from manufacturing to the scope of service.

This current study is distinguished by the actual application of the five stages of DMAIC methodology: (Definition– Measurement– Analysis– Improvement– Control) in internal audit units (non-industrial units) and also the application of such techniques used in each stage along with the introduction of the quality level according to which the unit performs its business from SIGMA 's point of view.

## Six Sigma

Sigma is eightieth letter of Greek Alphabet with symbol ( $\sigma$ ). Statisticians use such symbol to refer to the standard deviation which denotes the disproportionality and dispersion observed in a particular process away from the targeted objectives (AL Harbi, AL Sidairi, 2018:399). International Federation of Accountants (IFAC) defines SS as such methodology used to improve the process and a statistical concept seeks to identify the deviation rooted in any process (Council for Six Sigma, 2018:11).

The mathematical formulation of such methodology is as follows:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

Where:

S = standard deviation

$\sum$  = aggregation

X = value or values

$\bar{X}$  = Mean

N = volume of the sample

There are six levels starting from 1<sup>st</sup> level (with the highest level of defect and least quality) to the 6<sup>th</sup> level as shown in the below table:-

**Table No. (1): Six Sigma Levels**

SIGMA LEVEL	DPMO	% GOOD
1	690,000	31.000%
2	308,537	69.1463%
3	66,807	93.31933%
4	6,210	99.379%
5	233	99.9767%
6	3.4	99.99966%

(Patel and Chudgar, 2020:1205)

## SS Teamwork

The application of SS methodology does not require for the whole Organization to take part. This because SS methodology shall be applied only by nominated persons from a group of professionals who have been already trained (Alhuraish,2017:13)

### Leader

leader, in general, is the CEO or a member of 1<sup>st</sup> team formed in the Organization as the team in charge of the strategic cycle course (Knowles,2020:58). Leaders try to introduce new thoughts and knowledge into the Organization through their own training behaviors which may maximize the project success (Arumugam & Linderman, 2020:58).

Leaders shall: (Knowles,2020:58)

- The Transformation to SS through the development of the vision and message and connect this with the program via a visible manner.
- Supervise and activate the progress of projects.
- Attain a full vision as to the projects and their connections with strategic objectives.
- Coordinate the multi – function activities such as training.

### ***Champion***

Champion is one of the Organization 's high management members. SS leadership shall nominate the champion. The Champion has a good understanding of SS and methods of their application and takes part with SS leadership in setting up the strategy of the initiative application and identify its goals (AL Nahdir, 2017: 46) The champion 's most important role is to remedy such barriers which are beyond the power and scope of the team. This is fairly important to ensure the feeling of support by teams and not loss momentum. Champions are also in charge of the active operation of the team (Knowles,2020:58).

### ***Master black belt***

It represents those individuals with experience. They are affiliates of supporting managements. They are trainers and guiders of black belt members working in various projects and they act to develop training plans as well as they undertake to assist in the selection of such projects required to be developed or constructed within the Organization. Individuals of Master black belt guide and support the leader. (AL Baghdadi, 2018: 164). Master black belt shall be nominated based on leading and illuminist skills. He or she plays the role of the reference and supervision for black, green and yellow belts (Nasar,2018:34).

### ***Black belt***

They are specialized in quality and are guided by the Master black belt. Black belts are deemed as modifying factors. They play a leading role in the improvement throughout the project term (Pakdil,2020:48). They are in charge of identifying the problem and undertaking to manage and train the project staff (Alzabari et al., 2019). A black belt has the skills of using SS tools to asses problems and design procedures, processes and productions in general. His/her responsibility shall be devoted for the endeavors of quality and maintain the planned goals. Moreover, he / she is considered as the first person responsible for the preparation of the team to commence the work and vitalization of trust in the team (Hindawi, 2017:52).

### ***Green belt***

Individuals who are trained of SS skills and projects. They are mostly classified to occupy the same level that of the black belt. They spend most of their time to complete projects while their basic roles and responsibilities remain operative for the remaining time (Hindawi, 2017: 35). Green belt is a member of Sigma team or partially a team leader. He/ she spends around 10%-40% of his/ her time in applying Sigma Program at site (Nasar, 2018:35).

