Organisational benefits using explicit project management tools, techniques and knowledge

By

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TABLE OF CONTENT

ABSTRACT

Project Management Tools and Techniques are key element in project management. Several tools are available to support the different stages of a project life cycle. This report presents a study designed to identify not only the most widely used tools and techniques in Construction & Engineering (C&E) and Information Technology (IT) sector of UK industry, but also the tools and techniques that improve project management performance. The study is based on a questionnaire distributed to a sample of experienced project managers from the C&E and IT industry. The data were analysed in order to show which project management tools and techniques are more frequently applied among those two industries, what their impact of implementing them in project organisation and the extent to which organisations categorize their project in order to apply common tools to each category and consequently succeed in improving organisational performance. The study presents the priorities project management professionals need to identify and select nowadays, for future developments. While selecting priorities for development and implementation, professionals need to address which tools, techniques or processes need to be followed for successful project delivery and further on for improving organisational performance.

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Key Words: Project Management Tools and Techniques, Bodies of Knowledge, Project Success, Organisational Performance, Project Categorization

INTRODUCTION

1.0 Introduction

The present paper is based on a small–scale survey of 12 experienced project management practitioners in UK. The focus is on examining the organisational benefits of using different project management tools and techniques. An essential aspect of project management practice is presented, which is the use of tools and techniques that are specific either to the C&E industry or to IT sector. Using the right means in achieving "best practice" can result in improving the performance of the practice, because "best practice" is partly a function of using the appropriate tools and techniques.

Meanwhile, there are many corporations that have categorized their projects in different groups (e.g. type of project, size, etc) in order to standardize the processes and to apply specific project management tools and techniques to each group (Tatikonda and Rosenthal, 2000). Through the research on new product development projects at the execution stage of project life cycle, Tatikonda and Rosenthal (2000) argue that the majority of organisations try to find ways to standardize flexibility and stability of new product development projects. Moreover, many organisations apply similar project management tools, techniques and processes in order to manage a variety of projects. For instance, the management of the majority of projects at the control stage of the project life cycle in a corporation is usually being accomplished by two explicit techniques – Network Scheduling and Gantt Charts – which both are commonly referred to as Control Techniques.

However, the question arisen here is whether the use of those "common" and "popular" project management tools and techniques is so effective and efficient that the organisation meets its initial directives and the project outcome is in its highest level of success; otherwise, it would be better for a company life cycle to adopt different Project Management Tools and Techniques in managing different projects, according to the benefits each tool and technique provides on a project and organisational level.

Considering the literature, one can identify some of the guidelines and methodologies available today, which standardize the program and project management processes and facilitates managers to achieve those objectives that have been stated in the initial phase of the project. Even though the project management professional associations have created Body of Knowledge for standardizing the processes and procedures, an argument has been launched concerning the overall efficiency of the Body of Knowledge application, however their use is undoubtedly growing (Pons, 2008).

Furthermore, any project management process needs tools in order to be applied. The implementation of analysis, planning, control or any management tool or technique requires a certain investment, which sometimes might be very vital for the development of the corporation. Often cost corresponds to the investment needed (in both personal and organisational base) on terms of learning how to use new tools or techniques, understanding their effectiveness and maintaining the appropriate infrastructure, such as technicians, databases, computing aids, etc. Therefore it is highly important to know: **which tool or technique can provide the greatest benefits to individual and company level?**

This dissertation presents the results of a study created to answer the above question. The research consists of surveying a small sample of project managers (active in C&E and IT sectors of UK) in order to identify the most widely used tools and techniques, which of them are combined with the most effective and efficient project management and what are the benefits expected and gained by the contribution of the Project Management Tools and Techniques on individual and organisational level. The following sections indicate:

- **Theoretical Context** – specific concepts are defined, for the reader to have a holistic view of the under investigation subject,
- **Historical Data** – important project management tools and techniques are identified, discussed and located in space and time,
- **Literature Review** – several authors who have done a remarkable work on this field, are being presented,
- **Methodology** which includes:
    - **Method Selection** – Quantitative method (questionnaires for further mainly contextual data),
    - **Design of Questionnaires** – why and how the questionnaire of the research was created,
    - **Procedure and Analysis** – description of the procedure followed to analyse the findings,
- **Findings and analysis of information** – analysis of the findings of the research and discussion of each finding according to the hypothesis,
- **Conclusion** – results and a further discussion about the findings are presented.

