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MASTER THESIS

**IMPLEMENTATION OF A TOTAL QUALITY MANAGEMENT APPROACH AND
EFFICIENCY MEASUREMENT USING DATA ENVELOPMENT ANALYSIS**

Case: KPMG, Algeria.



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Abstract

From one hand, this work seeks to apprehend the implementation of total quality management as an advanced approach to quality management at an audit and advisory firm, as an advanced approach that reaches out for excellence at different levels and dimensions of an organization. From the other hand, this work aims at figuring out ways to rely on empiric methods: Data Envelopment Analysis to measure efficiency and inefficiency of audit engagements undertaken by KPMG Algeria.

Key words: Total Quality Management, Quality Management, Efficiency, Data Envelopment Analysis, Dashboard.

Resumé:

D'une part, ce travail cherche à appréhender l'implémentation du management de la qualité totale comme une démarche avancée du management de la qualité au sein d'un cabinet d'audit et conseil. D'autre part, ce travail vise à identifier les manières pour s'appuyer sur les méthodes empiriques : Data Envelopment Analysis pour mesurer l'efficience et source de l'inefficience des missions d'audits entrepris par KPMG Algérie.

Mots clés : Management de la qualité totale, management de la qualité, efficiency, Data Envelopment Analysis, tableau de bord.

ماخص

من جهة يسعى هذا العمل الى استيعاب وضع تسيير الجودة الكلية كمنهجية متقدمة فيتسيير الجودة في مكتب تدقيق و توجيه. من جهة اخرى يهدف هذا العمل الى ايجاد الطرق للاعتماد على المناهج الاحصائية لقياس الفعالية و ماسباب نقصها في مهام مراجعة تقوم بها شركة KPMG Algeria

المفاتيح : تسيير الجودة الكلية, الفعالية, لوحة القيادة, Data Envelopment Analysis

INTRODUCTION

Excellence, it's a relentless pursuit that only determined people and organizations strive for, it requires a long term commitment and discipline to do better things through better ways: It is a matter of consistent and rigorous decisions and actions to reach out for excellence. Such attitude will eventually pay off by making those who pursue it have a competitive edge enabling them to stand out of the crowd and astonish their stakeholders and customers.

Quality Management has emerged as a discipline to enable organization into satisfying their stakeholders' requirements. Total Quality Management rises as an advanced approach of Quality Management, TQM fosters businesses to excel in everything they do at all levels and department and exceed their customers' expectations, regardless of their operating economic sector.

It was initially aimed for manufacturing sector; however the quality management principals, methods and tools were generalized and adopted by diver economic sectors as they have proven strong impact and value creation.

In the recent year the Algeria economy have been noticing an increase in investments and business creation as well as multinationals implementation in Algeria, which demanded additional services in auditing and advisory to follow up with them and assistant them in their growth cycle.

That has led to the competition in the auditing and advisory service to rise shrinking the profitability of businesses operating in the area, and pressing them to look for new ways to gain competitive advantage, be cost-effective and deliver outstanding quality services to their clients.

In this sector, four companies are dominating the business at the global level; they're called the big four. KPMG is one of the big four, it was established in Algeria in 2002. KPMG Algeria is a leading auditing and advisory firm in Algeria, it is the case study of our work.

Adopting a quality management approach, tools and methods would earn businesses in the sector a competitive leading leap by: embracing the pursuit of excellence, engaging people, optimizing processes, provide assurance regarding the quality of the service, keep and attract new customers, increase financial profitability margin and develop efficiency.

Measuring efficiency and driving it – which is defined as the relationship between resources and results - and finding out sources of inefficiency is of a strategic matter, the efficiency enables businesses to optimize the use of their resources, hence increase their profitability margin.

Our study, undertaken at KPMG Algeria, the outlined problem statement is as follows:

“How can we implement a total quality management approach and measure efficiency using an empiric method in an auditing and advisory firm?”

To apprehend this problem, we will discuss it throughout our work under the following questions:

1. How relevant TQM is to KPMG Algeria, and what benefits could the application of its methods and tools can bring?
2. Can we rely on Data Envelopment Analysis as an empiric method to measure efficiency within KPMG Algeria and identify sources of inefficiencies?
3. What kind of dashboards and indicators is fit for a TQM implementation and efficiency improvement?

To answer these questions, we have adopted both methodologies: qualitative and quantitative approaches. From one side we want to quantify our measures to give them objectivity and accuracy, but from the other side we want to take some reserves to avoid being misled by maximizations functions that sometimes do not truly reflect the reality due to lack of variables reality reflection.

I have conducted this work during my internship at KPMG Algeria since February 2015, where I had participated in auditing and advisory engagements, that had enabled better comprehension on the internal organization and challenges facing KPMG Algeria, which strongly helped especially with the application of TQM part and dashboards development.

The writing of this thesis started around three weeks ago, this is cause by the challenges I faced to come up with the problem statement and get enough insights about KPMG Algeria to conduct a study that is actually relevant to the current context and can bring in added value.

This work is divided into three main axes: (1) the implementation of Total Quality Management approach, where we seek to present methods and tools of TQM and implement some of them depending on the available data. (2) measuring efficiency using Data Envelopment Analysis (DEA) method, which is a non-parametric method that not only measures efficiency but identifies sources of inefficiency, we then analyze results and come up with conclusions that are not obvious without such empiric methods. (3) conception of dashboards and selection of performance indicators, where we will present a procedure to conceive a dashboard, and a proposed dashboard oriented for the purpose to implement TQM and increase efficiency at KPMG Algeria.

Chapter 1

HOSTING ENTITY PRESENTATION

AND STUDY PROJECT

1. KPMG globally

1.1 History

KPMG is leading professional service firm at the global level, it operates in three main domains: financial audit, tax and advisory. It is one of the big four auditors (in alphabetical order):

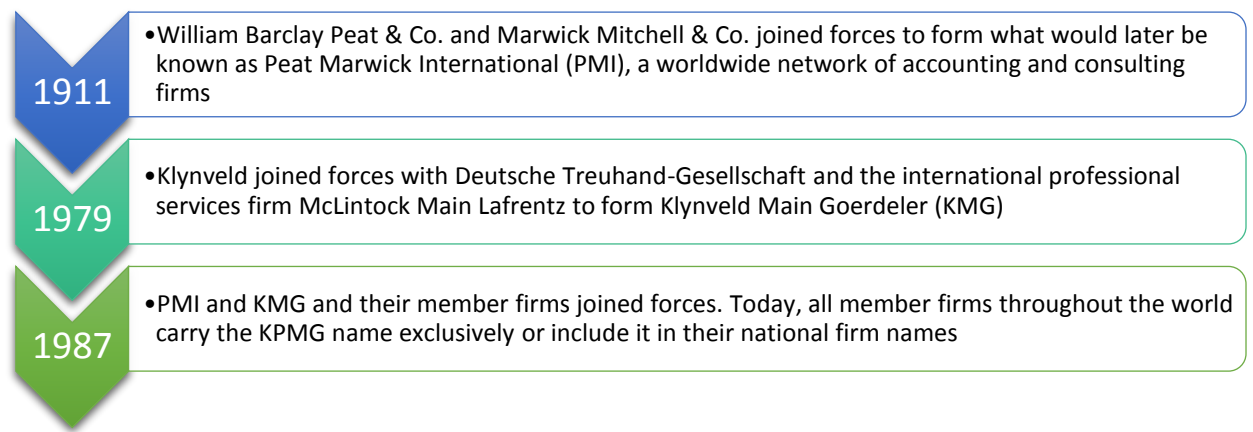
- Deloitte
- Ernst & Young (EY)
- KPMG
- PricewaterhouseCoopers (PwC).



KPMG was formed in 1987 with the merger of Peat Marwick International (PMI) and Klynveld Main Goerdeler (KMG) and their individual member firms. Spanning three centuries, the organization's history can be traced through the names of its principal founding members - whose initials form the name "KPMG."

- K stands for Klynveld. Piet Klynveld founded the accounting firm Klynveld Kraayenhof & Co. in Amsterdam in 1917.
- P is for Peat. William Barclay Peat founded the accounting firm William Barclay Peat & Co. in London in 1870.
- M stands for Marwick. James Marwick founded the accounting firm Marwick, Mitchell & Co. with Roger Mitchell in New York City in 1897.
- G is for Goerdeler. Dr. Reinhard Goerdeler was for many years chairman of Deutsche Treuhand-Gesellschaft and later chairman of KPMG. He is credited with laying much of the groundwork for the KMG merger.

Figure 1 : KPMG establishment key dates



SOURCE: (KPMG, Website. s.d.)

1.2 Values and culture¹

KPMG, as a leading multinational firm in professional services, has a culture that has been the result of several decades of development and empowerment. Its unique philosophy helped the firm to be one of the big fours auditors in the world.

KPMG presents its values and culture stating:

Our values create a sense of shared identity within the KPMG organization, which is a network of member firms in over 155 countries. They define what we stand for and how we do things.

Our values help us to work together in the most effective and fulfilling way. They bring us closer as a global organization.

- We lead by example

At all levels we act in a way that exemplifies what we expect of each other and our member firms' clients.

- We work together

We bring out the best in each other and create strong and successful working relationships.

- We respect the individual

¹ (KPMG, Website. s.d.)

We respect people for who they are and for their knowledge, skills and experience as individuals and team members.

- We seek the facts and provide insight

By challenging assumptions and pursuing facts, we strengthen our reputation as trusted and objective business advisers.

- We are open and honest in our communication

We share information, insight and advice frequently and constructively and managing tough situations with courage and candor.

- We are committed to our communities

We act as responsible corporate citizens by broadening our skills, experience and perspectives through work in our communities and protecting the environment.

- Above all, we act with integrity

We are constantly striving to uphold the highest professional standards, provide sound advice and rigorously maintain our independence.

1.3 Global performance and statistics

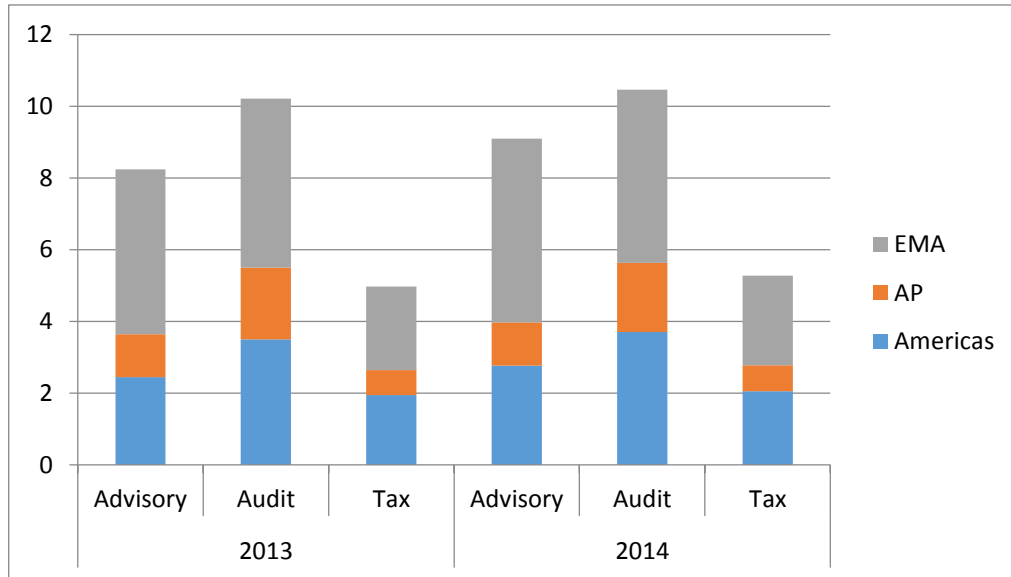
The KPMG network delivered strong growth and record-high revenues of USD24.8 billion for the 2014 fiscal year, an increase of 6.3 percent in local currency terms over the prior year, recording growth across Audit, Tax and Advisory.

Revenues rose in all three regions – the Americas; Europe, Middle East and Africa (including India); and Asia Pacific, with double-digit gains in many of the world’s fastest growing economies, including India (17.8 percent), Middle East (11.1 percent), Africa (8.0 percent)and China (7.3 percent). The quality and breadth of professional services we offer, combined with significant investments we’ve made to strengthen and broaden our services and capabilities, has enabled us to achieve strong and sustainable growth. Read more in the 2014 KPMG International Annual Review.² Analyzing the revues per function of KPMG for

² (KPMG, Website. s.d.)

2014³ shows that Audit generates 43% from its total revenues, advisory 36% and at last Tax 21%.

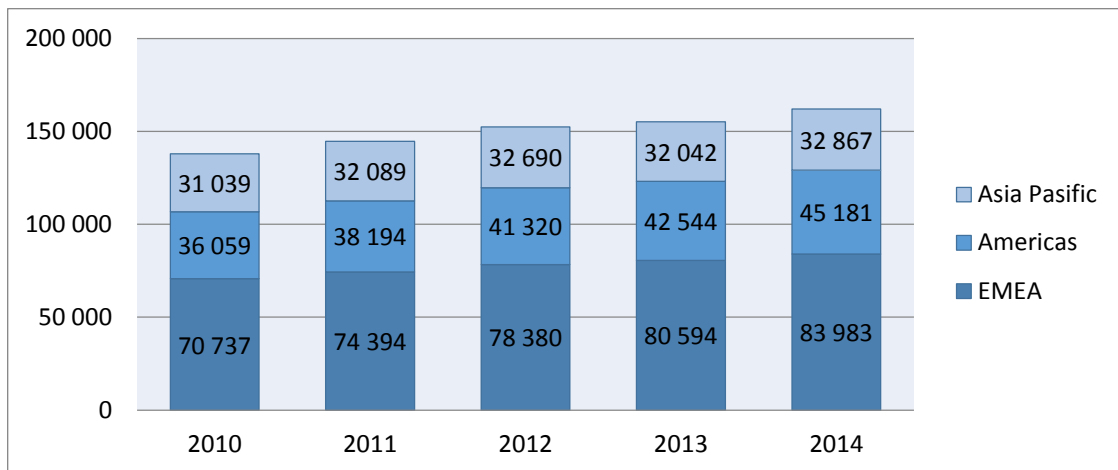
Figure 2 : KPMG revenues per function per region



SOURCE: (KPMG, Website. s.d.)

The following figure⁴ indicates the number of employees per regions has been increasing since 2010; the employees in EMA region represent 52% of the global number of employees.

Figure 3: KPMG’s Employees per region per year



SOURCE: (Statista 2015)

³ (KPMG, Website. s.d.)

⁴ (Statista 2015)

To visualize further the global performance of KPMG it is necessary to refer it to its peers of the big fours: Deloitte, Ernst & Young and PricewaterhouseCoop. The table below presents the revenues evolution for the big fours since from 2009 to 2014

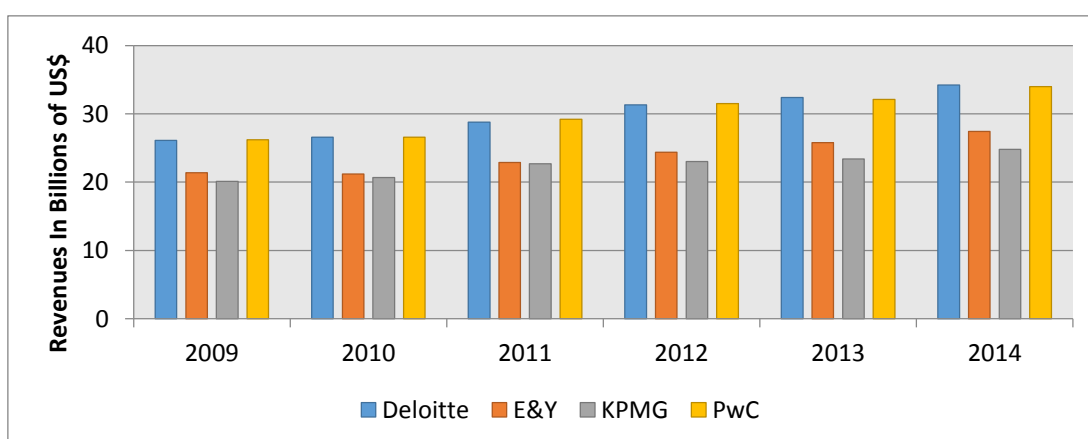
Table 1 : Big fours' combined revenues evolution

Revenues in Billions of US\$	2009	2010	2011	2012	2013	2014	% 2014
Deloitte	26,1	26,6	28,8	31,3	32,4	34,2	28%
E&Y	21,4	21,2	22,9	24,4	25,8	27,4	23%
KPMG	20,1	20,7	22,7	23,0	23,4	24,8	21%
PwC	26,2	26,6	29,2	31,5	32,1	34,0	28%
Total	93,8	95,1	103,6	110,3	113,7	120,3	100%

Source: (Big4 2015), p4.

The histograms below illustrate the previous table.

Figure 4 : Big fours' combined revenues evolution

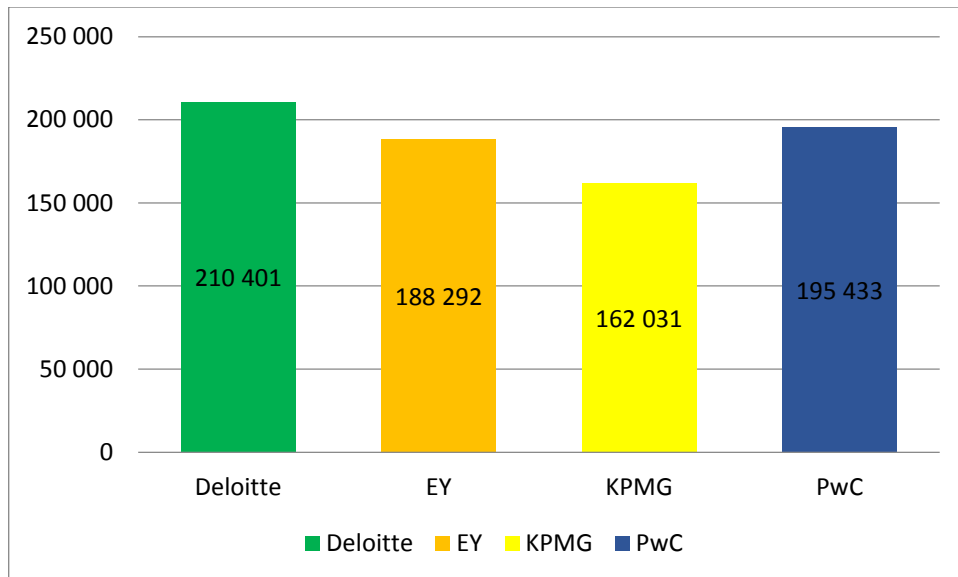


SOURCE: FIGURE CREATED FROM PREVIOUS TABLE.

We can observe that KPMG has been on the 4th positions since 2009. For instance in 2014 its revues represents 21% from the combined revues of the big fours, differently PwC and Deloitte hold the first position with 28%, after which comes EY with 23%

To further this analysis, we will compare the human resources of the big fours for 2014.

Figure 5 : Number of employees for big fours' firm for 2014.



SOURCE: (Statista 2015)

Calculating the revenue per employee ratio (RPE), which is calculated in the below formulas, for 2014 gives us the following results:

$$RPE\ ratio = \frac{Revenue}{number\ of\ employees}$$

Table 2 : Big fours' revenue per employee for 2014

Firm	# Employees	Revenue in bUSD	RPE in kUSD	RPE Rank
Deloitte	210 401	34	163	2
EY	188 292	27	146	4
KPMG	162 031	25	153	3
PwC	195 433	34	174	1

SOURCE: CALCULATED FROM PREVIOUS DATA.