### ***Yellow belt***

Yellow belt is one of process operators who receives a simple training about SS methodology and takes part in SS projects as a member with a part-time job under the leadership of black or green belt within his/ her job spatiality only in addition to the activities of his/ her routine job (AL Nahdir, 2017: 48). Yellow belt should have the following traits:

(job knowledge, cooperation, initiative and capability to use SS tools) (AL Baghdadi, 2018: 169).

## **DMAIC methodology**

DMAIC methodology is deemed as the most usable and spread methodology used when the company needs to develop its products or services. The emergence of such methodology dates back to 90's when Mike Harry submitted one of his researches to Arizona University entitled (Logic Filter). Then, the thought of such research was developed into DMAIC methodology and has been used to solve the problems of Organizations. Later, such methodology has become a roadmap to maintain quality sought by SS. Therefore, the steps used to apply SS methodology are called DMAIC since such methodology is deemed as the base to apply SS (Hindawi, 2017:56). DMAIC is the abbreviation formed by combining the initial letters of (Define, Measure, Analyze, Improve, Control) and used in projects and processes which are in progress or solving problems. We list below the steps adopted to apply such methodology:

### ***Define***

This stage is concerned with the identification of the problem, project requirements and success goals. Such identification of requirements and goals may be linked with a group of varied factors and depend to some extent on the guideline of team leadership and anticipated budgets (Council for Six Sigma, 2018:124). Define is the first stage of SS improvement process. During such stage, team leaders shall develop the project charter and a high – level vision as to the process (Krishnan & Prasath, 2018:112). Such stage focuses on the project and clients' requirements and defines the expectations of the project improvement and SS methodology to maintain the client's requirements (Gandhi et al, 2019:81).

### ***Measure***

During such stage, the current process is to be understood. Information shall be collected and then measured through statistical methods (Zhong, 2017:32), the defected item shall be identified, true and basic information shall be collected and improvement goals shall be identified (Gandhi et al, 2019:81). The scores and costs of process quality shall be described along with a precise reflection of the actual case. There is a need for a statistical perspective assigned to processes and the problems related thereto. Such measurements shall be conducted by various tools such as SIPOC method, descriptive statistics and brief drawings (Eshraghi, 2020:8).

### ***Analyze***

This stage is connected directly with the measurement process where information already collected during the second stage is now to be reassessed and then more accurate information can be obtained. The basic goal specified in this process is to find out the main cause of defects and wastage of the current information (Kumar, 2020:4). There are three steps in this stage: The development of cause and effect relation, identification of the main cause and verifying thereof and the development of the practical capability (Alzabari et al., 2019). During the aforesaid measurement stage, information related to the real causes shall be collected and then it shall be verified. Such causes should be connected with impacts to envisage the factors of the process affecting performance (Zhong, 2017:35). The hypothesis test may begin to check the validity of the assumptions and possible solutions in the analysis and shall continue until the improvement stage, teams may start to develop the design of the process through the



identification of the activities with and without add – value, locate the areas where errors and congestions may occur and improve the requirements to meet the project needs and goals properly (Council for Six Sigma,2018: 125).

### ***Improve***

During the improvement stage, solutions shall be set up to remedy the main causes which have been already identified during the analysis stage. Then, such solutions of the anticipated risks shall be assessed and improvement shall be assessed as well after conducting a pilot test (Alejandrino et al, 2020: 1344). During such stage, new thoughts related to the methods through which prior real causes can be remedied shall be triggered. This usually can be fulfilled through brainstorming and standardized comparison, assessment and identification of the priorities of thoughts, identification of the best thoughts and solutions and they shall be constructed in the map of” should be there” process, experiencing new thoughts to verify the validity thereof, check the test run for a sufficient period of time to attain a significant information sample (Neidel and Fanta, 2020:127).

### ***Control***

This stage often plays an important role in sustainability of process improvement. Performance control permits to assess the progress obtained by virtue of the executed improvements (before against after) with the presentation of the stability of the new process in the same time (Arcidiacono & Pieroni, 2018:147). The goal of the control stage is to make sure of the improvements ' continuity, control and that they have made a positive influence. The main success of this stage is represented by developing an overall control plan documenting all changes which have been already executed during the process and identifying such changes in the course of the process (Zhong, 2017:38).