THEORETICAL CONTEXT

2.0 Theoretical Context

In order to stet with the research, it would be useful to define the meaning of tools and techniques in a project life cycle and their importance for the organisation. In general, according to Besner and Hobbs (2008) tools and techniques are considered as those implements that "...project management practitioners use to "do the job" to "execute a process".

Project Management Tools are those means that help managers and the team members successfully plan, manage and execute the different tasks involved in each project. Due to the fact that there is a wide range of tools, it is difficult to select the right one for a specific project. It is essential to know that different tools are needed or are used in different stages of a project life cycle. The most widely known groups of project management tools are Gantt, charters, plans and ways to save time.

According to Morris and Pinto (2004), the different stages in project (or in genera in product) life-cycle is a sequence that needs to be followed in order to deliver a successful project. This sequence is briefly discussed below:

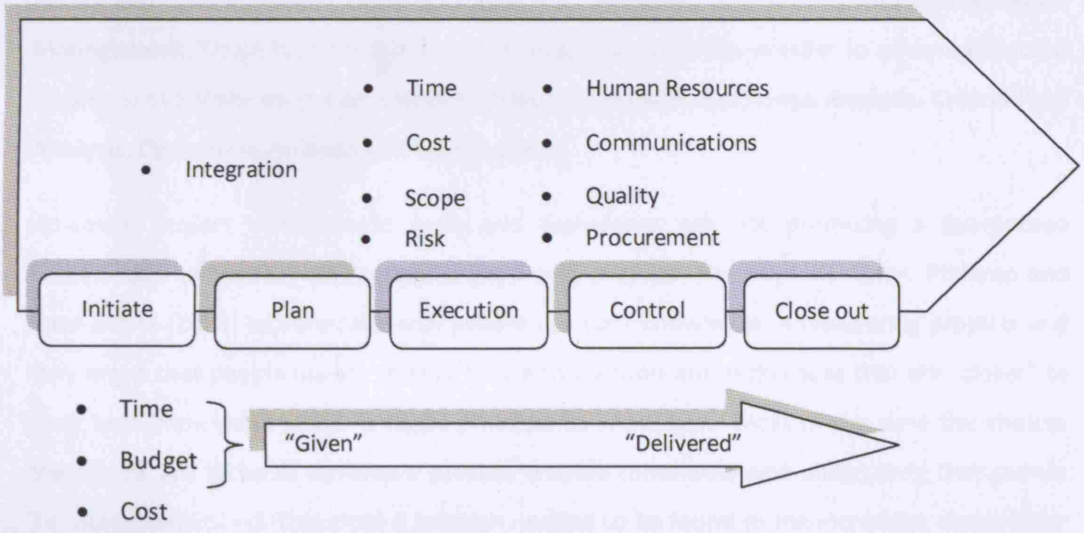

Figure 1: Project Phases (**source:** Morris and Pinto, 2004)

For the purpose of this research, both product and project life-cycle are going to be used as "maps" to lay on the project management tools and techniques. For example, there are some tools that are needed during **all the stages of a project life cycle**, such as **Milestones**

Reviews and **Business Plans**. However, there are some others that are useful only during specific project phase, such as the tools that are essential to be used during the **initiation phase**, which could be **Project Charter, Project Framework** (or **Overview**) or **Business Case Justification**. During the **Execution and Control phase, Risk Analysis** and **Score Cards** are important to be applied. However, on the **stage of Closure**, there are no specific tools needed.

Although the stages of the project should be treated equally, in practice, the front-end of the project usually does not receive the same attention as the rest phases (especially like the planning and execution phase). Morris (1998) argued that "the decisions made at the early definition stages set the strategic framework within which the project will subsequently develop. Get it wrong here, and the project will be wrong for a long time". Thus the role of the initiative stage is as important as the rests' in managing project.

Project Management Techniques describe how information is gathered, how the communication is taken care of and how things gets done in the most efficient and effective way. In general project management techniques enclose communication issues, complexity management, life-cycle planning and estimation fro planning. According to APMBOK (2006), techniques include **Requirements Management, Development Management, Estimating, Technology Management, Value Management, Modeling and Testing and Configuration Management**. Those techniques are used to organize resources in order to achieve expected results. Some of the most well known techniques are **Business Change Analysis, Critical Path Analysis, Cycle Time Analysis and Gap Analysis**.