2. KPMG Algeria

2.1 Establishment

KPMG Algeria was established in 2002, which makes it the first international audit & advisory firm to be implemented in Algeria. In 2009, a branch in Oran has been opened to reach out to its clients in western Algeria.

KPMG Algeria provides auditing, tax, legal and advisory services to a wide range of national and multinational companies in different sectors, which makes it one of the leading audit and advisory firms in Algeria.

2.2 Organization and statistics

The table below presents the organizational structure of the firm:

Table 3 : KPMG Algeria's services and their missions

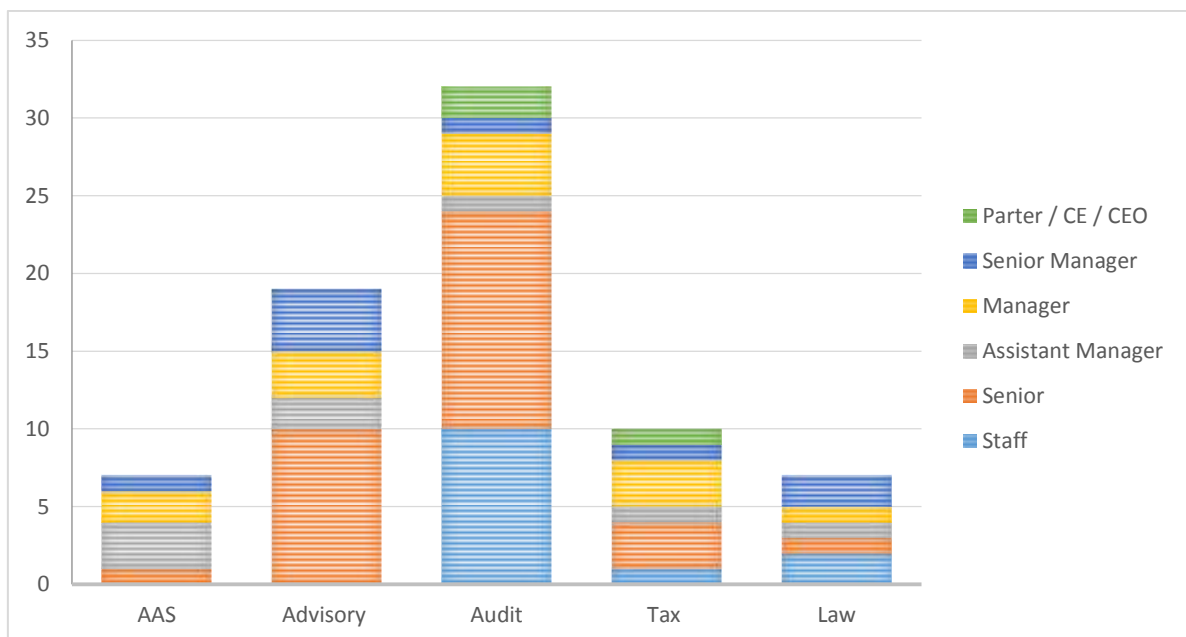
Department	Service	Mission
Audit	Contractual Audit	<ul style="list-style-type: none">•Financial Statements Review.•Internal control and systems review
Advisory	Transaction (TS)	<ul style="list-style-type: none">•Assistance in risks identification and assessment for fusion / transfer of shares operations.•Buy / Sell due diligence•Data room assistance
	Accounting Advisory and Services (AAS)	<ul style="list-style-type: none">•Conversion to IFRS standards•Book-keeping services•Tax report preparation•Reporting•Financial Statements
	Business Performance Services	<ul style="list-style-type: none">•Strategies elaboration•Business plan•Organization and process optimization•Change management•Internal control

	IT advisory Services	<ul style="list-style-type: none"> •Information systems audit •Technical specifications and solutions choice •Implementation assistance
Tax & Law	Tax	<ul style="list-style-type: none"> •Fiscal Audit •Tax Return •Fiscal review for contracts execution •Due diligence •Processes development, improvement and follow up. •Assistance in the implementation of conformity procedures.
	Law	<ul style="list-style-type: none"> •Implementation and creation of companies. •Legal conformity review. •Contractual Assistance (financing, technical and working contracts) •Legal secretary.
KPMG Administration	Accounting, HR and IT	<ul style="list-style-type: none"> •Internal services to KPMG.

SOURCE: (KPMG Algeria)

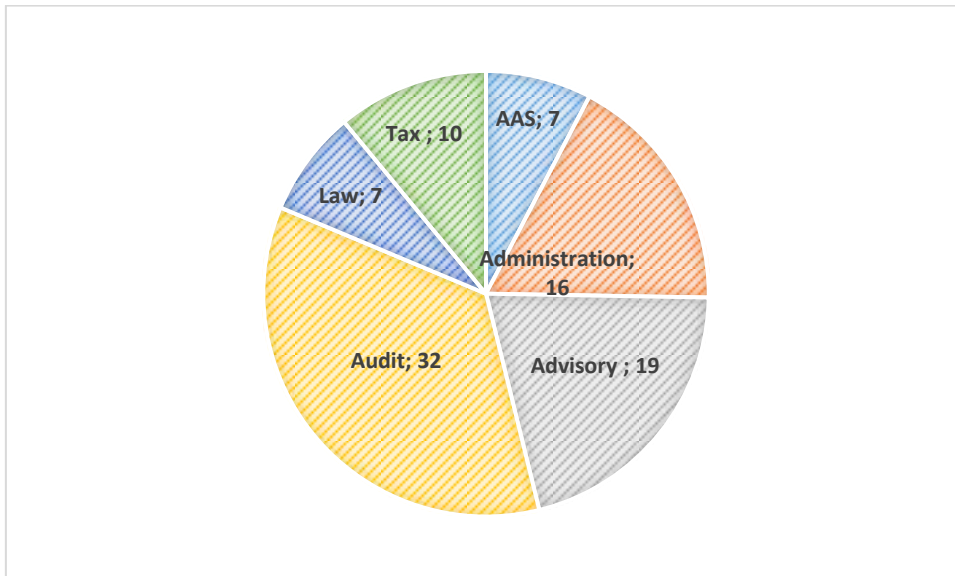
The chart below presents the HR structure of the firm

Figure 6: HR structure per departments per rank



SOURCE: (KPMG Algeria)

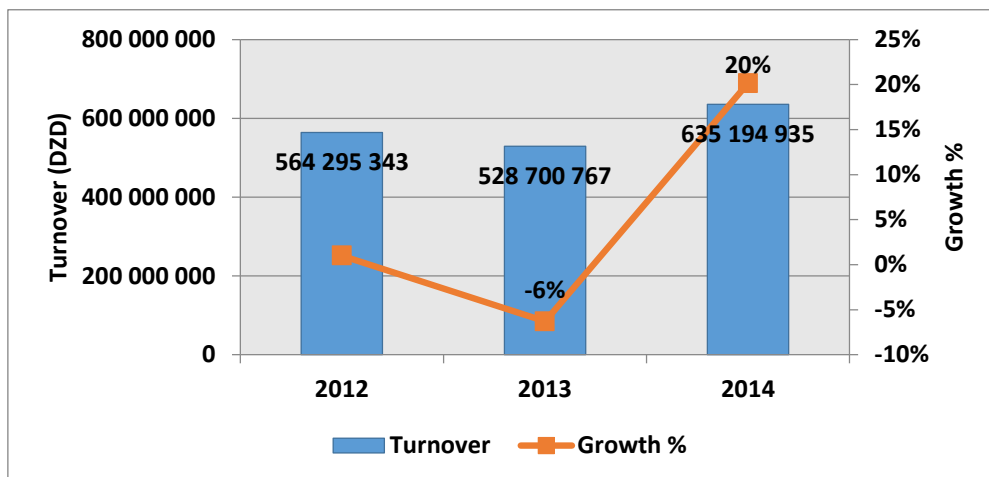
Figure 7 Number of employees per department



SOURCE: (KPMG Algeria)

Regarding economic performance, the figure below shows the evolution of KPMG Algeria's turnover for the past three years:

Figure 8 : KPMG Algeria's turnover growth



SOURCE: CHART CREATED BASED ON INTERNAL DATA

3. Study project

3.1 Methodological framework

3.1.1 Topic choice

What motivated us to choose this topic: “an implementation of Total Quality Management methods and Efficiency Measurement and piloting”. Is what follows:

Developing our own skills and talent in an area (quality, efficiency, performance driving) that is earning an increasing priority in the business sector.

An application of acquired theoretical knowledge and practical experience on the field to create value (the approach we used, descriptions and adaptation of methods, measuring efficiency not just effectiveness, propose multi-functional dashboards)

The belief that it is no longer sufficient to do the minimum (standards) to achieve greatness and push forward the competitive edge: moving from QC to QA and now to TQM. Especially that the studied entity “KPMG Algeria” operates in the professional services market: accounting, auditing, tax, legal and advisory which witnesses an increasing competition on the Algerian market.

Willingness to apply empirical methods and tools (Data Envelopment Analysis, descriptive statistics, operational research, etc.) to objectively quantify efficiency and figure out the sources of inefficiency with their scale, and prevent the risk of a subjective efficiency evaluation.

Figure out ways to improve the decision-making process, selecting the right performance indicators for the right objectives in the right context in order to insure proper planning and resources allocating, rigorous tracking and facilitate fast reporting and corrective actions.

3.1.2 Hosting entity choice

The entity of the study is KPMG Algeria. What motivated our choice for the entity is the quest to better apprehend and develop skills in the area of auditing and advisory. We hold a bachelor degree in Finance; we sought to find out a place where we can merge the two disciplines: Finance and Quality. I’m having an internship in KPMG Algeria since February 2015. The passion for the discipline rose after my internship at general electric Healthcare in 2014: I was studying quality management at the same time having an internship in Finance,

and we saw a great improvement potential that quality management can bring further into organization which their main service relies on finance and cross-related fields: audit, due diligence.

In addition, in such business: auditing and advisory services, which is quite different from a manufacturing sector, as the main resource in the human capital and the service is harder to quantify comparing to manufacturing industries, the application of Quality Management and the use of an empiric method to measure efficiency on the auditing and advisory service brings an additional value to this economic sector from one side and to the discipline from the other side.

3.1.3 Topic purpose

The purpose of our topic is built on three axes:

- i. Implementation of Total Quality Management (TQM)
- ii. Measure Efficiency of Audit Engagements
- iii. Drive performance

The first axes seeks to present some TQM methods and tools for a potential implementation, and use them of them with actual data and simulate their application to figure out the possible benefits it can bring to KPMG Algeria.

The 2nd axe's goal is the use an empirical method: Data Envelopment Analysis (DEA) to measure the efficiency of Audit Engagements and find out sources of inefficiencies. The approach is to quantify efficiency and inefficiencies to permit an objective assessment, in addition to providing analysis on how to increase efficiency through what alternatives and solutions.

At last but not at least, the third axe focuses on driving performance and the implementation of TQM through business dashboards. It aims at proposing a procedure to create dashboards and select performance indicators as well as an actual dashboard and indicators by relying on projects management and risk management principals, and this adapted for a TQM implementation and efficiency improvement actions.

The topic aims as well as linking the discipline of quality management and financial auditing for mutual benefits: quality management has a lot to bring in terms of tools, methods and

methodologies for auditing and advisory services, while the latter challenges quality management to broaden it and make it apprehend new sectors to incorporate new disciplines, hence quality management would be more relevant to organizations by taking into account different departments, sectors and industries: a greater cohesion in its methods and tools.

3.1.4 Study approach

In our work, we relied on both approaches: quantitative and qualitative. In the following sequence:

Figure 9: study approaches and sequencing



At first, we rely on a qualitative approach as we'll be introducing concepts of Total Quality Management with a set of tools and methods. After which we'll carry on the flow with a quantitative approach by using Data Envelopment Methods to measure efficiency and sources of inefficiency. At last but not least, we move again to a qualitative approach in order to introduce the business dashboard as a way to drive and pilot efficiency and performance generally. In addition, it's to put some reserves upon the use of maximization functions (the DEA methods) that might mislead the decision-making process by presenting optimum levels that may not reflect the true reality, this is where comes the 2nd qualitative approach that we'll take as inputs the outputs of quantitative approach to take forward the study and rely on a set of indicators from different sources to balance and rationalize the decision-making process.

3.1.5 Methodology

In our methodology, we relied on several techniques and tools to conduct our study.

3.1.5.1 Observation:

I have been an intern in the audit department of KPMG Algeria since February 2015, where I participate in several auditing engagements and due diligence engagements (pre-acquisition

audit), where I observed and participated in the process of audit engagement, not in all its steps but in some of them tough.

This allowed me to observe the flow of the process, take note of what to do before undertaking any actions as part of the planning phase. Then make a continuous report about what I did and document my work papers and communicate them to the people in charge.

These observations helped to choose the process to study upon the application of DEA method to measure efficiency, but also to understand the overall flow to be able to make a proper and correct approach of TQM tools and methods implementation by choosing the most relevant ones (that we'll be presented in this work).

3.1.5.2 Work sessions

Throughout my internship and thesis development I've had several work sessions with different people at different levels to better understand the audit process, its technics and approach, as well as to understand the Quality Control function within KPMG, its role and its system.

Several sessions were conducted with the Partner of Audit Partner, in order to better understand the organization of the department and the flow of an audit engagement and collect data relevant to the audit engagement flow and quality control.

In addition, I had work sessions with the Quality Control responsible to understand its functionalities with examples regarding the quality control of audit engagements along with the applicable tools and methods. Adding to those, receiving explanations about the Quality Control checkup points (criteria) that are critical to quality (CTQ).

Other work sessions have been conducted with employees at different levels: managers, seniors and staff, for further details about the flow of an audit and role of the different stakeholders.

3.1.5.3 Data collection

As our thesis incorporates the application of statistics and operational research (DEA), we sought to collect data to enable our analysis. The data we were able to collect were the activity report of the different audit engagement along with the resources allocated: #employees,

#hours worked per rank, #years of experience at KPMG, audit fees per hours, quality control reports.

CHAPTER 2

AN IMPLEMENTATION OF TOTAL QUALITY

MANAGEMENT

1. Quality Management

There are several definitions of Quality Management (QM) depending on the context and perspective. Most commonly, QM is the “*coordinated activities to direct and control an organization with regard to quality*”⁵

QM can be further explained “*as a generic term, it covers all activities that ensure fulfillment of the quality policy and the quality objectives and responsibilities and implements them through quality planning, quality control, quality assurance, and quality improvements mechanisms.*”⁶

Yang presented quality mathematically through as a ratio⁷:

$$Quality = \frac{Performance}{Expectations}$$

1.1 Induction and principles

According to ISO there are 8 principles for quality management:

Table 4: The 8 principles of Quality Management

Principle	Definition
Customer focus	Organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements and strive to exceed customer expectations.
Leadership	Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization’s objectives.
Involvement of people	People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization’s benefit.
Process approach	A desired result is achieved more efficiently when activities and related resources are managed as a process.
System approach to management	Identifying, understanding and managing interrelated processes as a system contributes to the organization’s effectiveness and efficiency in achieving its objectives.

⁵ (International Organization for Standardization ISO 2005, 9)

⁶ (VLĂȘCEANU, GRÜNBERG et PÂRLEA 2007, 76)

⁷ (Yang et El-Haik 2003, 2)

Continual improvement	Continual improvement of the organization's overall performance should be a permanent objective of the organization.
Factual approach to decision making	Effective decisions are based on the analysis of data and information.
Mutually beneficial supplier relationships	An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value.

Source: (International Organization for Standardization ISO 2005)

1.2 Approaches

A quality approach is the way and manner of how an organization models itself to initiate and implement a system to manage quality using a set of tools and methods, in order to fulfill its stakeholder's requirements.

There are three main approaches that have been developed overtime:

1. Quality Control (QC)
2. Quality Assurance (QA)
3. Total Quality Management (TQM)

1.2.1 Quality Control

Quality Control (QC) represents to the first approach of quality management. ISO 9000:2005 defines QC as follows: *"part of quality management focused on fulfilling quality requirements."*⁸

QC is the approach using tools and methods to figure out whether or not the product/service meets requirements, we can add that *"Quality Control just measures and determines the quality level of products or services. It is a process itself."*⁹

⁸ (International Organization for Standardization ISO 2005, 9)

⁹ (Difference between Quality Assurance and Quality Control 2011, 1)

1.2.2 Quality Assurance

While QA is presented by ISO 9000:2005 as “ part of quality management focused on providing confidence that quality requirements will be fulfilled”

QA is the approach using tools and methods to give confidence that the way by which we’re working will enable the product/service when produced to meet requirements, hence QA can be presented as *“a complete system to assure the quality of products or services. It is not only a process, but a complete system including also control. It is a way of management.”*¹⁰

Table 5: Comparison table between QC and QA

	Quality Assurance	Quality Control
Definition	QA is a set of activities for ensuring quality in the processes by which products are developed.	QC is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced.
Focus on	QA aims to prevent defects with a focus on the process used to make the product. It is a proactive quality process.	QC aims to identify (and correct) defects in the finished product. Quality control, therefore, is a reactive process.
Goal	The goal of QA is to improve development and test processes so that defects do not arise when the product is being developed.	The goal of QC is to identify defects after a product is developed and before it's released.
How	Establish a good quality management system and the assessment of its adequacy. Periodic conformance audits of the operations of the system.	Finding & eliminating sources of quality problems through tools & equipment so that customer's requirements are continually met.
What	Prevention of quality problems through planned and systematic activities including documentation.	Prevention of quality problems through planned and systematic activities including documentation.

¹⁰ (Difference between Quality Assurance and Quality Control 2011, 1)

Responsibility	Everyone on the team involved in developing the product is responsible for quality assurance.	Quality control is usually the responsibility of a specific team that tests the product for defects.
Example	Verification is an example of QA	Validation/Software Testing is an example of QC
Statistical Techniques	Statistical Tools & Techniques can be applied in both QA & QC. When they are applied to processes (process inputs & operational parameters), they are called Statistical Process Control (SPC); & it becomes the part of QA.	When statistical tools & techniques are applied to finished products (process outputs), they are called as Statistical Quality Control (SQC) & comes under QC.
As a tool	QA is a managerial tool	QC is a corrective tool

SOURCE: (Quality Assurance vs. Quality Control - Difference and Comparison | Diffen)

1.2.3 Total Quality Management

Total Quality Management (TQM) represents an evolution in the quality management approaches, as it brought new ways of apprehending quality and putting it in the core mission of organization implementing it; it is the relentless pursuit of excellence in everything the organization does, by engaging every actor and mobilizing every available resources.

TQM is *“a particularly influential comprehensive approach to quality management that places emphasis on factors such as continuous improvement, customer focus, strategic management, need for explicit systems to assure quality of high education, and a view of leadership and supervision that stresses employee empowerment and delegation”*¹¹

¹¹ (VLĂSCLEANU, GRÜNBERG et PÂRLEA 2007, 76)

It is important to highlight that TQM is not just a best case scenario that we're trying to reach, but it has concrete and operational implications, *"such an approach to quality management emphasizes assessment that is undertaken of: (i) defined objectives or standards (set internally or by external funding bodies); (ii) measures of customers satisfaction; (iii) expert and professional judgment; and (iv) comparator organization."*¹²

2. A Total Quality Management implementation

"We are what we repeatedly do. Excellence, then, is not an act, but a habit."

Aristotle

1.1 Lean Management

Lean management in its self, along with six sigma that we will discuss later in this work (that we'll discuss in this work) can be considered more of an approaches and methodologies and not as basic tools, that is because these two require an engagement of the entire organization and they use their own tools and methods. However, they can be considered parts of TQM as their implementation strongly help reach out the purpose of TQM.