## **Internal Audit**

Audit in general and Internal Audit in particular are deemed as a source of anxiety for many of the profession organizers and employers due to many failures and setbacks which have led to the state where the confidence in the work outcomes has greatly declined. Accordingly, the subject of Interior Audit has received remarkable attention within all economic units (Thijel et al., 2018). (INTOSAI) define the business of Interior Audit as: It is the business through which the Directors of the unit shall receive from the internal sources a confirmation that the processes for which they are hold accountable are undertaken through a manner which minimizes the possibility of making errors, inactive and noneconomic practices or fraud.(INTOSAI, 9150,2016:4) while Institute of Internal Auditors (IIA) defines Internal Audit as: an advisory activity and independent subjective confirmation designed to add value and improve the processes of the Organization. Internal Audit assists the Organization to maintain its objectives through the introduction of an organized and disciplined approach to assess and improve the activity of risk management operations, control and governance (IPPF-Standard, 2017:9).

Through the modern concept of Internal Audit, it appears that the goal of Internal Audit is to assist the Organization to maintain its goals, add value thereto, improve the work procedures, and maximize the competence of systems and processes. It requires to change the view towards internal audit in such a way that it is looked at as such business complementary and supportive to the activities and its goals are in line with those of the

Organization and do not contradict therewith. Internal auditors should then deepen such goals through ongoing enlightenment and proper behavior while on duty and communicate the parties subject to audit (AL Rimhi, 2017:24) that Internal audit aims to (IIA, 2017):

- Increasing the value of units and improve its processes.
- Assessing of and improving the effectiveness of risk management, control and governance.
- Correcting the compliance with the set up policies, procedures and plans
- Assessing the extent of safety and sufficiency of the procedures of used to preserve the assets available in the unit.
- Assessing the quality of the performance of missions required to be fulfilled by the unit 's personnel at all levels.
- Submitting recommendations which help to develop and improve the actual performance.

Audit quality is taken to be the capability of an auditor to discover the possible errors and provide recommendations for the purpose of improvement. Audit quality can be maintained if internal auditors fulfill their jobs and responsibilities actively through the full Audit process and they should comply with audit standards related to mission planning, collecting audit evidences and expressing opinions (Arum & Wahyudi,2021:9). Audit Quality is further defined by International Standard No. 220 as " It is represented by such policies and procedures applied in the audit company to check if performed audit activities have been executed in line with the applied audit standards " IAASB,2015:74). Therefore, the results of internal audit quality are: disclosure of internal control weak points, compliance with regulations, officers ' responses, circulation of audit reports and following up audit's recommendations subject to legal regulations (Addaraini & Erlina, 2020:3).

Audit quality is maintained if the team entertain the following traits: (IAASB,2015:44)

- Adopting proper values, ethics and behaviors.
- Having sufficient skills, knowledge and experiences and spare enough time to perform audit activities.
- Applying procedures related to quality control and compliance with applied laws, systems and standards.
- Submitting significant report in a timely manner.
- Interacting properly with the concerned parties.

Audit high quality is identified if the auditor complies with applied guiding standards and principles related to audit ethics which greatly help the auditor to set up principles related to the manner of overcoming ethical solicitations (Addaraini & Erlina, 2020: 2).

Audit International Standards issued by International Auditing and Assurance Standards Board (IAASB) describe the goals of audit and they further stipulate the minimum requirements. Yet, most of the requirements set forth by audit international standards either provide a frame for the judgments passed within a particular audit process or requires to pass certain judgments to applied correctly (IAASB,2015:40).

## **Practical application**

General Company for Ports of Iraq of Ministry of Transportation and Communications

established in 1919. It is one of the Governmental Sector. It is composed of the major ports: AL Ma'aqal Port, Southern / Western Om Qasr Port, Khor AL Zubair Port, Abo Floos Port and AL Fao Grand Port (presently under construction). The company aims to manage and run the port and harbors and set forth the rules and pass decisions required to operate, develop, upgrade and improve the conditions of such ports and harbors subject to Act of Ports No. 21 of 1995, Ships Registration Act No. 19 of 1942 and other Acts and systems regulating the aspects of their business (Talab et al., 2017). Company's nominal capital is (IQD 603,000,000) six hundred three million IQD. Reserves are equal to (IQD 451,861,430,520), Retained earnings of 2018 were amounting to (IQD 39,720,389,245), total distributable profit of 2018 was (IQD 124,727,841,545). Number of Personnel is 9006 employees.