However, project management tools and techniques are not promising a guaranteed success, due to the fact that people engage with projects. However, Koskinen, Pihlanto and Vanharanta (2003) explored the way people use tacit knowledge in integrating projects and they argue that people usually choose to use those tools and techniques that are "closer" to their tacit knowledge which is equal practical to know-how. Most of the time the choices individuals are taken to develop a project, creates complexity and uncertainty that cannot be utterly controlled. Therefore a solution needed to be found to the increasing demand for solutions to project management problems, which led to the creation of **Bodies of Knowledge (BoKs)** that sums up the most important topic areas of project management that people should be knowledgeable in and are being analysed later on this chapter.

At this point it would be essential to briefly define the meaning of **project success**, due to the fact that this research deals with an extensive discussion of the usefulness of project management tools and techniques that deliver successful projects. Therefore explaining what is meant by "project success" will avoid further misinterpretations and misunderstandings of the concept. Baker, Murphy, Fisher and De Wit (Morris and Pinto, 2004) have concluded in a definition of "project success" that embodies factors of both project management success (satisfaction of people on teams, technical performance specifications, etc) and project success (satisfaction in parent and client organisations, technical performance specifications, etc) by stating that "if a project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among the key people in the parent organisation, key people in the client organisation, key people in the project team and key users or clientele of the project effort, the project is considered an overall success". By adopting the definition of success Baker, Murphy and Fisher concluded that ten factors are related to success and failure of a project. Those are **goal commitment of project team, accurate initial cost estimation, adequate project team capabilities, adequate funding to completion, adequate planning and control techniques, minimal start-up difficulties, task (vs. social) orientation, absence of bureaucracy, on-site project management and clearly established success criteria.** Pinto and Slevin (1988 a, b) did a research that concluded in ten factors that influence project success. Those factors are based more in project phases (conceptualization, planning, execution and termination) than in outcome criteria of the projects (budget, schedule, performance, client satisfaction). Those factors are **project mission, top management support, project schedule/plans, client consultation, personnel, technical tasks, client acceptance, monitor and feedback, communication and troubleshooting.** Moreover, Pinto and Slevin (1988a) suggests a Model of Project Success for measuring success that includes two major components; factors that deals with the project (time, cost, performance) and with the client (use, satisfaction and effectiveness).

The project management tools and techniques stated below have been retrieved from three project management guides. Those models are *A Guide to the Project Management Body of Knowledge* (PMBOK Guide) (PMI, 2004), The Association of Project Management Body of Knowledge (APMBOK, 2006) and the OGC Guide for Managing Successful Projects. A short discussion of the three bodies of knowledge (referred above) will take place later on this chapter, in order to identify the knowledge they present and their usefulness in supporting

project management teams and providing them tools, techniques, processes, methods and procedures, to cope with projects successfully.

According to the content of *A Guide to the Project Management Body of Knowledge* (PMBOK Guide) (PMI, 2004) there is a wide range of project management tools and techniques that are being used to deliver successfully a project. Besner and Hobbs (2008) have created a list of 70 project management tools and techniques (cited in **Appendix A**) which will be used for the further research of this dissertation. Therefore, the following table (Table 1) has been modified in terms of having each project management tools and techniques of Besner's and Hobbs's list allocated into main "stages"- phases of project management. Although there are some T&T that are overlapping the stages or being used during the Life Cycle of the project, they have been placed according to their main most common and popular function; for example, PERT Analysis is being used in almost all phases of project, but its main use is to control time. Furthermore, on the left column of the Table 1 a ranking is stated according to the ranking of the main list of project management tools and techniques which is presented in Appendix A.