Lean management is a relentless pursuit to excellence; through which an organization seeks to improve itself at all its different aspects and levels in order to eliminate waste and increase productivity and quality, and meet the different stakeholders' requirement.

Donna Summer introduces lean stating: "Lean thinking is a mindset best described as a relentless war on waste. Companies implementing lean have reported significant reductions in cycle times, handling costs, lead times, floor space usage, inventory, and customer service activities. At the same time, they see a significant improvement in quality, inventory turns, profit margins, and customer responsiveness."¹³

A Honda process engineer, named Tadamitsu Tsuruoka, has identified seven sources of waste.

¹² (VLĂSCLEANU, GRÜNBERG et PÂRLEA 2007, 77)

¹³ (Summers, Lean Six Sigma: Process Improvement Tools and Techniques 2010, 3)

Table 6: source of wastes in an organization

Source of waste	description
1 Over production:	Making more than the customer ordered
2 Idle time (waiting time/ queue time)	Having parts waiting around to be worked on because a machine isn't working or having parts queuing up to be worked on because the line isn't balanced.
3 Delivery (transport / conveyance waste)	Conveying a part from one side of the plant to another because the two machines it needs to be processed on aren't located near each other.
4 Waste in the work itself	Having to repeat work because the first time there wasn't enough information to complete the job.
5 Inventory waste	Not using what was purchased or making too much of something in order to make up for quality problems.
6 Wasted operation motion	Walking to go get tools or parts.
7 Waste of rejected parts	Not making something correctly the first time.

SOURCE: TABLE CREATED AS AN ADAPTION FROM (Summers, Lean Six Sigma: Online Instructor's Manual with Selected Answers 2011, 1)

As previously discussed, we consider lean management a single tool itself, but it's a methodology part of itself. Its implementation requires the application of several tools and methods, that, themselves are tools and methods of TQM. Such as: Five s, value stream mapping. That we will explore individually later in this work.

1.2 Five s

Usually, organization when engaging in a TQM or a lean approach they *"start with the 5S technique — eliminating waste by organizing the workplace. 5S is simple and practical, and is implemented in two phases. Phase 1: Get rid of all the junk! Stop working around it. Phase 2: Create a system so there is a place for everything and everything stays in its place"*¹⁴.

¹⁴ (Sayer et Williams 2007, 152)

The lean healthcare dictionary illustrates it as “a disciplined approach to managing workplace organization of physical things and information to make it easy to identify errors, defects, abnormal conditions, and any other types of deviation from standard. The five S’s are sort, set in order, shine, standardize, and sustain. (The Japanese words for these are seiri, seiton, seiso, seiketsu, and shitsuke.)”.¹⁵

Table 7: Five S analysis

Japanese name	English Name
Seiri	Separate or sort
Seiton	Set in order, simplify the arrangement
Seiso	Shine, sweep, cleanliness
Seiketsu	Standardize
Shitsuke	Sustain, self-discipline

Source: table adapted from (Summers, Lean Six Sigma: Process Improvement Tools and Techniques 2010, 125)

Figure 10: 5 s analysis



Source: (Go Lean Six Sigma 2013)

1.3 Kano Analysis

Identifying the customers’ needs is a Critical Successful Factor (CSF) for any organization. As without have clear details about what the customers wants, the organization will be delivering goods that does not totally met the needs, especially that there explicit needs that

¹⁵ (Rona Consulting Group 2015, 5)

the customers wants and communicate but also implicit requirements that are mandatory to the customers' satisfactions but yet they are not communicated by the customer.

Kano model (also called Kano analysis) has been developed in 1978 by Prof. Noriaki Kano for this purpose: to specify the customer needs and make sure we covered what the customers want. That way we can focus the efforts to satisfy those needs. Its objectives are¹⁶:

- Classify expressed and not expressed customer needs into the factors of delighters, satisfiers, and dissatisfies.
- Identify and classify needs into those which the system must provide for and those it can provide for.

Steps:

- a) Every potential need is reviewed with a negative and positive question for the customer:
 - How would you feel if need x is not met?
 - How would you feel if need x is met?
- b) The customer is given the following possible answers:
 - I'd like that
 - That's normal
 - I don't really care
 - I wouldn't like that
- c) Based on these customer judgments the needs can be classified into:
 - I. Basis factors (dissatisfiers), i.e. attributes of the system which the customer expects
 - II. Performance factors (satisfiers), i.e. attributes of the system by which the customer measures the system quality.
 - III. Buzz factors (delighters), i.e. attributes of the system which exceed the customer's expectations.

¹⁶ (Staudter, et al. 2009, 92)

The matrix below will help assigning the needs to these categories

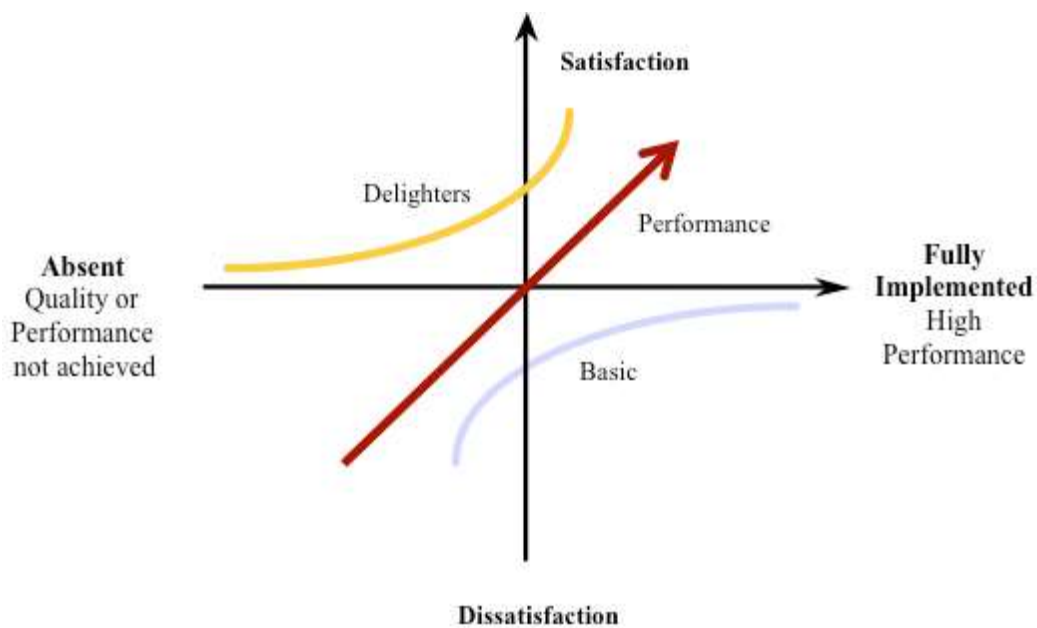
Table 8: Kano Matrix

		Answer to a negatively formulated question			
		I'd like that	Normal	I don't really care	I wouldn't like that
Answer to a positively formulated question	I'd like that		Delighter	Delighter	Satisfier
	Normal				Dissatisfier
	I don't really care				Dissatisfier
	I wouldn't like that				

SOURCE: (Staudter, et al. 2009, 93)

The following figure illustrates the classification of the needs. Where the horizontal axe represents the extent to which the need is being fulfilled (from left to right), and the vertical axe indicates the extent to which the need satisfies the customer (from bottom to up).

Figure 11: Kano Model



SOURCE: (American Society for Quality - Toronto Section 2012, 3), p3.

Its application makes the organization understand its explicit and implicit customers' needs, and therefore earn a competitive advantage comparing to competition by exceeding the customers' needs.

In order to see its application relevancy on KPMG Algeria we have run a simulation to find out what value can this tool bring to the business.

1.4 Benchmarking

Benchmarking allows an entity to compare itself to other entities in order to identify improvement opportunities and reshape its business model. There are several kinds of benchmarking depending on the scope and target. We can present four benchmarking kinds:

- Internal: compare between different departments of the same entity.
- Functional: compare a function of an entity with the same function of another entity in the same industry.
- Competitive: compare the characteristics of the products/services of an entity with those of a competitor.
- Generic Process: compare the process of an entity with a similar process of another entity in another industry seeking innovations and new ideas.

1.5 Pareto Analysis

It was first by Alfredo Pareto, who is an Italian economist.¹⁷ This tool helps tackling the most important causes of a problem following these steps:

1. List the causes of a problem (n_i)
2. Calculate the occurrence / frequency of each cause (x_i)
3. Calculate the total occurrences of all causes ($\sum X_i$), then calculate the percentage of each causes ($\% n_i$) and the % cumulative ($\% N_i$)
4. Reorganize the causes in a descending order from higher occurrence to lower occurrence.

¹⁷ (Kanji et Asher 1996, 56)

5. Tackle the causes having high occurrence in order to have a big impact unto solving the problem.

This tool “is sometimes called the 80/20 rule. This means that 80 per cent of the problems are caused by 20 per cent of activities and it is this important 20 per cent that should be concentrated on”.¹⁸

For the application of the Pareto Analysis we have taken as example the causes (categories) of anomalies detected by the Quality Control department¹⁹ of several audit engagements, then listed the categories of these anomalies and their frequency in the following table.

Table 9 : Cause and frequency of audits anomalies detected by QC

Cause	Frequency
Generalities	104
Risk assessment	22
Testing	78
Completion	19
Total	223

SOURCE: TABLE CREATED FROM KPMG’S INTERNAL DATA.

Continuing with the Pareto analysis steps, we will calculate the % of each category and its cumulative then reorganize the causes in a descending order depending on their frequency to create the Pareto Chart.

Table 10 : cumulative frequency of anomalies

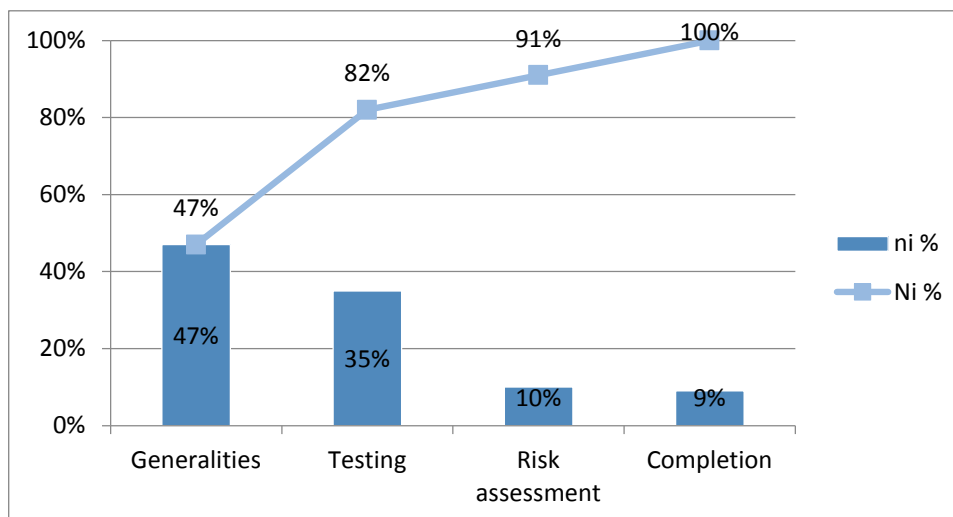
Cause (x_i)	Frequency (n_i)	n_i %	N_i
Generalities	104	47%	47%
Testing	78	35%	82%
Risk assessment	22	10%	91%
Completion	19	9%	100%
Total	223	100%	

¹⁸ (Kanji et Asher 1996, 57)

¹⁹ (KPMG Algeria)

Now we will draw the Pareto Chart using the previous table.

Figure 12 : Pareto Chart of the audit engagements anomalies



We can clearly see that we reach 80% of the anomalies by summing up: generalities and testing categories, we can conclude that these two categories are the focused areas to tackle first in order to solve most causes of the problem.

1.6 Value Stream Mapping

*Whenever there's a product for a customer,
there is a value stream.
The challenge lies in seeing it.*

Rother & Shook

In this part, we are seeking to present and explain a world-wide used tool: Value Stream Mapping (VSM), which helps seeing the value flow, and the different steps a product or service goes through, then we will see how it can be applied to KPMG Algeria.

“A value stream is all the actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product: (1) the production flow

from raw material into the arms of the customer, and (2) the design flow from concept to launch”²⁰

Value Stream Mapping (VSM) is usually used to schematize the flow of value throughout all the small operations it goes through. It is also helpful to identify where the process can be optimized and eliminate unnecessary operations to an efficient use of resources and time, in this regard it is a pillar in a TQM approach, as VSM “is a lean tool that employs a flow diagram documenting in high detail every step of a process. Many lean practitioners see value stream mapping as the fundamental tool to **identify waste, reduce process cycle times, and implement process improvement**. Some organizations treat the value stream map as the hallmark of their lean efforts.”²¹

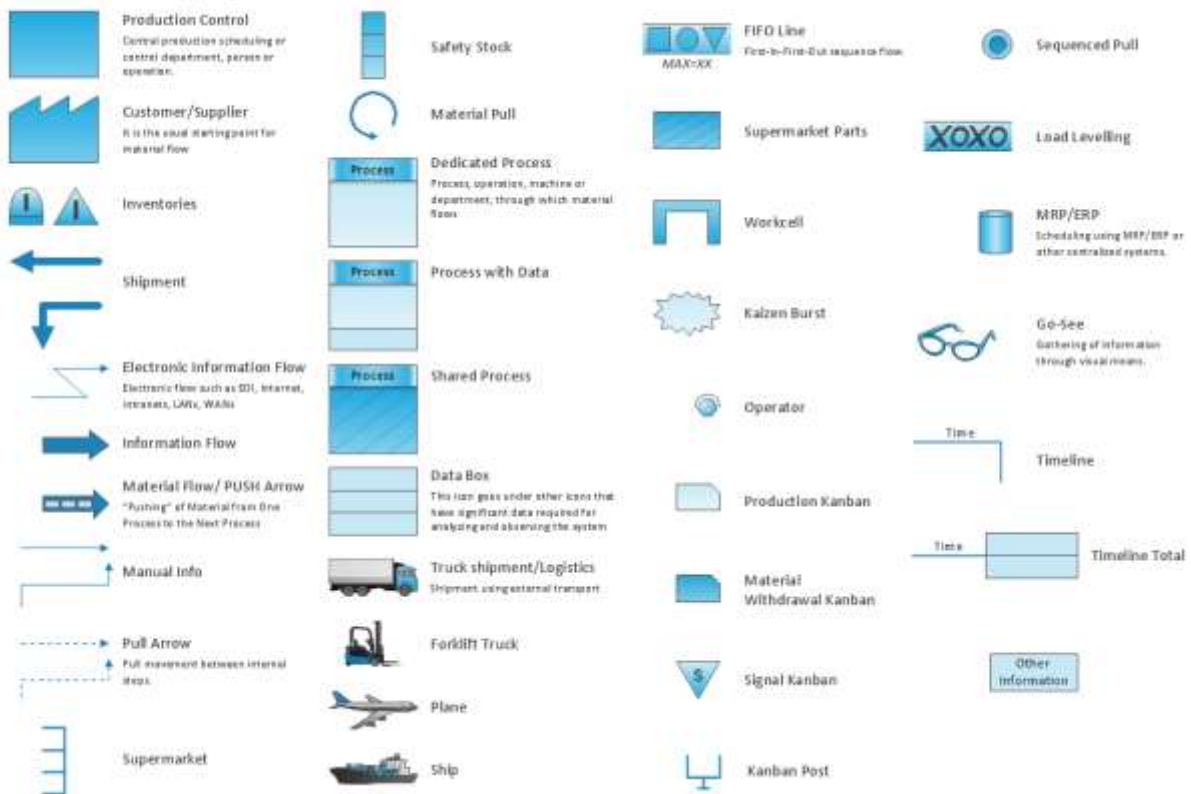
In addition, relying on VSM makes understanding the processes easier in a global language and easier better than descriptive texts. The VSM uses symbols when schematizing processes, where every symbol has a meaning.

Figure 13 : Some VSM symbols

²⁰ (Rother et Shook 1999, 13)

²¹ (American Society for Quality 2015)

Value Stream Mapping



Source: (conceptdraw 2015)

Understanding VSM requires apprehending some lean concepts related to time: takt time, cycle time and lead time.

a) Takt time:

Takt is originally a german word. It indicates the pace at which we need to produce in order to meet customers' demand.

$$Takt\ time = \frac{Available\ production\ time}{customer\ demand}$$

Example:

The customer demand of a product is 1000 units per day. The available production time is 7.5 hours a day = $7.5 * 3600 = 27,000$ Seconds as available production time.

$$Takt\ time = \frac{7.5 * 3600}{1000} = \frac{27,000}{1000} = 27\ seconds\ per\ one\ unit$$

In order to meet customers demand, we need to produce one unit every 27 seconds.

b) Cycle time

It refers to the time between two outputs of one of the activities that the product goes through. In other words, it “describes how long it takes to complete a specific task from start to finish. This task may be to assemble a widget or answer a customer service phone call.”²²

c) Lead time²³

It is also called the Production Lead Time (PLT), it represents the total time – value added and non-value added – it takes a product to make it through an entire value stream.

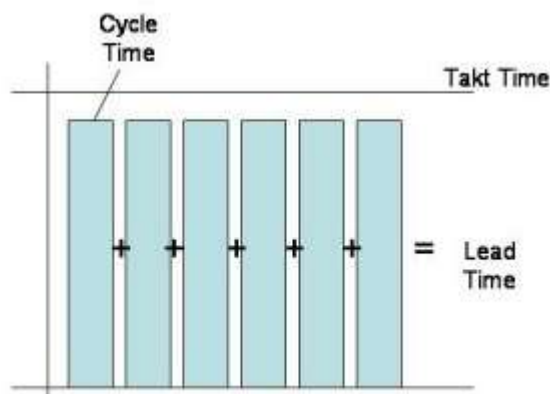
This is often called the “call to cash” time since it helps us understand the time between taking the order and receiving payment for the delivered goods.

d) Service-Level Agreement

SLA is the part of a contract that specifies the quantity and quality of the product / service that the supplier shall provide to its customer; it may include quantity, quality, delivery timeline, and other specifications.

To wrap up, the takt time indicates the pace at which we need to produce to meet the customer’s demand, the cycle time defines the time that a procedure or operations takes from its start to its end, the lead time is the time between order and delivery, it includes all the cycle times.

Figure 14 : Takt time, cycle time and lead time



²² (GEMBA Academy 2015)

²³ (GEMBA Academy 2015)

SOURCE: (BeyondLEAN 2015)

1.7 Six Sigma

Six sigma is considered to be a revolutionary approach on how to do business, as it truly combines both approaches: the qualitative approach and the quantitative approaches.

We usually criticize management theories (qualitative) stating that they describe a dream situation and perfection that we cannot reach, or that they do not bring action and make change. While we reproach to quantitative approaches seeking to quantify phenomena including human or organizational behaviors that are too complex to be modeled in a formulas, and generate statistics or forecasts that are barely real.

Six sigma comes not as a tool but as an approach or methodology complementary to lean management (as previously stated). In this work we will not make a detailed presentation about six sigma: history, statistics behind, proofs. But rather we will focus on explaining what it is and simulate its implementation on KPMG Algeria.

As lean management, six sigma comes as a methodology with a packages of tools and methods that are applicable to insure efficiency and effectiveness in the application of six sigma: couple of them have been presented (VSM, Benchmarking), other will be discussed here and other will be mentioned for reference to the reader such as: Quality Function Deployment (QFD), Statistical Process Control (SPC), Design of experiment (DOE).