## **The application of DMAIC methodology to the research sample**

SS methodology shall be applied to the research sample (General Company for Ports of Iraq) to check if such methodology can be actually applied through the following five stages:-

### ***Define:***

The following issues shall be managed during such stage: identification of the performance and current situation of the concerned unit (Al-Taie et al., 2017). Identification of the problem which faces the audit and internal control of the unit and the preparation of performance requirements.

### ***Description of the Present Business***

The business and performance outputs of audit have been identified. The outputs of the Internal Audit Department (the research sample) represented by the transactions processed in 2018 were taken in consideration and selected. Only the daily records of the Financial Affairs Department which had been already audited and revised by the Internal Audit Department were taken in consideration because they represent the outputs of the Internal audit Department on one hand and it is difficult to specify and observe all business performed by internal audit and follow up its transactions. The processed and audited entries as well as their associated transactions were (60,742) entries.

### ***Formation of Sigma Team:***

The teamwork was formed which is composed of those members listed in Table No.(1).

### ***Identification of Problem Y***

The following equation shall be used to identify the problems which face the performance of internal audit and specify their causes:

$$Y = f(X_1 + X_2 + X_3 \dots) \text{ (ASS, 2018)}$$

Where:

Y: Represents the problem which faces the unit.

X: Represents the causes of the problem

f: Represents the relation between the problem and its causes



The real problem facing internal audit shall be identified after introducing the company performance. Such problem shall be identified via some techniques including (interview, questionnaire, past problems, audit, and company internal reports). Here, the problem is represented by (poor quality of internal audit performance). This representation was maintained out of the averages of errors discovered in the business of internal audit which require re-modification, reformulation and spending much time.

**Preparation of Project Document**

**Table No. (2):** project of minimizing internal audit errors

<p><b>Case Description:</b>          Clients (whether Federal Board of Supreme Audit, management or users of financial statements) complain of the many errors and various modifications</p> <p><b>Problem:</b>          Poor quality of performance and high averages of errors in the business of internal audit which require re-modification, reformulation and spending much time.</p> <p>Project extent, obstacles and hypothesis</p>	<p><b>Teamwork</b>          1 – Prof. Dr. Alaa Fareed / head of the team          2 – Ghaleb Saad / member.          3 - Federal Board of Supreme Audit and General Company for Ports of Iraq / Advisors</p> <p><b>Goal:</b>          - Minimizing errors          Upgrading Sigma level of the performance of Internal Audit Department</p> <p><b>Individuals Unengaged and unconcerned with the project:</b>          - users of financial statements in General Company for Ports of Iraq.          - Investors in the company          - Employees serving in other departments other than Audit and Accounts Departments.</p>																								
<p>Project Execution preliminary Plan</p> <table border="1"> <thead> <tr> <th></th> <th>Targeted date</th> <th>Actual date</th> </tr> </thead> <tbody> <tr> <td>Date of work commencement</td> <td>1/11/2012</td> <td></td> </tr> <tr> <td>    Define</td> <td>5/11/2012</td> <td></td> </tr> <tr> <td>    Measure</td> <td>1/12/2021</td> <td></td> </tr> <tr> <td>    Analyze</td> <td>5/1/2022</td> <td></td> </tr> <tr> <td>    Improve</td> <td>30/1/2022</td> <td></td> </tr> <tr> <td>    Control</td> <td>15/2/2022</td> <td></td> </tr> <tr> <td>Date of Project Accomplishment</td> <td>1/3/2022</td> <td></td> </tr> </tbody> </table>			Targeted date	Actual date	Date of work commencement	1/11/2012		Define	5/11/2012		Measure	1/12/2021		Analyze	5/1/2022		Improve	30/1/2022		Control	15/2/2022		Date of Project Accomplishment	1/3/2022	
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The source is prepared by the researchers