	Project Management Tools and Techniques divided in project stages	**List's no.**
Scope and Requirements Definition (Initiate)		
	Statement of Work	**63**
	Scope Statement	**60**
	Requirements Analysis	**57**
	Project Charter	**49**
	Cost / Benefit Analysis	**14**
	Stakeholders Analysis	**62**
Contract Award (Initiate)		
	Bid Documents	**3**
	Bidders Conferences	**5**
	Bid / Seller Evaluation	**4**
Organizing (Plan and Execute)		
	Communication Plans (execute)	**10**
	Project Communication Room (War Room) (execute)	**50**
	Project Web Site (plan and execute)	**51**
	Kick – off Meeting (plan and execute)	**29**
	Responsibility assignment matrix (plan)	**58**
	Self Directed Work Teams (execute)	**61**
	Team Building Event (execute)	**64**

	Decision Tree (plan)	23
	Work Breakdown Structure (plan)	70
Planning and control		
	Metrics (Plan)	
	Financial Measurement Tools	26
	Estimating Cost (Plan)	
	Database of Cost Estimation	18
	Top – down Estimating	66
	Parametric Estimating	36
	PM Software for Cost Estimating	38
	Bottom – up Estimating	6
	Life Cycle Cost "LCC"	32
	Planning (Plan)	
	Activity List	1
	Feasibility Study	25
	Quality Plan	54
	Pareto Diagram (Quality Management)	37
	Baseline Plan	2
	Milestone Planning	33
	PM Software for Task Scheduling	45
	PM Software for Resources Scheduling	43
	PM Software for Resources Levering	42
	PM software for Multi-project Scheduling / Levering	41
	Critical Path Method & Analysis	16
	Critical Chain Method & Analysis	15
	Product Breakdown Structure	47
	Network Diagram (Time Management)	35
	Control (Monitor and Control)	
	Progress Report	48
	Client Acceptance Form	9
	Change Request	8
	Configuration Review	11
	PM Software for Monitoring of Schedule	40
	PM Software for Monitoring of Cost	39
	Earned Value	24
	Trend Chart or S – Curve	67
	Quality Inspection	53
	Control Charts	13
	Work Authorization	69

	Re-base lining	**56**
	Probabilistic Duration Estimate (PERT Analysis)	**46**
	Gantt Chart	**27**
Design (Plan)		
	Quality Function Deployment	**52**
	Value Analysis	**68**
Risk (Plan and Monitor)		
	Risk Management Documents	**59**
	Graphic Presentation of Risk Information	**28**
	Contingency Plans	**12**
	Ranking Risk	**55**
	Monte – Carlo analysis	**34**
	Cause and Effect Diagram (for Quality Management)	**7**
	PM Software for Simulation	**44**
Evaluation (Close Out)		
	Team Member Performance Appraisal	**65**
	Lesson Learned / Post-mortem	**31**
	Learning Curve	**30**
	Client Satisfaction Survey	**17**
Databases (Close Out)		
	Database of Historical Data	**19**
	Database of Lesson Learned	**20**
	Database of Risk	**21**
	Database or Spreadsheet of Contractual Commitment Data	**22**

Table 1, source: The allocation of Project Management Tools and Techniques was made according to Lester (2005)

However, in order to cope with the set of explicit project management tools and techniques, it is important to make a short identification to the primary purpose of having guides, such as PMBOK Guide, APMBOK and OGC.

The **Guide to the Project Management Body of Knowledge** (PMBOK Guide) was first issued by the Project Management Institute (PMI) in 1981; in an attempt gather the sum of knowledge within the profession of project management. PMBOK Guide is an internationally standard (IEEE Std 1490-2003) that presents the principals of project management that can be applied to a wide range of projects of different sectors, such as construction, software, engineering etc. It describes work as being accomplished by processes, which includes the **Inputs** (documents, plans, designs, etc), the **Tools and Techniques** (mechanisms applied to

inputs) and **Outputs** (documents, products, etc) (PMI, 2008). PMBOK Guide introduces an extensive set of project management tools and techniques which are, in most situations, applicable and valuable to many different kinds of projects. Although PMBOK Guide suggests that each project needs to be developed with the contribution of specific tools and techniques, it does not suggest which are those tools and techniques that would be more accurate and effective for the successful accomplishment of each project.

According to PMBOK Guide, there are 44 processes that have been recognized which have been allocated in five process groups (**initiating, planning, executing, controlling and monitoring,** and **closing**) and nine knowledge areas (**Project Integration Management, Project Scope Management, Project Time Management, Project Quality Management, Project Human Resources Management, Project Communication Management, Project Risk Management and Project Procurement Management**) that can cover almost all projects. Each process that is being followed in a discipline for creating an effective project management program is being related to one of the nine knowledge areas and one process group. Therefore, PMBOK is offering a general guidance to manage the majority of projects (PMI, 2008).