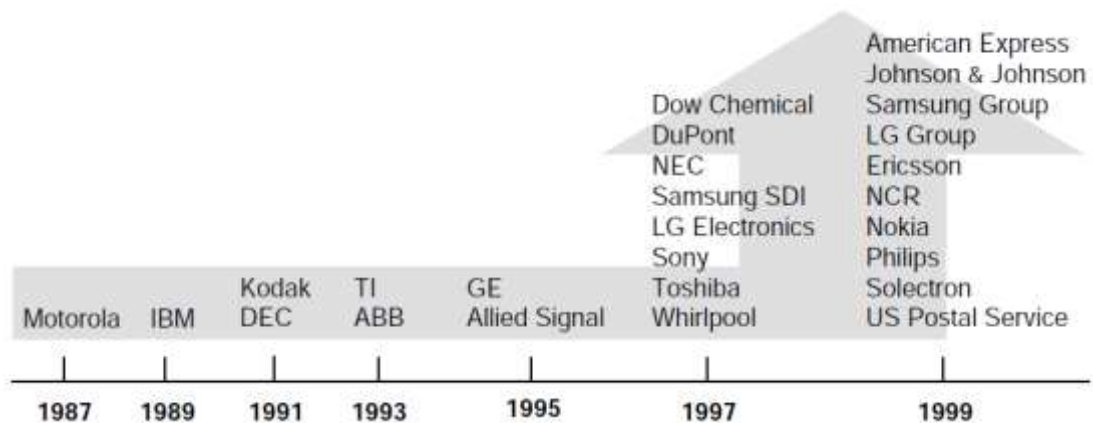
1.7.1 Presentation and history

Six sigma was first launched by Motorola in 1987, its engineers have developed a method to measure the processes variability, by relying on statistical process control technics, and set a methodology to go beyond just SPC: modeling the process and the entire business to reduce this variation, and therefore insure higher efficient and effectiveness. Motorola sought a new way to run its business to stay in business, “the results in terms of reduction in process variation were on-track and cost savings totaled US\$13 billion and improvement in labor productivity achieved 204% increase over the period 1987–1997 (Losianowycz, 1999).”²⁴

²⁴ (Park 2003, 1)

Other business came after to implement six sigma such as: IBM, ABB, AlliedSignal and especially General Electric that has put it in 1995 in the core of its strategy at the global level. *“Less than two years after the initial application of Six Sigma, General Electric had generated over \$320 million in cost savings. By 1998, it had generated three quarters of a billion dollars in cost savings and anticipated over a billion dollars of cost savings by 1999.”*²⁵

Figure 15: timeline of companies that have adopted six sigma



SOURCE: (Park 2003, 5)

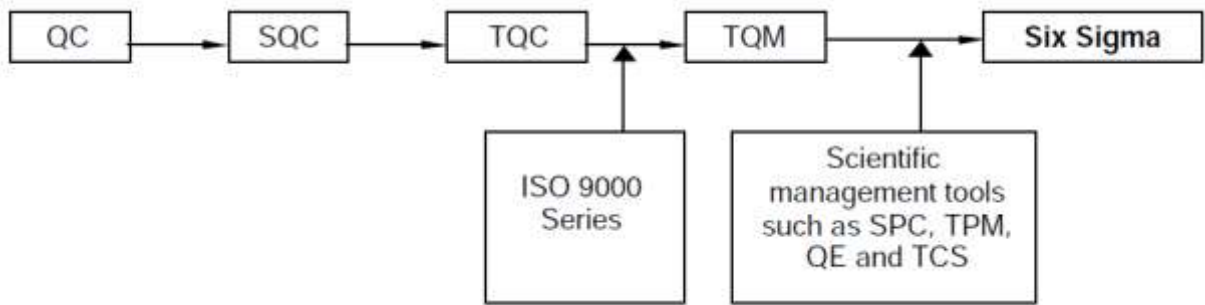
In such context, one would trust that six sigma is purely a tool to be applicable for manufacturing businesses that produce material products where we can measure variation in a processes’ outputs. However, six sigma as relevant and applicable to the service sector as it is to the manufacturing sector. In fact, *“The potential gains from Six Sigma are equally significant (if not greater) in service organizations and non-manufacturing activities as they are in “technical” environments.”*²⁶

In trying to place six sigma in regard to TQM, we can consider six sigma as an evolution of TQM as it takes the realization of TQM purpose in a upper level: excellence at all levels and seeking almost zero defect: 3,4 Defects Per one Million Opportunity (DPMO).

Figure 16: development process of six sigma in quality management

²⁵ (ECKES 2003, 10)

²⁶ (PANDE, NEUMAN et CAVANAGH 2000, xiii)



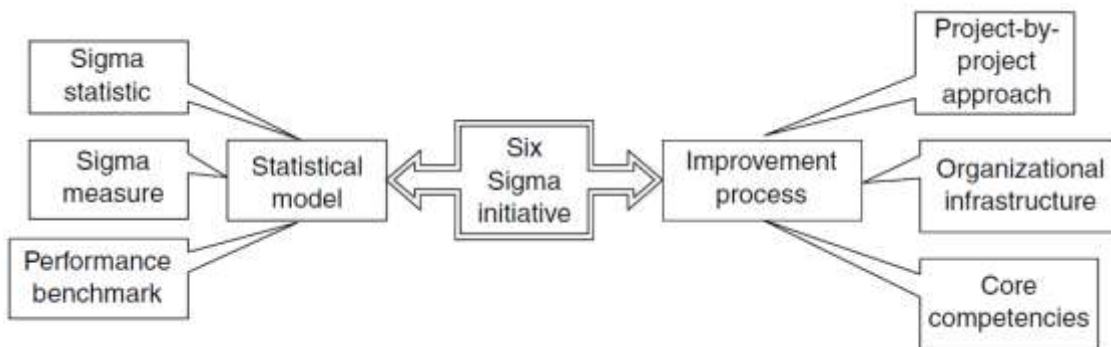
Source: (Park 2003, 3)

In what follows we will discuss the characteristics of the method and its application.

1.7.2 Characteristics

As previously explained, six sigma gathers the two approaches: the quantitative approach (statistical) in setting performance measurement of the extent to which we fulfill stakeholders' requirements, and the qualitative approach in addressing sources of variation, waste and defects by a continuous process improvement.

Figure 17: principal facets of the six sigma



SOURCE: (Truscott 2003, 2)

As stated in our methodology, we will discuss advanced details concerning the statistical formulas and their proofing to meet the thesis requirements (pages limitation and subject addressed); we limit ourselves to explaining the statistical concept of the six sigma.

In statistics, the term sigma “ σ ” represents the standard deviation (SD), which is a measure of variation. It is calculated following the formulas²⁷:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

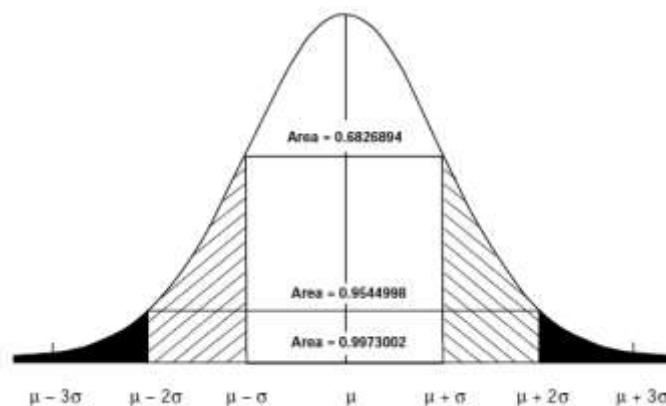
μ : the mean of the population

σ : standard deviation of the population.

“The distribution of a characteristic in Six Sigma is usually assumed to be Normal (or Gaussian) for continuous variables, and Poissonian for discrete variables. The two parameters that determine a Normal distribution are population mean, μ , and population standard deviation, σ . The mean indicates the location of the distribution on a continuous scale, whereas the standard deviation indicates the dispersion.”²⁸

The name six sigma actually means we want to set our process to be on the six sigma level of variation from the mean: we multiply the sigma by three for each side of the mean to get the specifications limits; upper specification limits (ULS) ($\mu+3 \sigma$) and lower specifications limits (LSL) ($\mu-3 \sigma$).

Figure 18: normal distribution law and sigma levels



SOURCE: (Park 2003, 13)

The following table illustrates the sigma levels the relative DPMO

²⁷ We refer the reader to see sampling technics and estimations of population’s mean and standard deviation.

²⁸ (Park 2003, 11)

Table 11: sigma levels and relative DPMO and yield

sigma	DPMO	Yield²⁹
6.0	3,4	99,9997%
5.0	233	99,977%
4.0	6 210	99,379%
3.0	66 807	93,32%
2.5	158 655	84,1%
2.0	308 538	69,1%
1.5	500 000	50,0%
1.4	539 828	46,0%
1.3	579 260	42,1%
1.2	617 911	38,2%
1.1	655 422	34,5%
1.0	691 462	30,9%
0.5	841 345	15,9%
0.0	933 193	6,7%

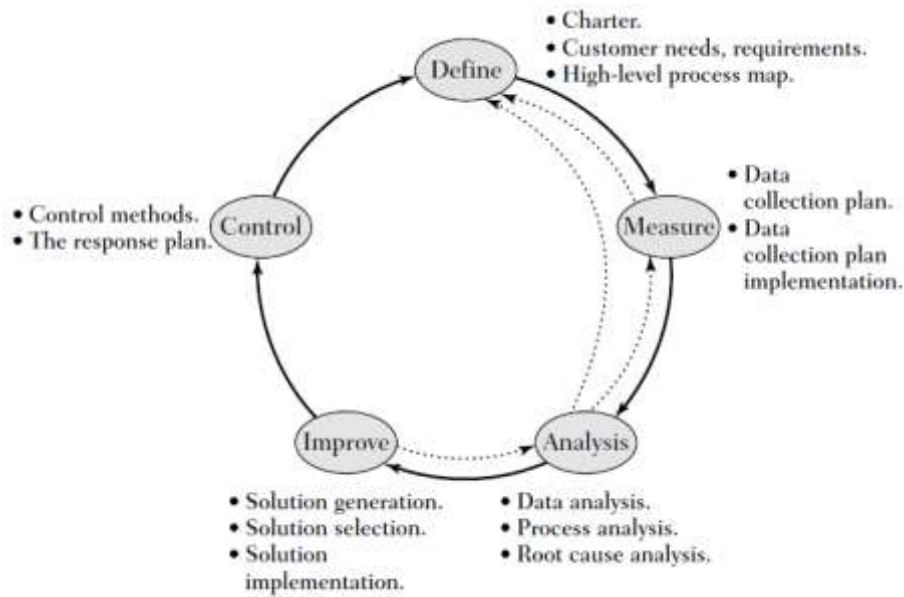
SOURCE: (Thomsett 2005, 11)

In a six sigma pursuit, the organization is relentlessly striving to reach out for 99.9997 % success rate in what it produces.

When applying six sigma, organization usually relies on a methodology called DMAIC (there are other applicable methodologies such as DFSS: Design For Six Sigma), each letter stands of step: define, measure, analysis, improve and control.

Figure 19: Six sigma DMAIC methodology

²⁹ Yield means the success rate of the outcomes.



Source: (ECKES 2003, 29)

At each stage or step six sigma seeks specific objectives and uses specific tools.

Table 12: objectives, results and tools of the different six sigma steps

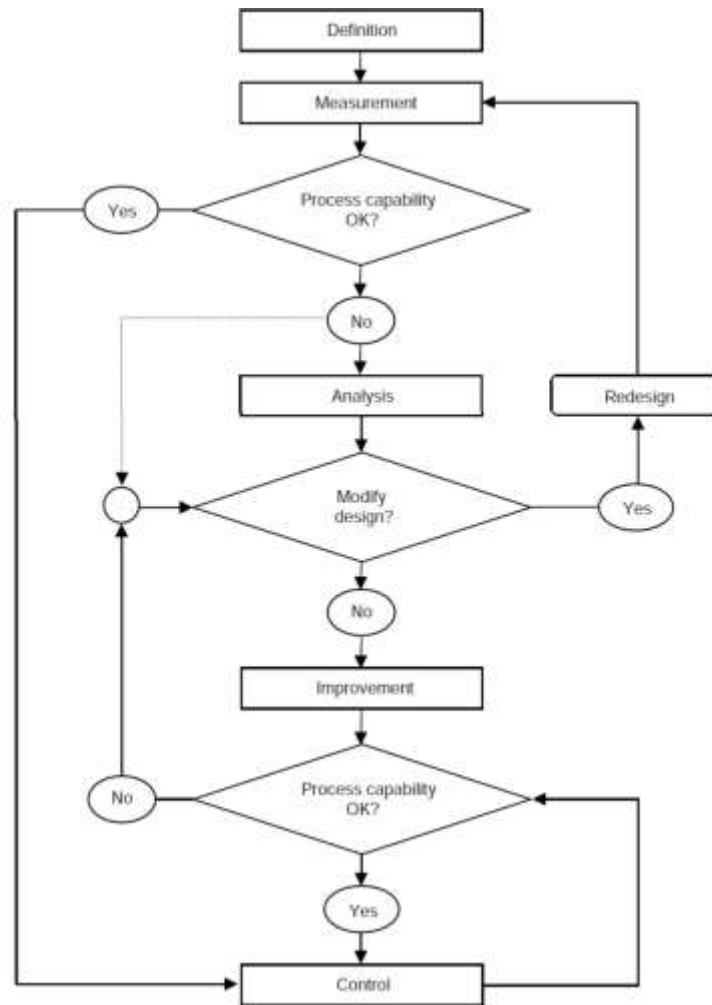
Step	Objectives/tasks	Results	Tools
Define	<ul style="list-style-type: none"> Define the project: expected benefits for the customer, the organization. Project framework and responsibilities 	<ul style="list-style-type: none"> Project charter Process map Planning and resources allocation 	<ul style="list-style-type: none"> CTQ³⁰ diagram QFD Kano analysis Benchmarking SIPOC map
Measure	<ul style="list-style-type: none"> Define and validate the measures means. Measure process' outputs and inputs variation. Calculate data and the Z of the process. 	<ul style="list-style-type: none"> Detailed process map Capability of the measures means. Process capability. 	<ul style="list-style-type: none"> Process analysis, flowchart. Ishikawa diagram. Statistical Process control (SPC).

³⁰ CTQ : Critical to Quality. It represents to most important "critical" elements to satisfy the customer.

Analysis	<ul style="list-style-type: none"> •Data analysis. •Establish the relationship between the process' inputs and outputs. •Identify key process' variables. 	<ul style="list-style-type: none"> •Statistical review •Process comprehension. 	<ul style="list-style-type: none"> ▪Descriptive statistics. ▪Inferential statistic. ▪Experience plans.
Improve / innovate	<ul style="list-style-type: none"> •Imagine solutions. •Select promising progress trails. •Test improvements. 	<ul style="list-style-type: none"> •Pilot process •Improve the Z •Determine the characteristics to have under control 	<ul style="list-style-type: none"> ▪Creativity method. ▪Failure mode and effects analysis (FMEA)
Control	<ul style="list-style-type: none"> •Have under control the selected solution. •Formalize the process. 	<ul style="list-style-type: none"> •Develop standard operation procedures (SOPs). •Control charts. 	<ul style="list-style-type: none"> ▪Statistical process control. ▪Auto-control
Standardize	<ul style="list-style-type: none"> •Sustain the solution. •Share best practices. •Close the project. 	<ul style="list-style-type: none"> •Key Performance Indicators (KPIs). •Dashboard. •Audit plan. •Project report. 	<ul style="list-style-type: none"> ▪Auto-control ▪Audit ▪Benchmarking ▪Best practices.

Source: (PILLET 2004, 26)

Figure 20: DMAIC in a logogram



SOURCE: (Park 2003, 40)

In what follows we will take the process of financial audits conduction as a project for six sigma implementation.

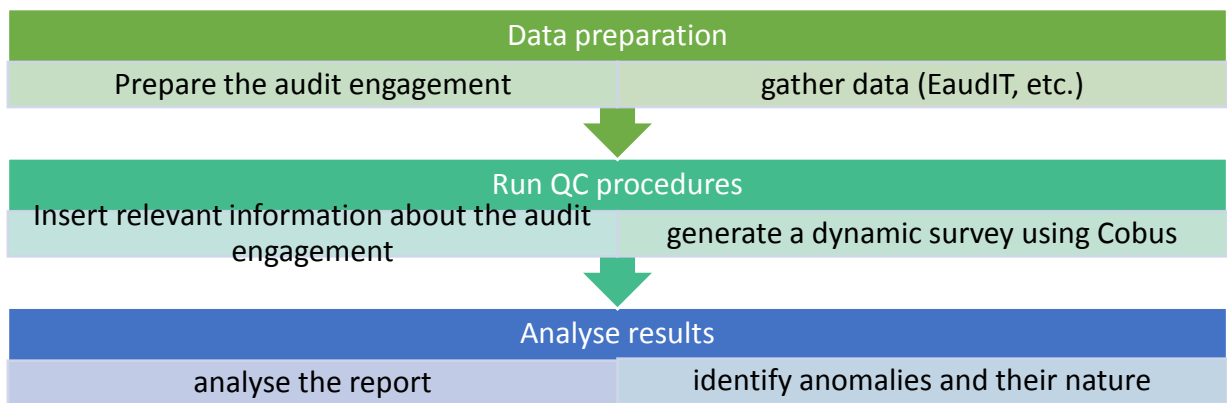
1.7.3 Application

We start by defining the project and understand it. The process output we will study is the degree of audit engagement conformity.

KPMG uses a software along with a set of procedures as part of its Quality Control called: Cobus. A dynamic survey –a survey is generated for each audit engagement depending on its specifications by following up with the answers, hence the total number of qualities varies from an engagement to an other- is sent to gather data about the conduction of each audit, after which the survey along with other sources of data such as Eaudit (which is a software

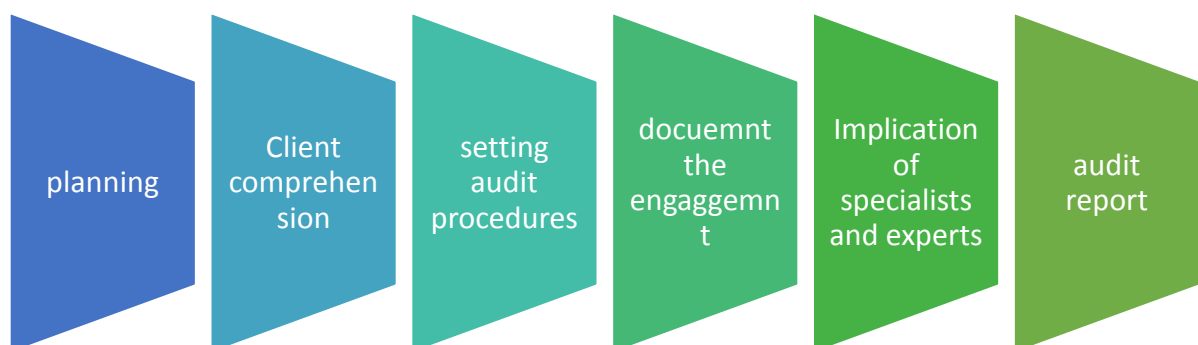
used to plan, organize, conduct, document and close an entire audit engagement) to analysis all the questions generated by Cobus and check out to which extent to answer of each question is in conformity with the applicable references. Cobus generates a detailed report including the questions and the answers, the QC staff identifies the anomalies and their causes; each question from the survey represents a quality checkup point, hence not fulfilling a point is an anomaly.