**Preparation of SIPOC Chart for the processes of Internal Audit Department:**

**Table No. (3):** SIPOC Chart for the processes of Internal Audit Department

Supplier	Inputs	Process	Outputs	Customer
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- Accounts Dept.	- Financial statements	- Salary	- List
- Administration Dept. and other Departments	- Recorders	- Inspection	- High Management Board of Supreme Audit
- High management	- Documents	- Audit Expression of opinion	- Audited financial statements
- Federal Board of Supreme Audit	- Lists and documents with remarks	- Repo	- Reports

The source is prepared by the researchers

**Measure**

During such stage, the following issues shall be performed: measurements shall be prepared, causes of problems shall be identified, numbers shall be assigned against each cause of problem, Sigma level shall be measured to check the closeness and distance of such causes from such level and finally the accuracy of the unit business shall be recognized that each level of Six Sigma has a specific percentage of both accuracy and errors as shown in the table.

**Table No. (4) Sigma level of Research Sample**

Number of Transactions (1)	Number of errors (2)	Errors percentage per Opportunity (3) 2/1	Yield (4) 100-3	PDMO 3*1000000	(Sigma) level*
60742	661	1.0882%	98.9%	10882	3.794

The source is prepared by the researchers

\* Six Sigma calculator was used to maintain Sigma level

[/http://www.isixsigma.com/process-sigma-calculator](http://www.isixsigma.com/process-sigma-calculator) or use Sigma tables.

We recognize that Sigma level is 3,794 and accuracy percentage is (98,9%). Initially, it is thought that the performance of internal audit is perfect but after we refer to DPMO which is (10,882) error per million opportunities and this is considered highly massive concerning financial issues which require a significant percentage of accuracy especially within the performance of internal audit and such massive level of errors shall cause serious financial consequences. In addition, the level of quality is rather far away from Six Sigma to great extent and it requires serious work to maximize Sigma level to the 4<sup>th</sup> level and then 5<sup>th</sup> and finally 6<sup>th</sup> whose DPMO is 3,4.

**Analyze**

During such stage, the following issues shall be fulfilled: the numbers obtained during the past stage shall be analyzed, correlations shall be made for data through the charters, the introduction of the relative weight of each problem and specification of the level with most serious defects and the impacts of such defects on the project and then the most significant defects shall be focused on so as to be remedied in time. There are some tools can be used in this respect, the most important of which are:

- 1 - Identification of real causes of problems:
- 2 - Drawing Pareto chart: Through such chart, defects with most serious risk on the unit shall be identified so as to take the corrective measures used to remedy thereof and as follows:

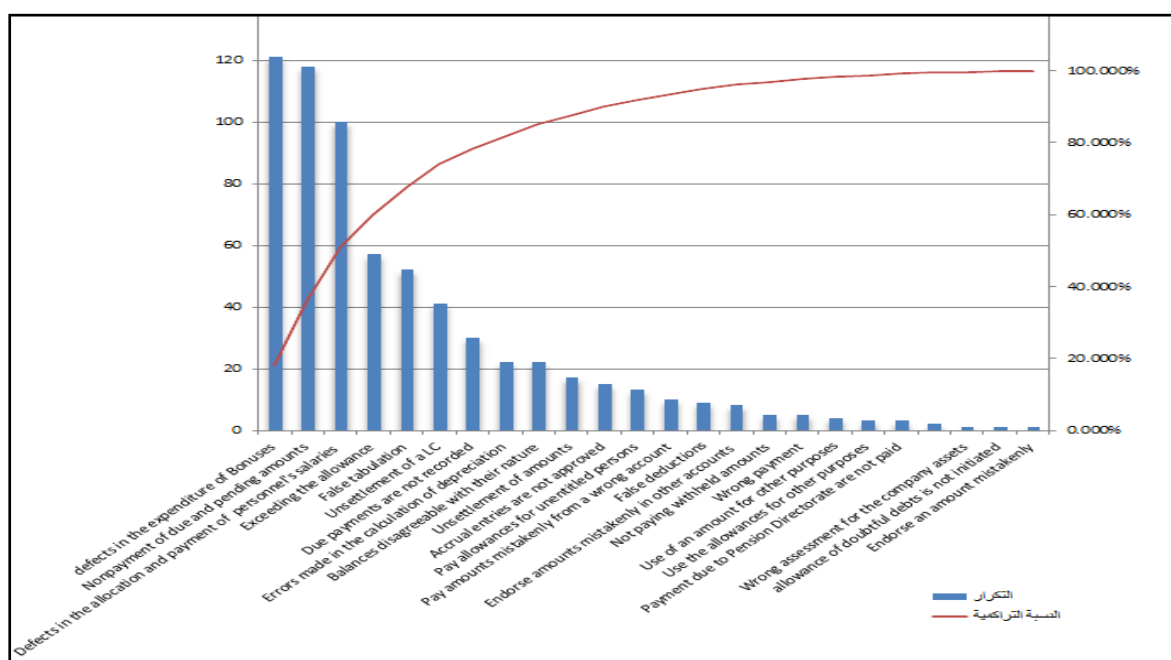
**Table (5) Causes of deviation**

No.	Cause of Defects	Frequency	Percentage	Accumulative total	Accumulative percentage
1	defects in the expenditure of Bonuses	121	18,3%	121	18.306%
2	Nonpayment of due and pending amounts	118	17,9%	239	36.157%
3	Defects in the allocation and payment of personnel's salaries	100	15,1%	239	51.286%
4	Exceeding the allowance	57	8,6%	396	59.909%
5	False tabulation	52	7,9%	448	67.776%
6	Unsettlement of a LC	41	6,2%	489	73.979%
7	Due payments are not recorded	30	4,5%	519	78.51%
8	Errors made in the calculation of depreciation	22	3,3%	541	81.846%
9	Balances disagreeable with their nature	22	3,3%	563	85.174%
10	Unsettlement of amounts	17	2,6%	580	87.746%
11	Accrual entries are not approved	15	2,3%	595	90.015%
12	Pay allowances for unentitled persons	13	2,0%	608	91.982%
13	Pay amounts mistakenly from a wrong account	10	1,5%	618	93.495%
14	False deductions	9	1,4%	627	94.856%
15	Endorse amounts mistakenly in other accounts	8	1,2%	635	96.067%
16	Not paying withheld amounts	5	0,8%	640	96.823%
17	Wrong payment	5	0,8%	645	97.579%
18	Use of an amount for other purposes	4	0,6%	649	98.185%
19	Use the allowances for other purposes	3	0,5%	652	98.638%
20	Payment due to Pension Directorate are not paid	3	0,5	655	99.092%

21	Pay amount for other entities which have no connection with the company business	2	0,3%	657	99.395%
22	Wrong assessment for the company assets	1	0,2%	658	99.546%
23	allowance of doubtful debts is not initiated	1	0,2%	659	99.697%
24	Endorse an amount mistakenly	1	0,2%	660	99.849%
25	Pay allowances for unentitled persons	1	0,2	661	100.000%

The source is prepared by the researchers

Numbers of frequency (defects Number) was identified out of the reports of Federal Board of Supreme Audit based on the data of the above table and the Pareto chart has been drawn as shown in Fig. No. (1)



**Fig. No. (1)** Pareto chart for the research sample (audit department)

As shown in the above Fig. it seems obvious that 73% of defects representing 24% of causes should be taken in consideration and focused on upon the treatment process and then the remaining defects shall be considered, i.e, what should be treated firstly are those defects represented by those errors resulted from (errors related to payment of bonuses which represents 18% out of the case total. Secondly, the treatment of suspended and not paid amounts. Thirdly, errors committed in the (employment). Fourthly, Defects related to the exceeding of the allowance. Finally, treating other defects as per their descending order. As to Pareto chart compared with the use of tables individually and despite the simplicity associated with the design of such chart, it nonetheless helps to introduce defects clearly and attracts the attention to the most significant thereof

### *Improve*

After the main causes of defects are being identified during the past stages, it is time during this stage to find out solutions used to improve such defects to attain the least level of defects, i.e, and improvement of quality. This can be undertaken through the focus on activities. The process of improvement is undertaken gradually that Sigma current level is 3,794, i.e, DPMO is 10, 882 which shall be gradually minimized to become 4<sup>th</sup> level with DPMO equal to 6210. After minimizing the defects to such DPMO, the team shall treat other problems already identified and act to minimize defects to 230 for example which represent Sigma 5<sup>th</sup> level until the attainment of 6<sup>th</sup> level with 3,4 DPMO. Sigma DPMO is to be re-measured per each process of correction which is made to make sure of the upgrading the relative DPMO to higher level