On the other hand, **The Association of Project Management Body of Knowledge** (APM, 2006) was first published in 1992. It comprises a mean that tries to transmit the knowledge and not to introduce methods, practices or processes of project management to each discipline of managing projects. It actually suggests a strategic approach to the management of projects (APM, 2006). The APMBOK refers to seven sectors (**Project Management in Context, Planning the Strategy, Executing the Strategy, Techniques, Business and Commercial, Organisation and Governance and People and the Profession**) that are not fixed in terms of their structure, format or sequence, however they are logical and clear (APMBOK, 2006).

Additionally, the **Office of Government and Commerce: Guide for Managing Successful Programs** (OGC, 2003) identifies Program Management as a way to apply organisational strategies and to deal with change either in a group of organisations, either in one single organisation or in a specific part/s of it. OGC introduces Program Management and supports it by providing guidelines in order to transmit the knowledge to the organisation. Moreover, it acts as a sponsor of "best practice" in **Project Management, Program Management, Risk Management and Service Management**. The main focus of the guide is: accountability, leadership and organisation on corporate structure, change control, benefit management

(from the initiative phase until the closure), stakeholders' management, risk management, program planning and control, business case management and quality management.

The most important argument against the Body of Knowledge approach is that there is no single way of coping with every project, which means that there are different ways of approaching each project and no single methodology that fits and works in every project. Consequently, every project needs explicit project management tools and techniques to be applied in order to get the appropriate outcome of this procedure. For instance, more complex projects need different treatment than the less complex projects. Therefore, complex projects need to be defined in terms of complexity, in order to be analysed and further developed (Williams, 1999).

HISTORICAL REVIEW

3.0 Historical Review

In order to proceed with the research, it is important to review the literature related to project management tools and techniques and then compare it to the results of the survey. However, before proceeding to the literature review and the findings of the survey, it's important to make a short reference to when, where and why the most important project management tools, techniques, processes and disciplines did appear. The historical review is presenting those tools and techniques that have been created in the past and are still being used today in their initial or advanced form. The historical exploration will provide important information as to where project management practice focused through the years, which will provide support to the finding of the research.

According to Morris (1994) management of projects "unofficially" existed since the building of large ancient structure such as the Babel Tower or the Pyramids, due to the fact that those were large-scale complex project that interfered thousands of people who needed to be coordinated in order to complete the structures. However, in the early 20th century (between 1930's and 1950's), the first theories of project management appeared. Those theories such as Weber's (on bureaucracy) or Taylor's (on scientific management) (Walker, 2007) were introducing simple rules of administration and organisation, which are still used in modern project management (Morris, 1994).

Modern project management was developed within different sectors and industries such as construction, engineering and defense. The pioneer of introducing planning and control techniques in management of projects was Henry Gantt in the USA after the end of the First World War. Therefore, the need to develop more scientific methods in managing more complex project such as the led to the creation of **Gantt Charts** as a project management tool. Gantt Charts regarded as one of the most commonly used tools in modern project management and a forerunner to many project management tools and techniques that are being used today, including the Work Breakdown Structure (WBS) and Resource Allocation.

Until the 50's projects were managed by using only Gantt Charts and informal techniques and tools. However, at the same time another two very important network scheduling systems we re created. The first one is the **Program Evaluation and Review Technique (PERT)** by the US Navy's Special Projects Office (SPO) as a part of Polaris missile submarine program in 1958. The second tool named **Critical Path Method (CPM)** was created by Du Pont de Nemours in 1959. PERT was initially designed to simplify the planning and

scheduling of large and complex projects; its main advantage is the creation of a schedule of a project by embodying uncertainty of the precise durations of all activities need to be done. On the other hand, Du Pont was researching a pattern in achieving the best balance between cost and time in C&E projects. Nowadays, the CPM is commonly used in all kinds of project that involves interdependence activities (Lester, 2005). CPM is very similar to PERT nevertheless the last did not include cost estimations, not until 1962 when **PERT/Cost** was developed. Both techniques were quickly introduced and used by private corporations.