Figure 21: Quality Control for audit engagements using Cobus software



In order for us to better apprehend the audit process itself we relied on the MBA graduation project of the Audit department Partner, for the year 2013. The data used for six sigma project are related to 2012 audit engagements. For this year (2015) quality control is still ongoing and therefore we preferred to use the 2012 available data.

Figure 22: financial audit process applied in KPMG Algeria.



Source: adapted from (TANSAOUT 2013)

1. Planning
 - review potential conflicts of interests
 - contract
 - set the audit strategy
 - plan resources
2. Client comprehension
 - understand the organization and specificities of the client
 - identify and evaluate risks that may cause significant anomalies on the financial statements
3. Setting audit procedures
 - set procedures to cover risk zones and have assurances that financial statement do not include significant anomalies
 - Internal control effectiveness.
 - Substantive tests upon financial data to get assurances that amounts on financial statement are real.
 - Other procedures: conduct walkthroughs, cross-checking balance with third parties.
4. Document the engagement
 - Through the entire audit phases: from planning till reporting, there's the necessity to generate work papers to synthesize the work and conducted tests and conclusions.
5. Implication of specialists and experts
 - Specific profiles must be involved in the audit: the manager and the partner. According to KPMG standards, these management profiles must have at least 20% of the number of hours charged by the entire engagement team to review and validate the work and tests.
 - when there's a need for specific expertise, experts in the needed area interfere: IT, tax, actuary.
6. Audit report
 - At the end of the audit a management letter along with the audit opinion is sent to the client.
 - The audit report contains the findings and recommendations to improve the internal control and quality of financial statements.

We have collected the QC report of 16 audit engagements; each engagement was for a different client. Then we have calculated the number of questions (each action reflects a quality checkup point) for each engagement. After which we have taken the number of anomalies detected by QC for each engagement, and calculate the % of conformity (100% - % anomalies) and anomalies (number of anomalies divided by total number of questions)

Table 13: conformity and anomalies of audit engagements

Audit Engagement (AE)	# Questions	# Anomalies	% conformity	% anomalies
Audit engagement 14	151	4	97,4%	2,6%
Audit engagement 8	149	5	96,6%	3,4%
Audit engagement 1	70	7	90,0%	10,0%
Audit engagement 2	51	7	86,3%	13,7%
Audit engagement 5	154	22	85,7%	14,3%
Audit engagement 7	57	11	80,7%	19,3%
Audit engagement 11	41	9	78,0%	22,0%
Audit engagement 9	59	13	78,0%	22,0%
Audit engagement 15	55	13	76,4%	23,6%
Audit engagement 4	62	15	75,8%	24,2%
Audit engagement 12	34	9	73,5%	26,5%
Audit engagement 6	77	23	70,1%	29,9%
Audit engagement 10	59	19	67,8%	32,2%
Audit engagement 13	49	16	67,3%	32,7%
Audit engagement 16	39	24	38,5%	61,5%
Audit engagement 3	41	26	36,6%	63,4%
Total	1148	223	77,2%	22,8%

Source: created from QC data.

Reviewing the statistical characteristics of the yield are indicates in the following table:

Table 14: mean and standard deviation of the Audit engagement yield

variable	Mean	Standard deviation
Audit engagement conformity %	74.9%.	16,65%

Considering this % as the yield of the audit process, by referring it to the table 10 (sigma levels), the process is operating at 2.2 sigma level.³¹

To find the major cause of variation we rely on our previous Pareto Analysis, where we identifies that the two categories we should tackle in priority are: generalities and testing.

³¹ Table with detailed sigma levels available : (Six sigma level 2015)

However, to deepen our analysis, we reviews the nature of anomalies and not just the category (a category contains several natures). That is from a quantitative perspective, from a qualitative perspective we must highlight that are QC checkup points that are more critical to quality (CTQ) then others, we therefore give higher priority to such natures. In total there are 67 anomaly natures, of which 8 are critical to quality. We selected the audit engagements with such critical anomalies.

Table 15: audit engagements and Critical to Quality anomalies

Audit Engagement	# Questions	# Anomalies	% conformity	% anomalies	# CTQ anomalies	% CTQ anomalies
Audit engagement 14	151	4	97,4%	2,6%	0	0,0%
Audit engagement 8	149	5	96,6%	3,4%	0	0,0%
Audit engagement 1	70	7	90,0%	10,0%	1	14,3%
Audit engagement 2	51	7	86,3%	13,7%	1	14,3%
Audit engagement 5	154	22	85,7%	14,3%	4	18,2%
Audit engagement 7	57	11	80,7%	19,3%	0	0,0%
Audit engagement 11	41	9	78,0%	22,0%	1	11,1%
Audit engagement 9	59	13	78,0%	22,0%	2	15,4%
Audit engagement 15	55	13	76,4%	23,6%	0	0,0%
Audit engagement 4	62	15	75,8%	24,2%	1	6,7%
Audit engagement 12	34	9	73,5%	26,5%	0	0,0%
Audit engagement 6	77	23	70,1%	29,9%	3	13,0%
Audit engagement 10	59	19	67,8%	32,2%	4	21,1%
Audit engagement 13	49	16	67,3%	32,7%	3	18,8%
Audit engagement 16	39	24	38,5%	61,5%	2	8,3%
Audit engagement 3	41	26	36,6%	63,4%	4	15,4%
Total	1148	223			26	

Source: created from QC data.

%CTQ anomalies are the % of anomalies that have high criticality divided by total number of anomalies.

The findings show interesting results, as the audit engagements (AE) 5 seems to be of higher quality than AE 7, 9 and 12, though these three last AEs have lower yield than AE 5 but they do not have any CTQ anomaly while AE 5 has 4 CTQ anomalies.

The improvement of the audit process relies on the analysis to understand the source of variation in quality: is it due to the kind of client, experience of the human resources, and commitment of management and follow up? And obviously it can be a combination of all these variables. The application of FMEA would help set preventive actions, identify, quantify risks, and their nature.

Kano analysis can be helpful to identify the needs of the customer, as in regard to QC standards the audit might be in conformity but still it does not fully satisfy the needs of the customer. In addition, running a benchmark analysis of the auditing process with KPMG in other countries can generate innovative ideas to push forward to competitive edge of KPMG Algeria.

The improved process should be test on pilot audit engagement in order to adjust any details before implementing it. A simple tool is usually used for such purposes it's called KISS: Keep, Improve, Stop and Start during the brainstorming meetings conducted to improve the process, we might as well ask ourselves a reverse question: what do we need to do to have a low quality audits? Then we strive into avoiding the findings.

The control step in such context can be set by relying on SPC, dashboards and action plan with GANTT charts to follow up what the plans and allocate resources in an efficient and effective way.

Our study about the application of six sigma is limited to what has been presented. However, further studies might rely on more operational data and a wider sample (exceeding 30 observation to apply the normal distribution law) to further measurement and analysis phase. With the implication of management and experienced employees, the improvement of the audit process would be made through a knowledge management approach to gather best practices and understand what high quality engagement are “high quality” and how the low ones are lows.

CHAPTER 3

AN APPLICATION OF DATA ENVELOPMENT

ANALYSIS TO MEASURE EFFICIENCY

1. Efficiency: concept and measurement

“What gets measured gets managed”

Peter Drucker

Measuring performance has always been a focus, in order to assess where we stand, to which extent we are achieving our objectives, and how well we are managing our resources.

There are several approaches and methods to measure performance, but it is necessary to first to have a common understanding about we mean by performance and what are its components.

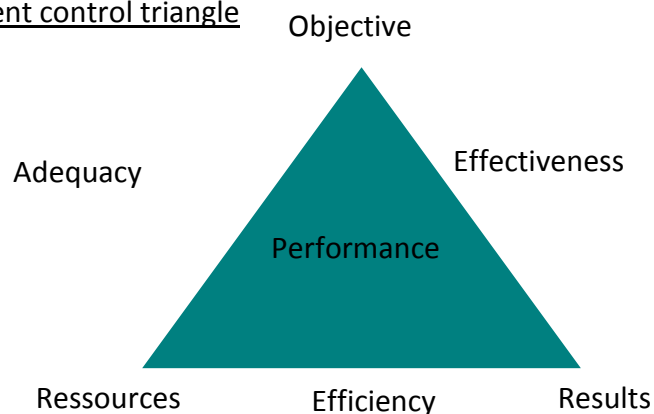
At the business level, most commonly performance measurement is one of the key roles of the Management Control service, it does not only measure performance for the sake to know who’s the employee of the month, but the goal is to measure performance to drive and pilot it for a continuous improvement by identifying factors jeopardizing performance and tackling them.

A triangle called the management control triangle has been developed to apprehend performance and its components to drive performance.

1.1 Efficiency: a key performance component

The management control triangle illustrates performance and its different components:

Figure 23: Management control triangle



SOURCE: (Le contrôle de gestion : organisation, outils et pratiques 2008, 3)

1.1.1 Efficiency

It can be defined as the “*relationship between the result achieved and the resources*”³², the efficiency ratio indicates the extent to which we are optimizing the use of resources, and therefore minimizing wastes.

$$Efficiency = \frac{Results (outputs)}{Ressources (inputs)}$$

Efficiency, according to STERN and EL-ANSARY comprehends two concepts³³:

- i. Productivity: the optimization of the physical resources implemented
- ii. Profitability: the optimization of the financial resources implemented

1.1.2 Effectiveness

Effectiveness can be explained as the “*extent to which planned activities are realized and planned results achieved*”³⁴, the effectiveness ratio points out to which extent the results obtained meet the objectives.

$$Effectivness = \frac{Results (real outputs)}{Objectives (expected outputs)}$$

1.1.3 Adequacy:

Adequacy reflects how relevant resources are to the objectives, it therefore focuses on assessing the adequacy of resources in their nature, quantity and quality and the objectives set. This analysis indicates if we are over or under budgeting resources (human, financial and physical).

1.2 Efficiency measurement

We previously have presented the components of performance (performance triangle). Qualifying the relationship between resources and results (efficiency) requires mathematical and statistical approaches to model it, due to the variety and diversity of inputs and outputs units of measure (weight, length, number, age, nature, etc.).

³² (International Organization for Standardization ISO 2005, 9)

³³ (VILLARMOIS 2011)

³⁴ (International Organization for Standardization ISO 2005, 9)

In addition, one of the objectives of TQM is seeking to reduce waste in inputs and increase outputs conformity (Lean, Six Sigma), making the business more competitive. Hence measuring efficiency indicates how well TQM approach is implemented, besides to identifying the sources of inefficiencies and therefore set priorities for TQM to tackle and address.

1.2.1 Efficiency measurement

The concepts of efficiency and its measurements has its origins back to the work of DEBREUU (1951) and KOOPMANS (1951), their researches sought to find out a way on defining the concept of production efficiency which is the utilization of a set of inputs (resources) to produce a set of outputs (results). After which, the work of FARREL (1957) came along to introduce a method to evaluate production efficiency. He has stated that *“when one talks about the efficiency of a firm one usually means its success in producing as large as possible an output from a given set of inputs.”*³⁵

According to FARREL, productive efficiency is composed of:

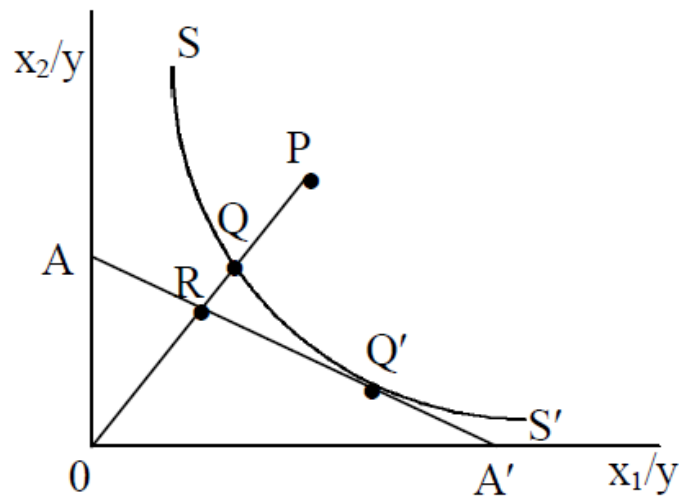
- Technical efficiency: it reflects the ability to optimize the use of available inputs. Therefor an organization is technical efficient if it’s able to use inputs and produce outputs with zero wastes.
- Price (allocative) efficiency: *“reflects the ability of a firm to use the inputs in optimal proportions, given respective prices”*³⁶. The *“price efficiency measures the extent of a firm’s adaptation to a particular set of prices, and will therefor give a good measure of its efficiency in adapting to factor prices only in a completely static situation”*³⁷

³⁵ (FARREL 1957, 254)

³⁶ (T. Coelli 1996, 3)

³⁷ (FARREL 1957, 261)

Figure 24: technical and allocative efficiencies



SOURCE: (T. Coelli 1996, 4)

This figure illustrates a firm using two inputs (x_1 and x_2) to produce one output (y) (under constant return to scale and known production function).

The isoquant SS' represents the various combination of inputs that a perfectly efficient firm might use to produce y .

P is an inefficient firm producing an output, the firm Q represents a firm using the same ratio of inputs as firm P but in an efficient Q (Q is on the isoquant SS'). The distance QP equals to the waste of inputs of firm P . We can calculate technical efficiency (TE) as follows:

$$TE = \frac{OQ}{OP} \quad (0 < TE < 1)$$

OQ : distance from 0 to Q . OP : Distance from 0 to P

A firm i with $TE = 1$ means that the firm i is technically efficient.

Now, regarding price (allocative) efficiency, suppose that AA' has a slope similar to the prices proportions of inputs. In this case, Q' has perfect price efficiency over Q . the allocative efficiency of firm P is defined by the ratio³⁸:

$$AE = \frac{OR}{OQ} \quad (0 < AE < 1)$$

³⁸ (T. Coelli 1996, 4)

“given the measure of technical efficiency, the total overall cost efficiency (CE) can be expressed as a product of technical and allocative efficiency measures:”³⁹

$$TE * AE = \frac{OQ}{OP} * \frac{OR}{OQ} = \frac{OR}{OP} = CE$$

Measuring efficiency relies on comparing the efficiency of a firm and then compare it to the production function. There are two approaches to define the production function and measure efficiency: parametric and non-parametric approaches.

1.2.2 Parametric approach

This approach supposed that the production function can be estimated and it is composed of limited number of parameters (mean, standard deviation). To estimate the production function and its parameters this approach relies on econometrics and statistical methods.

1.2.3 Non-parametric approach

This approach supposes that the production function is composed of efficient units, and therefore estimating the production function requires relying on linear programming to identify the efficient units. An efficient unit is a unit that there is no other unit that can product more outputs with the same level of inputs, or product the same outputs with lower level of inputs.

Two methods are applied in such approach: Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH).

2. Data Envelopment Analysis method

The DEA method has gone through several development and amelioration since its creation in 1978 by Charnes, Cooper and Rhodes. They have relied on the work of Farrel (1957) to present a model that optimizes a ratio called “efficiency ratio” using linear programming.⁴⁰

Further in this thesis, we will present an application of DEA to measure efficiency in KPMG Algeria as an audit & advisory firm.

³⁹ (Coelli, et al. 2005, 256)

⁴⁰ (Nadji, Atik et Kachiche 2012)

2.1 The DEA presentation and characteristics

2.1.1 DEA program

DEA is a non-parametric method that seeks to measure the efficiency of Decision Making Units (DMUs). We understand by the term DMU a unit that transforms inputs into outputs. The DEA helps identify the efficiency frontier, composed of the efficient DMUs, after which the rest of inefficient DMUs are compared to this frontier to measure their efficiency rate and identify their benchmarks (set of efficiency DMUs). For each inefficient DMU, DEA identifies its benchmarks.

Considering a DMU using inputs to produce outputs, DEA calculates the following efficiency ratio:

$$\text{Efficiency} = \frac{\text{Sum of weighted outputs}}{\text{Sum of weighed inputs}}$$

To introduce the linear program, consider each DMU_j (j= 1...n / n: number of DMUs) uses inputs $X_j = \{X_{ji}\}$ (i= 1...m / m: number of inputs) to produce outputs $Y_j = \{Y_{rj}\}$ (r= 1...s / s: number of outputs).

The “proposed measure of the efficiency of any DMU is obtained as the maximum of a ratio of weighted outputs to weighted inputs subject to the condition that the similar ratios for every DMU be less than or equal to unity. In more precise form:⁴¹

$$\text{Max } h_0 = \frac{\sum_{r=1}^s u_r y_{r0}}{\sum_{i=1}^m v_i x_{i0}}$$

Subject to:

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1$$

$$u_r, v_i \geq 0$$

$$j = 1 \dots n$$

$$i = 1 \dots m$$

⁴¹ (Charnes, Cooper et Rhodes 1978, 430)

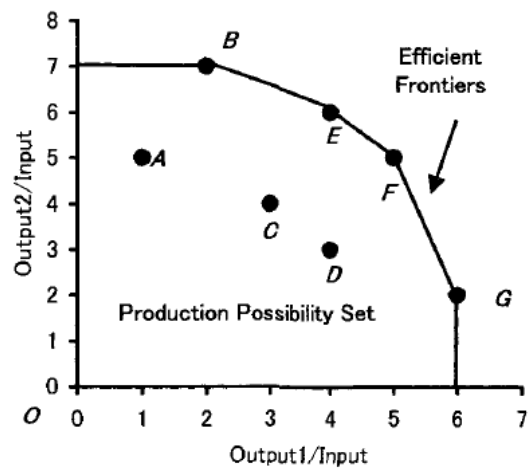
$$r = 1 \dots s$$

$$u_r, v_i \geq 0$$

u and v are the variable weights to be determined by the solution of this problem.

The DEA's linear program identifies the efficient units that represent the efficiency frontier.

Figure 25 : An example of efficient frontiers



SOURCE: (COOPER, SEIFORD et TONE 2007, 9)

In this example DMUs: B, E, F and G are perfectly efficient, while DMUs: A, C and D are not efficient. The distance between inefficient DMUs and efficient DMUs represent the measure of inefficiency.

For inefficient DMUs, DEA estimates the slacks of inputs and slacks of outputs: inputs slacks are the amount of inputs we need to reduce in order to efficient, and the outputs slacks are the amount of outputs we need to increase in order to efficient. In other words, slacks represent the excess use of resources or the production shortfalls of outputs.

Considering DMU_j which inputs are $(X_{1j}, X_{2j}, \dots, X_{mj})$ and outputs are $(Y_{1j}, Y_{2j}, \dots, Y_{sj})$, the inputs and outputs matrix can be introduced as follow:⁴²

⁴² (COOPER, SEIFORD et TONE 2007, 22)

$$X = \begin{pmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{pmatrix}$$

$$Y = \begin{pmatrix} Y_{11} & Y_{12} & \cdots & Y_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ Y_{s1} & Y_{s2} & \cdots & Y_{sn} \end{pmatrix}$$

Example: X_{12} means input 1 of DMU 2, and Y_{35} would mean output 3 of DMU 5.

2.1.2 Discretionary and non-discretionary inputs and outputs⁴³

When the inputs a DMU used to produce outputs are under the management control, meaning that management has control over these inputs and outputs and can actually make actions to increase/decrease an input or an output, in such case we call them "discretionary" inputs / outputs.

However, it is obvious to ascertain that some inputs and outputs might be out of the control of management, in other words these are the inputs or outputs that management cannot control and does not have influence on them: they are determined by external factors out of management. In this situation, we call these inputs and outputs "non-discretionary".