## Identification of Solutions

Solutions assigned to the problems which have been already taken inconsideration shall be identified via some methods and styles such as brainstorming where the team is to develop thoughts for each case and set up the proper solutions thereto as shown in table No. (6)

**Table No. (6)** Proposed solutions used to remedy the causes of problems

Cause of problem	Solutions
X1 Defects in the expenditure of Bonuses	- All regulations related to award bonuses should be complied with and award such bounces only to individuals who meet the conditions of warding bounces contained in the regulations of public Budget Execution.
X2 Nonpayment of due amounts	- There shall be no delay in paying the amounts and payments due to companies especially after such they complete their related works and such completion is duly confirmed. - Allocations assigned to projects shall not be used to other purposes whatsoever.
X3 Defects of employment and Personnel 's Salaries	- Identify the actual need for the required HR and Specializations, financial allocation, comply with the regulations of employment issued by the General Secretariat of the Council of Ministers and make no exceptions thereof
X4 Exceeding the allowance	- High management shall grant no approvals to exceed the allocation of any account except the case where a transfer is made subject to an explicit approval under applied regulations. - Preparing estimations and planned budgets accurately for the company department and reject any exceeding to such payment.
X5 Wrong tabulation	- Launching courses covering the tabulations of the Unified Accounting System and Governmental Accounting System - Stimulate employees to check out accounts tabulation before processing transactions.

- 
- X6 Unsettlement of L.C
- High management shall issue such instructions related to the settlement of all LC's on the dates of their expiry and take the necessary measures in case works are sustained.
  - Serious follow up and observation shall be given by internal audit to LC's by using electronic programs showing LC's expiry dates and all measures taken in terms thereof in coordination with the Financial Affairs Department.
- 

The source is prepared by the researcher

After the said solutions are identified, the team shall:

- Follow up the execution of such solutions with the concerned Departments.
- Develop a clear mechanism and timings required to implement each item.
- Identify obstacles.
- Act to improve the performance continuously.

### ***Control***

During such stage, the track of the process shall be observed, the level of the achieved performance shall be maintained, the momentum of such improvement shall be maintained through the development of the improvement process under continuous control and observation. The goal behind this is ensure that the same old defects which resulted in the minimization of quality shall not be ever made, statistical tools shall be continuously used to measure the volume of defects, regular reports shall be prepared and referred to the management, make sure of the improvements which have been already applied and have a positive impact on performance and the response to the changes have been undertaken subject to the plans. Control shall be continuous. Therefore, if the number of defects is discovered to be maximized, then we should go back to the first stage, i.e (define stage) to analyze and remedy the causes of such defects as well conducting Sigma measurements before and after improvement and make comparison for the development of performance.

Out of the aforesaid steps,(Zero Defect) hypothesis shall be then rejected and instead, the alternative hypothesis (SS Methodology is possibly applied in Internal Audit units to control the quality of performance " shall be approved.

## **Conclusions and Recommendations**

Six Sigma DMAIC methodology is possible to be applied in Internal Audit units started from " Define Stage" through the formation of a teamwork and identification of the problem facing the Department represented by (Poor quality of internal audit performance) and then a detailed plan used to apply SS shall be prepared. Second stage is " Measurement ", the team conducted a deep study for the problem and measured the level of the current level of performance and DPMO. Later, SS level was then maintained (SIGMA (3,79) under which such Department is managing their business. During "Analyze Stage", the team analyzed the main causes of the problem, percentage each cause out of the problem volume and then the solutions were concentrated on the causes with most significant impacts on performance. It has been observed that there are 6 causes representing 74% of the problem volume and therefore such causes shall be focused in the first place and then the remaining causes shall be taken in consideration according the effect of each one of them and in this analyze stage the most



significant solutions were assigned for each cause. In the " Control Stage " in which the improvement which has been already applied would be confirmed and controlled. Therefore, the researchers recommend for DMAIC methodology to be applied to control the quality of internal Audit performance and minimize the defects percentage that may occur.

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