Extending the CCR and BCC models to address discretionary inputs/outputs was the purpose of Banker and Morey articles "efficiency analysis for exogenously fixed inputs and outputs" in 1986, where they have introduced it "We evaluate, by means of mathematical programming formulations, the relative technical and scale efficiencies of decision making units (DMUs) when some of the inputs or outputs are exogenously fixed and beyond the discretionary control of DMU managers."⁴⁴

2.1.3 Number of inputs and outputs:

The number of selected inputs and outputs comparing to the number of DMUs is crucial to an accurate and proper efficiency measurement. That is because the smaller the number of DMUs is, the larger the portion of efficient DMUs will be.

⁴³ (COOPER, SEIFORD et TONE 2007, 63)

⁴⁴ (BANKER et MOREY 1986)

COOPER, SEIFORD & TONE mentioned in their book: "DATA ENVELOPMENT ANALYSIS: A Comprehensive Text with Models, Applications, References and DEA-Solver Software" (2007) that: "if the number of DMUs (n) is less than the combined number of inputs and outputs ($m + s$), a large portion of the DMUs will be identified as efficient and efficiency discrimination among DMUs is questionable due to an inadequate number of degrees of freedom. ... Hence, it is desirable that n exceed $m + s$ by several times. A rough rule of thumb in the envelopment model is to choose n (= the number of DMUs) equal to or greater than:

$$\text{Max } \{ m * s, 3 * (m + s) \}^{45}$$

Meaning:

$$\text{Number of DMUs} \geq 3 * (\text{Number of Inputs} + \text{Number of Outputs})$$

Example: if we have 2 inputs and 4 outputs, the total number of DMUs its preferable to have is equals:

$$\text{Number of DMUs} \geq 3 * (2 + 4) \rightarrow \text{number of DMUs} \geq 18$$

2.1.4 Orientations

As previously explained the efficiency score is the ratio of outputs divided by inputs. To increase this ratio we seek to decrease the inputs or increase the outputs. This too possibilities have been modeled unto two DEA orientations: inputs orientation and outputs orientation.

2.1.4.1 Inputs orientation

In this orientation, the linear program is set to optimize the efficiency score by finding out the optimum decrease in inputs for fixed outputs.

This orientation is usually applied when a DMU wants to focus on decreasing its inputs and/or cannot increase its outputs (out of its control).

⁴⁵ (COOPER, SEIFORD et TONE 2007, 116)

2.1.4.2 Outputs Orientation

In such orientation, the linear program is set to identify the optimum increase in outputs for fixed inputs in order to optimize the efficiency score.

This is usually applied when a DMU seeks to increase its productivity.

2.1.5 Return to Scale

This concepts explains the relationship between factors of production and products, we can find three possible return to scale: constant, increase and decreasing return to scale:

2.1.5.1 Constant Return to Scale (CRS)

In this situation, any change in inputs will generate the same change of outputs in the same proportion.

2.1.5.2 Increasing return to scale (IRS)

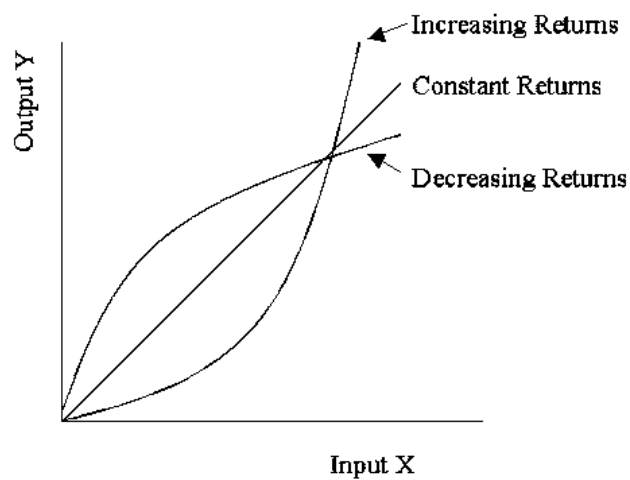
In such case, an increase in inputs will generate a bigger increase in outputs; the organization benefits from the reduction of cost per unit.

2.1.5.3 Decreasing return to scale (DRS)

Here, an increase in inputs will generate a smaller increase in outputs; the organization is suffering a reversed return to scale.

The latter two cases the return to scale is variable: Variable Return to Scale (VRS).

Figure 26 : Return to Scale



SOURCE: (FAO 2015)

2.1.6 Scale efficiency

Scale efficiency illustrates if the DMU is operating on the best possible size. It “allows to rapport the measure of technical efficiency on scale of return obtained for optimal activity levels”.⁴⁶

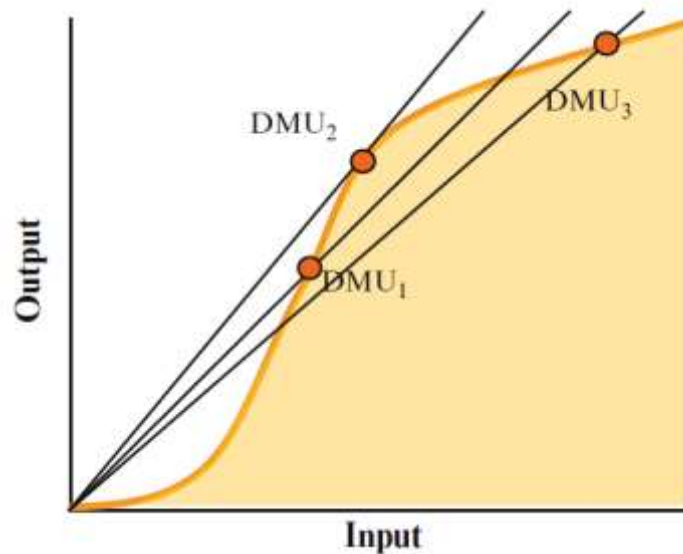
The figure below shows three DMUs that operate on the production possibility frontier. The slopes for each DMU represent their productivity ratio (output/input). The higher it is, the better.

DMU₂ has the highest productivity slope, *“because the ray passing through DMU₂ is a tangent to the production frontier at this point, it has the greatest slope indicating DMU₂ has the best possible productivity—its output/input—ratio is maximal. It is operating at the optimal scale size. If all DMUs had the same slope on the production frontier, then we should say that the production frontier specifies constant returns to scale (CRS); otherwise it specifies variable returns to scale (VRS). The returns to scale of DMU₁ is clearly lower than that of DMU₂. If VRS is assumed, then DMU₂ is efficient, but for becoming optimal it has to improve its productivity. It cannot happen unless it decreases its input and/or output as well. It is said to operate on the area of increasing returns to scale. The returns to scale of DMU₃ is also lower than that of DMU₂, but DMU₃ operates on the area of decreasing returns to scale. If its input increases, it cannot preserve its current productivity level; it decreases. Thus even if the units are technically efficient, they may increase their productivity by exploiting scale efficiency.”*⁴⁷

⁴⁶ (HOUNSOUNON 2009)

⁴⁷ (Joro et Korhonen 2015, 8)

Figure 27: Scale efficiency



Source: (Joro et Korhonen 2015, 8)

Since CRS includes both technical efficiency and scale efficiency, while VRS represents technical efficiency, hence the efficiency score of CRS divided by the VRS one gives us the scale efficiency.

$$\text{Scale efficiency} = \frac{\text{CRS efficiency score}}{\text{VRS efficiency score}}$$

2.2 Models

We have introduced the basics of the DEA method and the mathematical program it uses, however further in the development of the DEA efficiency program, several models have been developed to better apprehend the divers context upon which the DEA is applied and to fit the kind of data and phenomena being measured. In this work we will discuss the two basic models of DEA: CCR model and BCC Model.

2.2.1 CCR Model

This model was named after his developers (their first names' initial): Charnes, Cooper and Rhodes in 1978. This model uses a program in order to optimize the efficient ratio Θ , which is the sum of weighted outputs divided by the sum of weighted inputs. The CCR model solves the problem by finding out the weights for each DMU.

For a DMU0 the fractional program (FP) is as follow⁴⁸:

$$(FP_0) \max \theta = \frac{u_1 y_{10} + u_2 y_{20} + \dots + u_s y_{s0}}{v_1 x_{10} + v_2 x_{20} + \dots + v_m x_{m0}}$$

Subject to:

$$\frac{u_1 y_{10} + u_2 y_{20} + \dots + u_s y_{s0}}{v_1 x_{10} + v_2 x_{20} + \dots + v_m x_{m0}} \leq 1 \dots \dots \dots (1)$$

$$v_1, v_2, \dots, v_m \geq 0 \dots \dots \dots (2)$$

$$u_1, u_2, \dots, u_s \geq 0 \dots \dots \dots (3)$$

Constraints number 2 and 3 are herein set for managerial consideration, we assume that all inputs and outputs are of nonzero values, hence the weights being assigned some positive values.

The previous FP can be written in a linear program (LP) as follow⁴⁹:

$$(LP) \max \theta = \sum_{r=1}^s \mu_r y_{r0}$$

Subject to:

$$\sum_{r=1}^s \mu_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0$$

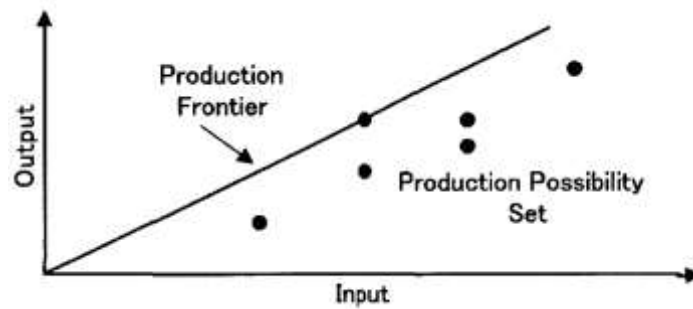
$$\sum_{i=1}^m v_i x_{i0} = 1$$

$$\mu_r, v_i \geq 0$$

As expressed in the methodology of this work, we will not discuss the proof of the functions and programs presented, but rather use them and refer the reader to their references.

Figure 28 : Production frontier of the CCR model

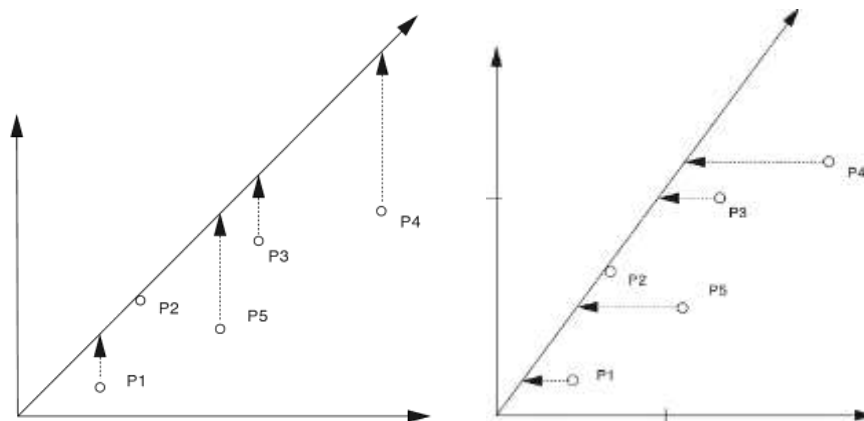
⁴⁸ (COOPER, SEIFORD et TONE 2007, 23)
⁴⁹ (COOPER, SEIFORD et TONE 2007)



SOURCE: (COOPER, SEIFORD et TONE 2007, 86)

One of the characteristics of the CCR model is that it operates on a CRS basis. Both orientations are applicable on CCR: input orientation and output orientation.⁵⁰

Figure 29 : Input and output orientations of the CCR model



SOURCE: (COOPER, SEIFORD et ZHU 2011, 15)

2.2.2 BCC Model

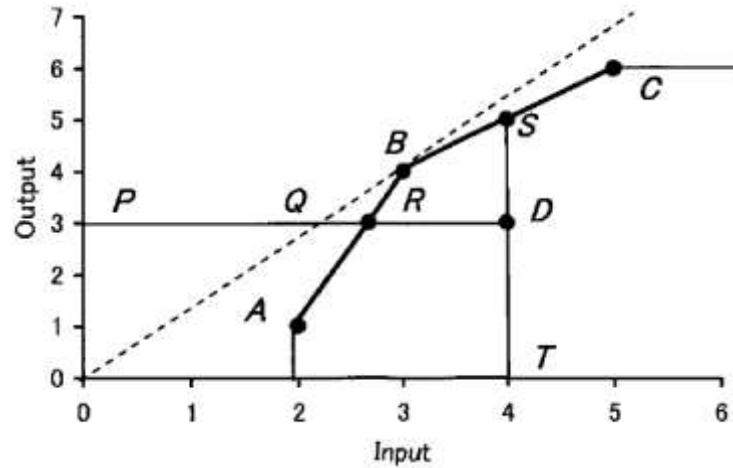
The model was named after Banker, Charnes and Cooper, who have developed a model in 1984 that measures efficiency based on Variable Return to Scale (VRS); the production frontier takes a convex shape due to the addition of the following constraint:

$$\sum_{j=1}^n \lambda_j = 1, \lambda_j \geq 0, \quad \forall j$$

⁵⁰ Additional linear programs of input orientation and output orientation can be found at the references used in this work.

In the figure below we see the result of this constraint: in the BCC model the production frontier (bold line) takes a convex form comparing to the CCR model (dashed line):

Figure 30 : Production frontier of the BCC model and CCR model



SOURCE: (COOPER, SEIFORD et TONE 2007, 90)

We can see that only DMU B is CCR-efficient, while DMU A, B and C are efficient as well in BCC model.

For DMU₀ (O=1 ... n), the input-oriented BCC model operates by solving the following program⁵¹:

$$(BCC_0) = \min_{\theta_B, \lambda} \theta_B$$

Subject to:

$$\theta_B x_o - X \lambda$$

$$Y \lambda \geq y_o$$

$$e\lambda = 1$$

$$\lambda \geq 0,$$

Same as CCR model, the BCC model can be input-oriented or output-oriented.

⁵¹ (COOPER, SEIFORD et TONE 2007, 91)

In addition to these two models, there are other models for DEA method: additive model, Slacks-based model (SBM) which we will not discuss in this work. However, we will present a table that sums up the characteristics of these models:

Table 16: Summary of DEA models characteristics

Model		CCR-I	CCR-O	BCC-I	BCC-O	ADD	SMB (Hybrid)
Data	X	Semi-P	Semi-P	Semi-P	Free	Free	Semi-P
	Y	Free	Free	Free	Free	Free	Free
Trans.	X	No	No	No	Yes	Yes ^α	No
Invariance	Y	No	No	No	No	Yes ^α	No
Units invariance		Yes	Yes	Yes	Yes	No	Yes
Θ*		[0, 1]	[0, 1]	(0, 1]	(0, 1]	No	[0, 1]
Tech. Or Mix		Tech.	Tech.	Tech.	Tech.	Mix	Mix
Returns to Scale		CRS	CRS	VRS	VRS	C(V)RS ^b	C(V)RS

^α: The additive model is translation invariant only when the convexity constraint is added.

^b: C(V)RS means Constant or Variable returns to scale according to whether or not the convexity constraint is included.

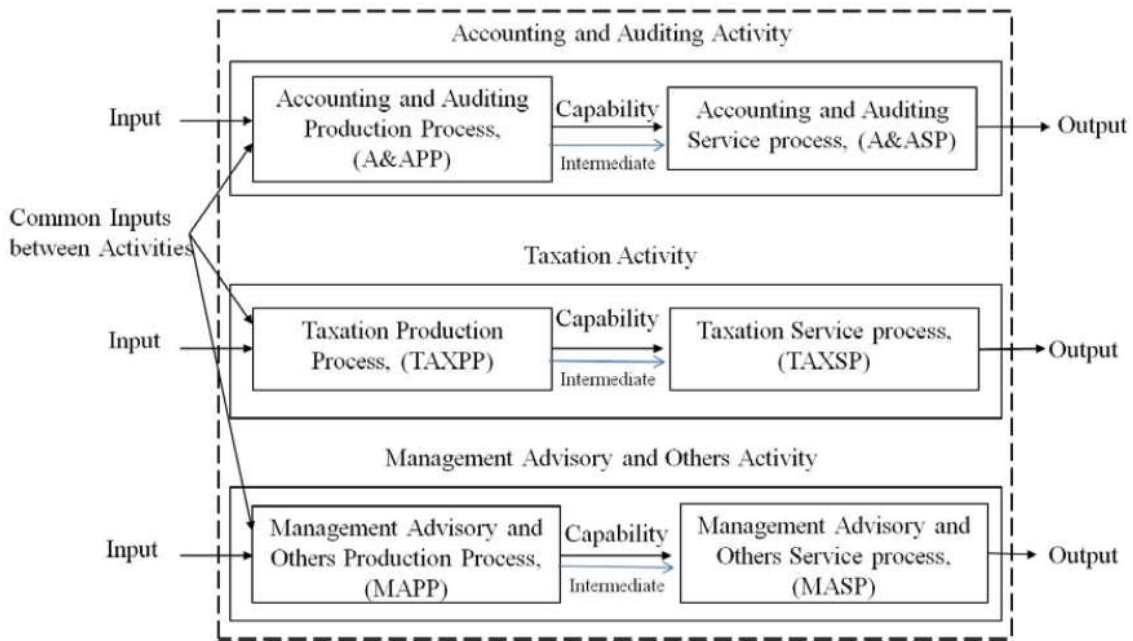
Source: (COOPER, SEIFORD et TONE 2007, 115)

2.3 Application of DEA to measure efficiency in auditing and advisory firms

In this part, we'll review some research and work that have conducted similar analysis by applying DEA to measure the efficiency in organizations offering services in accounting, auditing, legal, tax and advisory.

Such firms have very close structure: they common inputs (mainly human capital) to produce similar service: tax, audit, advisory, etc. to their clients.

Figure 31: structure of an auditing and advisory firm



Source: (Hsiao, Shu and Chou 2014, 5)

For such studies, we find that the elements of inputs and elements of outputs are very similar. For example the inputs and outputs used by (Hsiao, Shu and Chou 2014): number of employees for each activity (as shown in previous figure), the training expenses, Human capital index (calculated based on the level of education) and revenue per activity. In another study (Kamyabi et Salahinejad 2014, 138), the inputs and outputs used are: real cost, number of audit team, number of weak points and recommendations in audits reports as outputs.

3. DEA application on measure the efficiency of audits

3.1 Presentation of the measurement framework: approach, models, inputs, outputs and orientation

3.1.1 Measurement approach

In our study, we will take a set of 30 audit engagements for different client and calculate their efficiency using DEA method. These engagements were conducted in 2015 to audit the 2014 financial year (except for one client where he was audited for 2013 and 2014).

This choice is justified by the fact that in the previous chapter, we took as study subject the same process. In addition, we trust that the core profession of KPMG is auditing (plus tax, legal and accounting), it's this process that reflects the value creation of the entity, hence focusing on this process is of higher relevancy to KPMG Algeria, plus it's the process through which KPMG Algeria delivers its unique value proposition or unique selling points (USP).

We sought to use DEA to measure efficiency and take the analysis further by determining the source of inefficiency as well. That creates value when applying TQM; we have a clearer idea where to focus and with what variables to start to insure higher improvement impart.

3.1.2 Measurement models and Orientation

We have conducted our analysis relying on both the CCR and BCC model. Since the entity has more control on the inputs than the outputs, the orientation used in our study is inputs-orientation.

3.1.3 Inputs and outputs and their models

Several models (combination of inputs and outputs) have been applied to see the change in the efficiency score and sources of inefficiency. We have presented the rule stating that $\#DMUs \geq 3 * (\#inputs + \#outputs)$. The maximum number of inputs plus numbers of outputs is 6 inputs and 2 outputs, in total 8. The number of DMUs (30) exceeds three times the number of inputs + outputs ($8*3=24$). In addition to that, as the sample we took equals 30, we're able to apply the characteristics of the normal distribution law (requires a sample equal or exceeding 30).

The inputs and outputs are presented in the following table.

Table 17: DEA inputs and outputs description and justification

variables	Abbreviation	Description	justification
Quality level	QL	Represent the conformity of the engagement. We obtained the data after the appreciation of KPMG top management.	As an output, this variable reflects to which extent the audit is aligned with the set of applicable methods and standards in addition to level of customer satisfaction.
Turnover per hour	TPH	Represents the engagement fees charged by KPMG Algeria divided by the number of hours (might differ from actual spent hours on the audit).	It reflects the profitability of the engagement in regard to the resources employed.
# employees	NEM	Indicates the number of employees engaged in the audit (partner, manger, senior, staff)	A measurement of the resources employed.
# hours (NH)	NH	Represents the total numbers of hours spent on the engagement by the entire engagement team.	To measure the volume of the resources by hours and not by person. And for a more detailed assessment of the consumption of resources in terms of hours.
# hours : Partner + Manager	NHP	Represents the total numbers of hours spent on the engagement by the partner(s) and manager(s).	To measure the volume of the resources by hours and not by person. And for a more detailed assessment of the consumption of resources in terms of hours per rank.
# hours Senior	NHS	Represents the total	

		numbers of hours spent on the engagement by the senior(s)	
# hours Staff	NHF	Represents the total numbers of hours spent on the engagement by the staff.	
Team's total years of experience	TXP	Reflects the sum of years of experience within KPMG of the entire engagement.	Indicates about the expertise of the resource. We used it as inputs and non-discretionary input to measure both possibilities of adjusting the expertise allocated or not.
Client cooperation	CC	Represents the cooperation of client throughout the entire audit process. Measured by the appreciation of top management at KPMG.	As a non-discretionary input: it is considered as a resource for the engagement but out of the control of management.

Table 18: Models, inputs and outputs of the DEA efficiency measurement

variables	Model 1	Model 2	Model 3	Model 4	Model 5
Quality level	Output	Output	Output	Output	Output
Turnover per hour	Output	Output	Output	Output	Output
# employees	Input	Input	Input	Input	Input
# hours	Input	/	/	/	/
# hours : Partner + Manager {l}	/	Input	Input	Input	Input

# hours Senior	/	Input	Input	Input	Input
# hours Staff	/	Input	Input	Input	Input
Team's experience sum of years	/	/	Input	IN	IN
Client cooperation	/	/	/	/	IN

IN: non-discretionary inputs.

3.1.4 DEA software

We used the EMS software: Efficiency Measurement System V1.3.0⁵²

3.2 Results and analysis

3.2.2 Interpreting the results information

The DEA as a method does not only measure efficiency but it provides further information such as the weights for each variable (input/output) and also the slacks, hence we can identify the source of inefficiency and its impact.

The information that the DEA gives us for model 1 for instance are:

Table 19: Information gives by DEA for model 1

Information	Interpretation
DMU	The DMU with its information, in our case it's the audit engagement (AE)
Score	The score of efficiency of every AE: score between 0% and 100%, where 100% indicates perfect efficiency.
# employees {I}{V} # hours {I}{V} Quality level {O}{V} Turnover per hour {O}{V}	This indicates the weights for each input and outputs. The sum of inputs' weights equals 1, same thing for outputs' weights. The weight represents the extent of the contribution of the variable (inputs/outputs) to efficiency.
Benchmarks	For inefficient DMUs, it shows the benchmarks of the DMU (set of

⁵² Software can be downloaded for free for academic purposes at: (holger-scheel s.d.)

efficient DMUs). And for efficient DMUs it should to inefficient DMU for which this efficient DMU is a benchmark.

{S} # employees {I}

{S} # hours {I}

{S} Quality level {O}

{S} Turnover per hour {O}

These indicate the slacks for each variable (input/output). As explained before, the slack are the economies in inputs and increase in outputs to be done to reach efficiency score 100%. It then illustrates the source of inefficiency (for variable having high slacks).

3.2.3 Efficiency scores results

We run the program for the five models in CCR and BCC using an input-orientation.

Table 20: Efficiency score results for all models

DMU	Model 1		Model 2		Model 3		Model 4		Model 5	
	CCR	BCC	CCR	BCC	CCR	BCC	CCR	BCC	CCR	BCC
AE 1	43,22%	100%	49,12%	100%	52,24%	100%	49,12%	100%	49,12%	100%
AE 2	33,42%	34,96%	36,11%	39,68%	37,92%	39,68%	36,11%	39,68%	39,65%	98,98%
AE 3	75,36%	100%	77,78%	100%	94,28%	100%	77,78%	100%	77,78%	100%
AE 4	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AE 5	33,44%	50,00%	33,64%	50,00%	37,25%	50,00%	33,64%	50,00%	33,64%	50,00%
AE 6	55,60%	66,67%	61,28%	66,67%	64,79%	66,67%	61,28%	66,67%	61,28%	66,67%
AE 7	86,76%	100%	88,64%	100%	100%	100%	100%	100%	100%	100%
AE 8	21,67%	33,33%	28,66%	33,33%	34,19%	37,34%	28,66%	33,33%	28,66%	33,33%
AE 9	45,51%	50,00%	48,24%	50,00%	64,47%	74,84%	48,88%	50,00%	48,88%	50,00%
AE 10	60,20%	66,67%	66,67%	66,67%	80,81%	80,81%	66,67%	66,67%	66,67%	66,67%
AE 11	25,53%	40,00%	27,87%	40,00%	30,27%	40,00%	27,87%	40,00%	27,87%	40,00%
AE 12	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AE 13	32,26%	50,00%	35,71%	50,00%	35,71%	50,00%	35,71%	50,00%	35,71%	50,00%
AE 14	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AE 15	58,33%	66,67%	64,70%	66,67%	65,00%	66,67%	64,70%	66,67%	64,70%	66,67%
AE 16	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

AE 17	25,36%	28,57%	28,06%	28,57%	31,51%	32,42%	28,06%	28,57%	28,06%	28,57%
AE 18	37,64%	40,00%	40,72%	41,78%	42,78%	43,88%	40,72%	41,78%	40,72%	41,78%
AE 19	21,78%	28,57%	23,30%	28,57%	25,87%	28,57%	23,30%	28,57%	23,30%	28,57%
AE 20	36,55%	66,67%	37,20%	66,67%	44,72%	66,67%	37,20%	66,67%	37,20%	66,67%
AE 21	67,15%	75,73%	79,39%	100%	91,21%	100%	87,30%	100%	87,30%	100%
AE 22	58,51%	66,67%	81,08%	100%	81,08%	100%	81,08%	100%	81,08%	100%
AE 23	71,21%	81,71%	93,09%	100%	93,09%	100%	93,09%	100%	93,09%	100%
AE 24	59,53%	66,67%	65,18%	66,67%	69,63%	71,15%	65,18%	66,67%	65,18%	66,67%
AE 25	43,42%	50,00%	48,78%	50,00%	52,67%	52,71%	48,78%	50,00%	48,78%	50,00%
AE 26	34,25%	50,35%	37,65%	100%	39,96%	100%	37,65%	100%	100%	100%
AE 27	90,60%	100 %	91,71%	100%	93,17%	100%	91,71%	100%	100%	100%
AE 28	35,51%	40,00%	44,68%	54,50%	44,68%	54,50%	44,68%	54,50%	44,68%	54,50%
AE 29	11,58%	15,38%	14,06%	15,38%	14,10%	15,38%	14,06%	15,38%	14,06%	15,38%
AE 30	67,34%	79,23%	88,89%	100%	88,89%	100%	88,89%	100%	88,89%	100%
Mean	54,4%	64,9%	59,7%	70,5%	63,7%	72,4%	60,4%	70,5%	62,9%	72,5%
Median	50,6%	66,7%	55,2%	66,7%	64,6%	73,0%	55,2%	66,7%	63,0%	66,7%
St dev	26,2%	26,1%	26,9%	28,3%	27,3%	27,5%	27,6%	28,3%	28,4%	28,1%
Max	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Min	11,6%	15,4%	14,1%	15,4%	14,1%	15,4%	14,1%	15,4%	14,1%	15,4%

The descriptive statistics of the results for CCR are present in the following figure:

Figure 32: descriptive statistics of CCR efficiency results

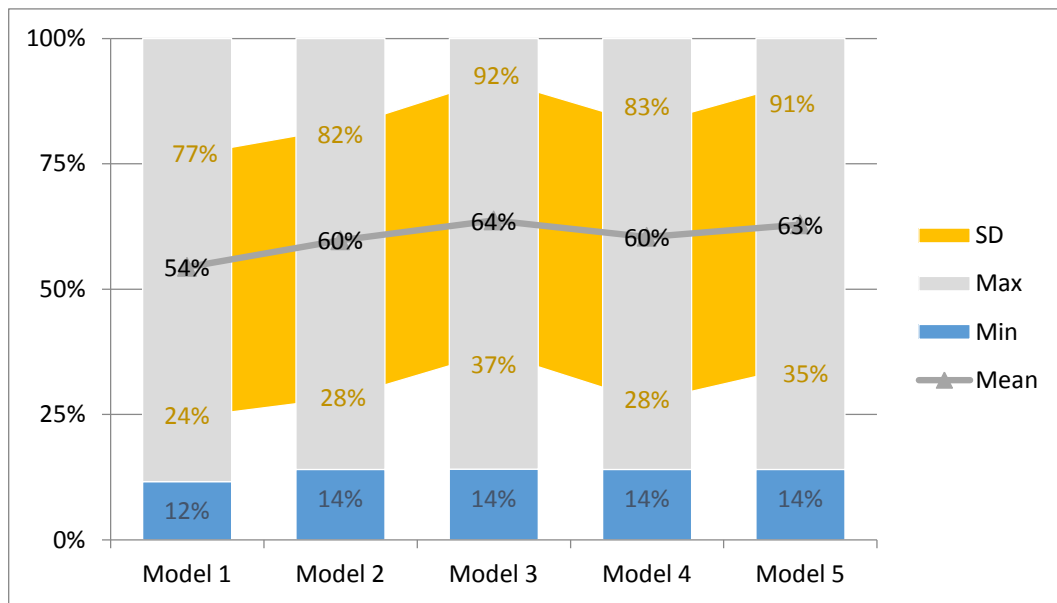


Figure 33: Audit Engagements Scale efficiency for each model⁵³

DMU	Model 1	Model 2	Model 3	Model 4	Model 5
AE 1	43,2%	49,1%	52,2%	49,1%	49,1%
AE 2	95,6%	91,0%	95,6%	91,0%	40,1%
AE 3	75,4%	77,8%	94,3%	77,8%	77,8%
AE 4	100,0%	100,0%	100,0%	100,0%	100,0%
AE 5	66,9%	67,3%	74,5%	67,3%	67,3%
AE 6	83,4%	91,9%	97,2%	91,9%	91,9%
AE 7	86,8%	88,6%	100,0%	100,0%	100,0%
AE 8	65,0%	86,0%	91,6%	86,0%	86,0%
AE 9	91,0%	96,5%	86,1%	97,8%	97,8%
AE 10	90,3%	100,0%	100,0%	100,0%	100,0%
AE 11	63,8%	69,7%	75,7%	69,7%	69,7%
AE 12	100,0%	100,0%	100,0%	100,0%	100,0%
AE 13	64,5%	71,4%	71,4%	71,4%	71,4%

⁵³ As explained previously, scale efficiency is calculated by dividing CCR (CRS) efficiency score upon BCC (VRS) efficiency score.

AE 14	100,0%	100,0%	100,0%	100,0%	100,0%
AE 15	87,5%	97,0%	97,5%	97,0%	97,0%
AE 16	100,0%	100,0%	100,0%	100,0%	100,0%
AE 17	88,8%	98,2%	97,2%	98,2%	98,2%
AE 18	94,1%	97,5%	97,5%	97,5%	97,5%
AE 19	76,2%	81,6%	90,5%	81,6%	81,6%
AE 20	54,8%	55,8%	67,1%	55,8%	55,8%
AE 21	88,7%	79,4%	91,2%	87,3%	87,3%
AE 22	87,8%	81,1%	81,1%	81,1%	81,1%
AE 23	87,1%	93,1%	93,1%	93,1%	93,1%
AE 24	89,3%	97,8%	97,9%	97,8%	97,8%
AE 25	86,8%	97,6%	99,9%	97,6%	97,6%
AE 26	68,0%	37,7%	40,0%	37,7%	100,0%
AE 27	90,6%	91,7%	93,2%	91,7%	100,0%
AE 28	88,8%	82,0%	82,0%	82,0%	82,0%
AE 29	75,3%	91,4%	91,7%	91,4%	91,4%
AE 30	85,0%	88,9%	88,9%	88,9%	88,9%

3.2.4 General analysis

In this part, we will present general analysis upon the entire results to identify the number of efficient DMUs, the effect of changing the inputs/outputs (change of model). As well as correlation between the different models.

3.2.4.1 Number of efficient Audit Engagements

Table 21: number of efficient Audit Engagements per model

Model	Model 1	Model 2	Model 3	Model 4	Model 5
CCR	4	4	5	5	7
BCC	8	13	13	13	13

We observe that the number of efficient AEs slightly increases (considering the sample contains 30 AEs, hence an increase by 1 AE reflects a 3% increase in number of efficient AEs).

Regarding scale efficiency, taking the model 5 as example for the analysis: 7 AEs are efficiency in CCR, however in BCC 13 AEs, that means from these 13 AEs: only 7 are scale efficient. Meaning, 6 AEs need to adjust their scale (increase/decrease their inputs depending on whether they are on increase eon decreasing return to scale respectively) to be scale efficient.

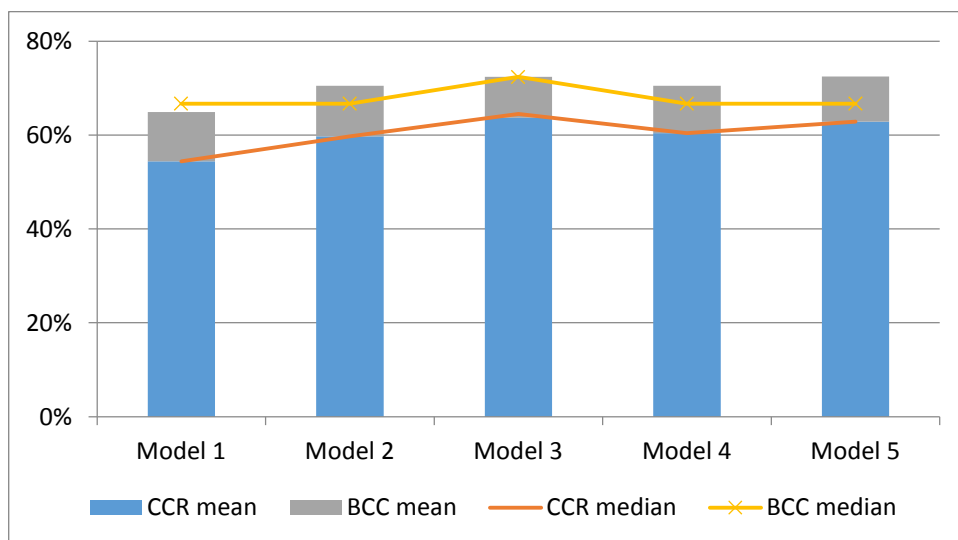
3.2.4.2 Mean and median of efficiency

Table 22: efficiency mean and median per model

	Model 1		Model 2		Model 3		Model 4		Model 5	
	mean	median	mean	median	mean	median	mean	median	mean	median
CCR	54,4%	54,4%	59,7%	59,7%	63,7%	64,5%	60,4%	60,4%	62,9%	62,9%
BCC	64,9%	66,7%	70,5%	66,7%	72,4%	72,4%	70,5%	66,7%	72,5%	66,7%

The following figure visualizes this table:

Figure 34: efficiency mean and median per model



In CCR, the mean and median are super close, no significant skew. However in BCC, the median is sometimes up of the mean (model 1 and 3) and the rest of times it's down the

mean. In the first case it indicates a left skew of distribution; in the second case it signifies a right skew of distribution.

3.2.4.3 Models correlations

	Model 1	Model 2	Model 3	Model 4	Model 5
Model 1	/	97,28%	96,20%	96,98%	89,72%
Model 2	/	/	98,34%	99,63%	91,71%
Model 3	/	/	/	98,67%	90,28%
Model 4	/	/	/	/	91,99%
Model 5	/	/	/	/	/

We can see that the correlation between models is high, that means that the change in inputs/outputs had a small impact. The lowest correlation is 89,72% between model 1 and model 5: that is because we built our models on an additional way, meaning each new model incorporates new inputs (not additional outputs) with change in the kind of inputs: discretionary input or non-discretionary input.

3.2.5 Specific analysis

3.2.5.1 AE with significant improvement

In this part, we'll take some AEs and analyze them with more details. Some AEs whose efficiency score on CCR for model 1 has strongly improved in model 5:

Table 23: Audit Engagements with Strong efficiency score improving

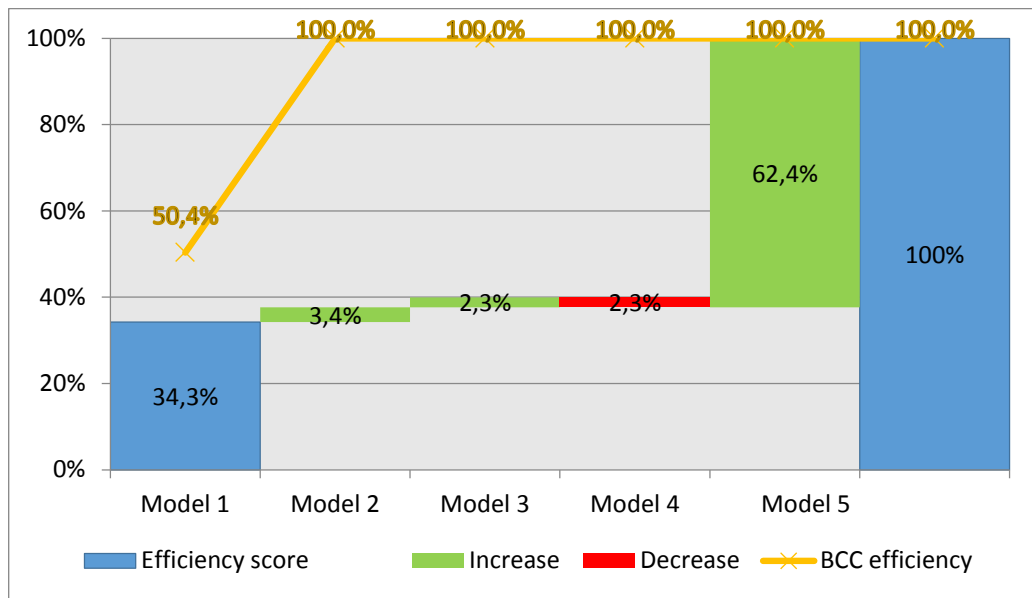
DMU	CCR Model 1	CCR Model 5
AE 7	86,8%	100,0%
AE 21	67,2%	87,3%
AE 22	58,5%	81,1%
AE 23	71,2%	93,1%
AE 26	34,3%	100,0%
AE 27	90,6%	100,0%
AE 30	67,3%	88,9%

This improvement can be indications that the additional inputs had an impact in a way that they allowed a more detailed efficiency measurement by highlighting the fact that these AEs have fewer resources and yet they were able to be productive comparing to the rest of AEs.

3.2.5.2 Analysis of an Audit Engagement

The AE that had the highest improvement score is AE 26 whose efficiency score skyrocket from 34% to 100%.

Figure 35: Audit Engagement #26 Efficiency Bridge



The bridge indicates that the efficiency score significantly rose in model 5. What changed then is the addition of the non-discretionary input: Client cooperation. This means that this AEs suffers from a significant an unfavorable working environment, that’s why when we included this variable AE 26’s efficiency skyrocketed.

Details (data and results) of AE 26 for the first model:

Table 24: details of Audit Engagements #26

DMU	# employees {I}	# hours {I}	Quality level {O}	Turnover per hour {O}
AE 26	6	725	80%	7 238

Score	NEM {I}{V}	NH {I}{V}	QL {O}{V}	TPH {O}{V}	Benchmarks	{S} NEM {I}	{S} NH {I}	{S} QL {O}	{S} TPH{O}
34,25 %	1	0	0,96	0,04	12 (0,92) 16 (0,11)	0	118,94	0	0

Reading these details indicates that its efficiency score (CCR) is 34,25%. The weights for inputs are 100% for # Employees, 0 for # hours. We can conclude from this that the main efficiency for this AE is coming from to use of employees. In the other hand, the weights for the outputs are 96% for Quality level and 4% for turnover per hour, therefore this AE is more efficient by using employees to insure high quality audit.

The only slacks the DEA program reported are slacks in #hours (input) which are up to 118.94 comparing to the actual number of hours spent 725, the slack represents 16.41%: that's the amount that needs to be reduced in order to reach out to efficiency.

Its scale efficiency score equals 68%, it would mean that it is not operating at this best production level. We are in a situation of variable return to scale. The analysis we can make here is that it would be more efficient to adjust the inputs level to reach CRS hence this would improve the quality of the service and the turnover per hour, in the latter the earning would be spending less time hence increase the ratio. The resources can be allocated to other engagements in shorter time.

4. Business dashboards to control and drive performance

After the presentation of TQM tools and methods and measuring efficiency using DEA method on the auditing process, in this part we will focus on dashboards to feed the decision-making process for successful TQM methods implementation, and to drive performance to meet KPMG Algeria's goals: financial, operational and quality goals.

We will start by presenting two world-wide known dashboards: the Balanced Score and OVAR, then we will make propositions in regard to dashboards with links to TQM and efficiency improvement.

Discussing dashboard makes us discussing the decision-making process, the latter makes us discuss how the human brain operations to take decisions, *“behavioral decision researchers and psychologists have suggested that human beings have two modes of processing information and making decision. The first, System 1 thinking, is automatic, instinctive, and emotional. It relies on mental shortcuts that generate intuitive answers to problems as they arise. The second, System 2, is slow, logical, and deliberate. (Daniel Kahneman, winner of the Nobel prize in economics, popularized this terminology in his book thinking, Fast and slow.)”*⁵⁴

In such context, the information and its kind influence the decision-maker perception about the information, have a compelling wide range of information enables a better decision making activity by balancing between both system.

3.2.1 Balanced Scorecard

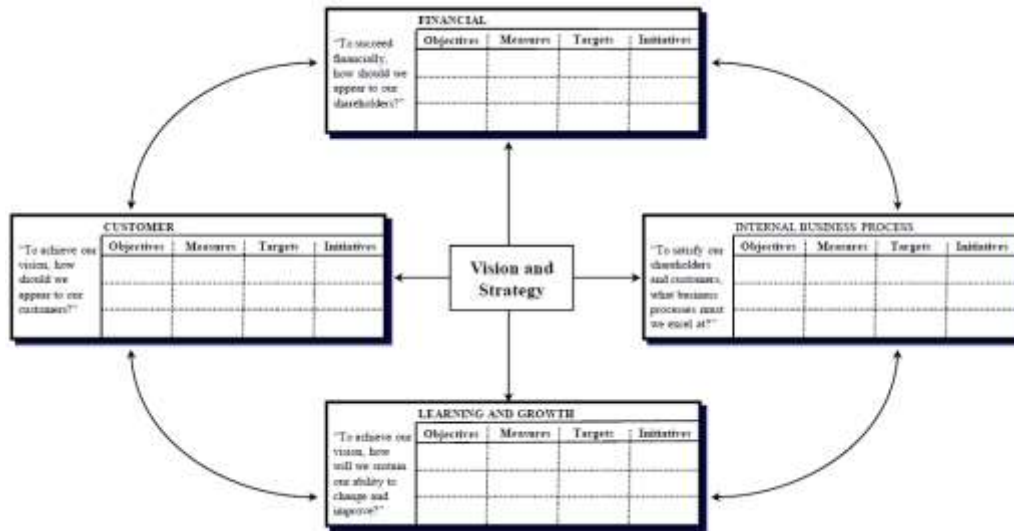
The BSC was created by Kaplan & Norton in 1992, in their work they sought to figure out a way to measure performance by incorporating financial information and non-financial information, as the financial information can mislead the decision making-process. The goal was to create a balanced scorecard that gives manager fast and comprehensive overview of the entire business.

They present it stating that the *“the balanced scorecard includes financial measures that tell the results of actions already taken. And it complements the financial measures with operational measures on customer satisfaction, internal processes, and the organization's*

⁵⁴ (Beshears et Gino 2015, 52)

innovation and improvement activities-operational measures that are the driver of future financial performance.”⁵⁵

Figure 36: Translating Vision and Strategy: Four Perspectives



Source: (Kaplan, Conceptual Foundations of the Balanced Scorecard 2010, 4)

The BSC was further developed; it was merged with six sigma to create a six sigma business scorecard.

Table 25: Balanced Scorecard and Six Sigma Business Scorecard comparison

Balanced Scorecard	Six Sigma Business Scorecard
A strategic management system.	A performance measurement system.
Relates to a longer-term view of the business.	Can provide a snapshot of a business’s performance, as well as identify measurements that would drive performance toward profitability.
Designed to develop a balanced set of measurements	Designed to identify a set of measurements that impact profitability.
Identifies measurements around vision and values.	Establishes accountability for leadership for wellness and profitability.

⁵⁵ (Kaplan et Norton, The Balanced Scorecard - Measures that Drive Performance 1992, 79)

Critical management processes are to clarify vision/strategy, communicate, plan, set targets, align strategic initiatives, and enhance feedback and learning.	Includes all business processes, management and operational, i.e., leadership, innovation, rate of improvement, sales, service, purchasing, and production operations.
Balances customer and internal operations without a clearly defined leadership role.	Balances management and employees' roles; balances cost and revenue of heavy processes.
Emphasizes targets for each measurement.	Emphasizes aggressive rate of improvement for each measurement, irrespective of target.
Emphasizes learning of executives based on the feedback.	Emphasizes learning and innovation at all levels based on the process feedback. Enlists all employees' participation.
Focuses on growth.	Focuses on maximizing profitability.
Heavy on strategic intent.	Heavy on execution for profitability.
Management system consisting of measurements.	A measurement system based on process management.

Source: (Gupta 2004, 88)

3.2.2 OVAR dashboard

It was conceived by two professors from HEC Paris: Daniel Michel, Michel Fiol and Hugues Jordan in 1981. The idea was to conceive a system of dashboards for different levels and focusing on specific elements that compose its name: **OVAR**.

O: Objective

VA: Variable of Action

R: Results

This method *“recommends the construction not of a business dashboard, but of a system of dashboards differentiated by the different entities and responsibility level of the company and articulate in a coherent way”*⁵⁶

⁵⁶ (Giraud, et al. 204, 106)

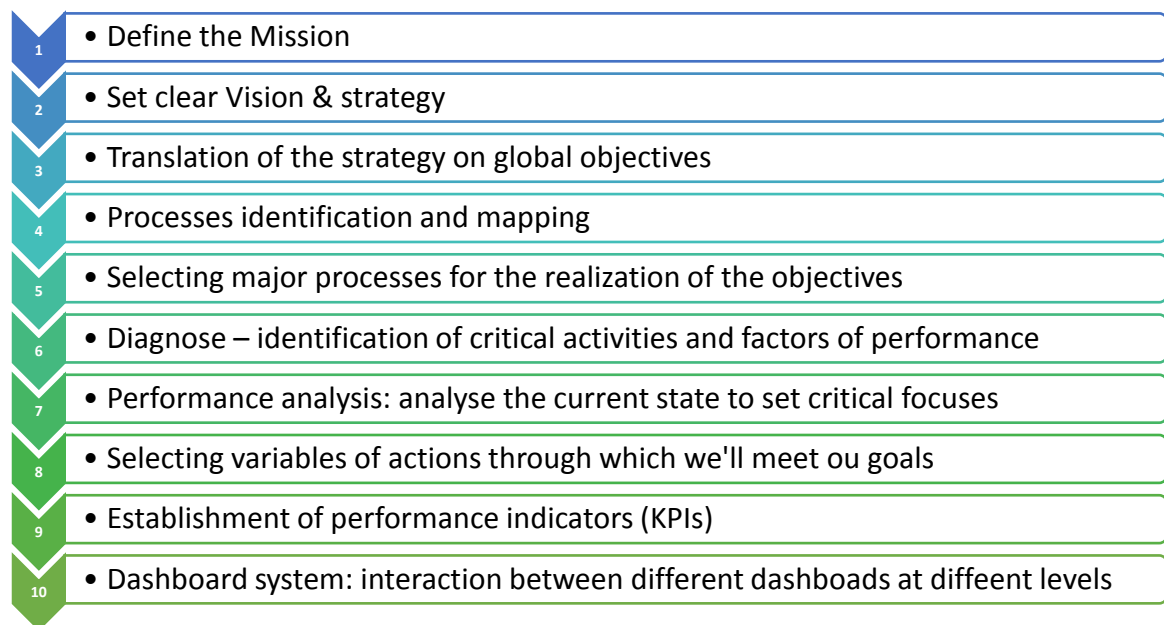
3.2.3 Conception of a business dashboard

In this part, we will present the steps to create a dashboard and its indicators. We'll make this dashboard relevant to our previous work by including parameters reflecting quality, efficiency. The dashboard we'll develop is set in a way to support the decision-making process to plan and track the implementation of TQM methods and tools and also use them to build indicators (use the data it's collected and findings).

3.2.3.1 Process to build a dashboard

The steps to build a dashboard depend on its purpose on what kind of information and intelligence it is expected to provide. The steps proposed here in made in a way to support a TQM implementation and drive performance.

Figure 37: Dashboard Conception steps



Source: adapted from (ATIK 2013) and formateur.ca

In addition to this process, AFRNOR (French standardization agency) published a guideline FD X 50-171 that presents a methodology to conceive, implement and improve KPIs and indicators. These guideline provides a wide range of scopes (financial, HR, etc.) with examples of objectives and indicators. That fits the philosophy of the BSC as it relies on mainly four perspectives as already presented.

Table 26: examples of scopes, objectives and indicators

Scope	Objective	Indicator
Financial Management	<ul style="list-style-type: none"> • Optimization of financial profitability 	<ul style="list-style-type: none"> ▪ Gross / net profit margin ▪ Cash collection rate ▪ Cash collection deadline
Human Resources	<ul style="list-style-type: none"> • Talents management • Resources optimization • Personnel awareness 	<ul style="list-style-type: none"> ▪ Percentage of trained personnel / personnel to train ▪ Absence rate ▪ Personnel turn over
Sales	<ul style="list-style-type: none"> • Growth • Prosperity • Competitiveness • Innovation 	<ul style="list-style-type: none"> ▪ Evolution of orders ▪ Increase of market share ▪ Competitive positioning ▪ Escape rate: #lost clients / # total clients ▪ Total period of clients rotation

Source: (AFNOR 2000, 14)

3.2.3.2 A proposed dashboard to implement TQM and drive performance

In this part, we will present a proposal for a system of dashboards oriented to the implementation of TQM approach along with its methods and tools, in addition to driving performance with a focus on efficiency.

This system of dashboards is not only a tool of reporting, but it's a method to create periodic action plans and individual negotiated activities. We rely on principals of projects management: Logical Framework Analysis, Work Breakdown Structure, GANTT, etc., risks management principles: risk matrix (impact x frequency), risk prevention and response strategies, etc. to support our work.

In our wok, we do understand by a project a *“unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources”*⁵⁷ And by a risk we understand *“effect of uncertainty on objective”*⁵⁸.

Our proposed dashboard is BSC based, in each perspective (4) there are several CSF: Critical Successful factors.

⁵⁷ (International Organisation for Standardization ISO 2003, 2)

⁵⁸ (International Organisation for Standardization ISO 2009, 1)

Perspective	CSF	Objective
Financial	Profitability	Increase the profitability margin
	Investments	Invest in the human capital and business development
Customers	Customer satisfaction	Set a qualitative and quantitative methods to assess customers satisfaction
	Portfolio	Diversity of portfolio and needed resources to satisfy its needs
Internal Business Process	HR	Training, administration.
	IT	IT data base, knowledge management
	R&D	Improve the organization, develop new services, tools and methods
Learning and growth	Value and culture	Keep insight the values and culture
	TQM	An approach to reach out for excellence

Table 27: action plan elements:

Colons	description
project	Includes the name of the project
Project champion	The person who is in charge of the entire project
Activity level 1	
Activity level 2	Work break structure of the project
Activity level 3	
Priority	Priority of the lowest activity level, varies from: lows, moderate, high and critical.
Deadline	The deadline of the lowest activity level
Responsible support	The main responsible of the lowest activity level
Key Performance Indicators	KPIs of the respective activities
hypothesis	Includes what the activity depends on to be realized. For example: project will be started if budget secured.
What might go wrong (WMGW)	Risks of deviation from objective or occurrence of unexpected concerns that would jeopardize the project success.

Conclusion

In a competitive environment, quality management plays a strategic role to improve the capacity of an organization to meet its customers' requirements. Total Quality Management takes this to another level; its methods and tools foster an organization to go beyond simple requirements satisfactions, it goes to reach out for continuous improvement and strive for excellence at all levels and dimensions of an organization.

At first our work discussed total quality management implementation, where we presented tools and methods pertaining to TQM, we were able to answer to part of our problem statement: the implementation of TQM needs not only commitment but the belief, as it is a heavy approach that shapes up daily acts into habits. In addition, the operational data available enable measurement of quality variables and extent of meeting these requirements.

In addition, a successful implementation of TQM relies on the relevancy of the tools and methods adopted. We gave a specific focus to Six Sigma, and we presented the steps of its methodology and showed the benefits it can bring to reducing the number of anomalies in the quality of audit engagements and therefore increase the conformity rate and customer satisfaction. This is mutually done by a review and improvement of its process by taking down unnecessary tasks to optimize the process. We can relate to efficiency by the fact that one of the objectives of TQM is to reduce waste in resource and defects.

A proper efficiency measurement requires an empiric method; in our work we have used Data Envelopment Analysis, which is a non-parametric study, on the auditing process. We have taken as a sample 30 Audit Engagements (AE) to measure their efficiency under the two models: CCR, which based on Constant Return to Scale, and BCC, which is based on variable return to scale.

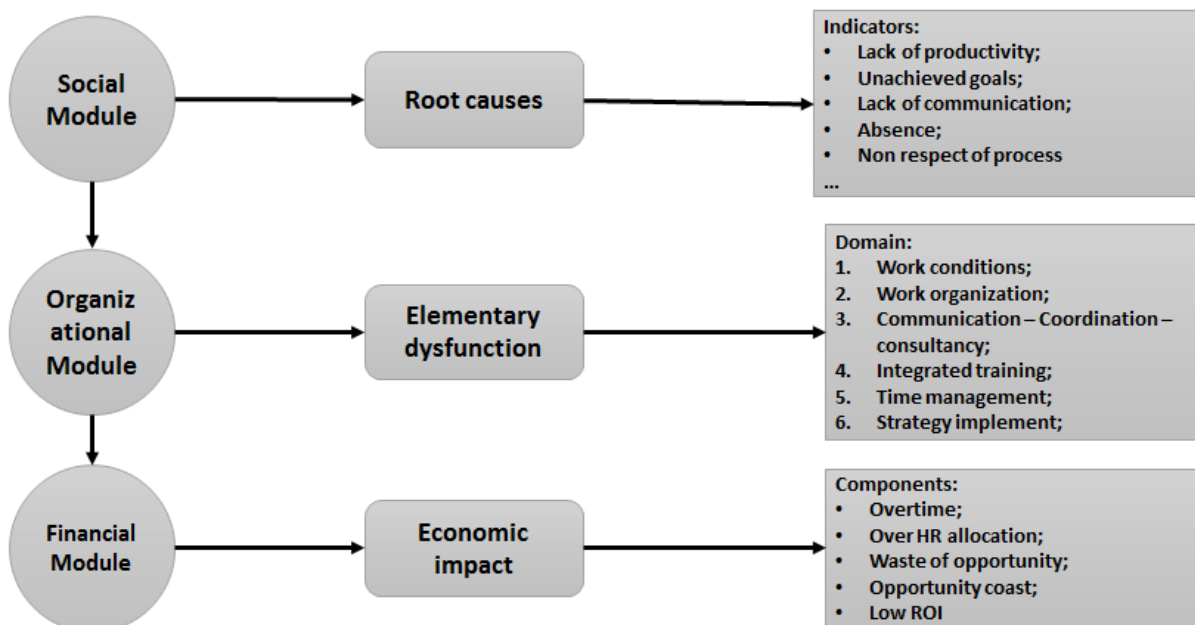
We identified several AE that their efficiency significantly improved when adding more discretionary and non-discretionary inputs. That led us to conclude that some AEs suffered from a unfavorable environment due to the lack of client cooperation. In addition, the DEA identified sources of inefficiency and quantified them. These sources of inefficiency represent the improvement topics with the highest priority to tackle by TQM approach.

This allows us to respond to the 2nd sub-question stated in our introduction: the DEA is a reliable method to objectively measure efficiency and inefficiencies under divers contexts represents by divers models.

At last but not at least, we proposed a procedure to conceive a dashboard based on BSC approach with a set of CSF and KPIs. The dashboard aims to drive performance and efficiency with an orientation to quality management. Through this part of work we found it that the BSC is adapted for a TQM approach, as the BSC perceives an organization from different perspectives and tries to balance them to feed the decision-making process with information from different perspective. The TQM tackles the organization from different aspects and corners as it seeks to reach out to excellence in all levels, department and dimensions of an organization.

To close our work, we find it suitable to propose the use of an socio-economic analysis as a basis for the TQM implementation and efficiency improvement. This analysis enables us to identify hidden dysfunctions that are the sources of low efficiency and low conformity with quality standards. It is a multi-dimensional analysis as illustrated below

Figure 38: Socio-Economic Analysis



Source: (ISEOR s.d.)

Such analysis will insure that the TQM approach tackles the root causes of dysfunctions and not the symptoms. It is a way to diagnose the organization at different levels to set prioritize for urgent actions.

Our work had some limitations due to the data available in such short period. Further studies on a similar subject might measure efficiency between different auditing and advisory firms, and run implementation simulations on the TQM methods and tools to evaluate to which extent these methods and ools are actually improving quality.

Further analysis are expected to take up at KPMG taking as input this work in order to measure the internal efficiency using a wider range of data and models. And proposals to implement TQM methods and tools for “quick-wins” at a first stage before undertaking heavy approaches such as lean six sigma.

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