Due to the fact that PERT was a technique unable to combine cost estimations with schedule control processes, the Navy in association with Lockheed, General Electric, the Mitre Corporation, Stanford University and other contractors started to create tools that could conclude in this result. It was realized that it is difficult to have cost estimations on a network activity tool, such as PERT, thus they turned into relating costs with the **Work Breakdown Structure (WBS)**. The WBS was developed at the same period as PERT in the US Department of Defense (DoD). It's a technique that defines and organizes the total scope of a project, without it, it was difficult to have a clear view of the total scope of the project and to organize its various data. WBS is fundamental to **project control** (Morris, 2004). The result of Navy's research was a new tool named **PERT/Cost System Design** and it was first introduced by the *DoD and NASA Guide* in 1962. Nowadays, PERT/Cost System Design is perceived as a common fundamental tool in project management and systems engineering. Other important procedures that established in mid 70's, to provide cost estimating and analysis support are **Design-To-Cost (DTC)** and **Life-Cycle Costing (LCC)**.

Nevertheless, *DoD and NASA Guide* did not only introduced PERT/Cost System Design tool, but also **Milestone Events**, which is a technique that can add considerable value to project scheduling. The use of Milestone combined with PERT or CPM could conclude in more accurate data on whether or not the project is on schedule. Even though this tool is commonly used in monitoring processes, its effectiveness is limited due to the fact that it shows progress only in critical paths; therefore the non critical path activities are not shown consequently the project might seem to be on schedule when actually the non path critical activities have been ignored (Morris, 1994). However, its use was actually misinterpreted by government and industry which produced incorrect outcomes due the fact that organisations were using the tool in a detailed level and not in a more generic or conceptual one. Thus, in 1963 **Earned Value Analysis (EVA)** was adopted, designed by Brigadier General Philips. This tool was created in the context of Minuteman Contractor Performance

Measurement System program and measures the progress of the project in a more holistic way. Furthermore, if EVA is implemented correctly, then it can provide an early notice in performance problems of the project.

Additional, in the 1950s US DoD developed a new technical management discipline for managing information, supporting the control of the design, manufacture and project (Kidd, 2004). **Configuration Management (CM)** focuses on establishing and maintaining consistency of a product's performance and its functional and physical attributes with its requirements, design, and operational information throughout its life; it covers all the stages of project life-cycle, from initiation to close out. Kidd (2004) states that "as a value added activity, Configuration Management is, almost invariably, rated as less significant than, for example, quality management or project management. The irony is that neither of these activities is possible without an effective configuration management process. Quality management, for example, requires us to know when configuration meets stated requirements". Kidd further cites that having the right information, in the right time, on the right format is highly beneficial in terms of assisting on the decision making process of managing projects.

During 1965 a new project management technique was developed by Phillips to be used on Apollo project. The **Program Development Plan** is a very efficient tool since it embodies practices for managing changes, organizing the program and meeting the projects requirements, such as **Sections for Specifying Procedures, Procurement, Data Management, Configuration Management, Logistics, Facilities, Funds and Manpower** and **System Engineering**. Program Development Plan consist a basic technique of modern project management (Morris, 1994).

In 1969 a **Program Management System (PMS)** was established – which embedded main project management techniques that are considered today as standard – in order to develop projects within budget and on schedule. The PMS was installed for UK and European Defense/Aerospace developments and includes **WBS, Program Control Centre, Configuration Management, Systems Specification Tree, Data Management System and Cost and Schedule Control System Criteria (C/SCSC).**

Additionally, at the late 60's the **Project Management Institutes (PMI)** was founded. It's an Association that provides information about every aspect of project management. In 1981, PMI Board of Directors published the PMBOK Guide that contains standards and guidelines

of practice and a wide range of tools and techniques that had been developed and are being implemented in projects today.

Although the interest showed on tools and techniques and on practical problems of organizing and running teams continued at a higher level as the 1960s and 1970s, a major dimension began to emerge, which continued to compromise the accomplishment of project on time, in budget and to technical specification, namely community and environmental opposition. Some major projects were already experienced difficulties with community opposition in the late 60's, but the problem did not heightened not until the 1970s.

Consequently, during the 70's concerns arose for poor project performance. Series of mistakes and technical errors occurred in several projects of different industries – which are acceptable due to the fact that all projects experience faults – however they couldn't be tolerant (Morris, 2004). Therefore poor quality of technical performance led to the practice of **Quality Assurance (QA)** in the industry. Due to the new US guidelines for quality assurance – which was published at 10 CFR 50 Appendix B in July 1970 – one had to document each process that had been followed in project development, in order to show that quality had been achieved. Nevertheless, Quality Assurance as a discipline was essential for the early engineering management disciplines of **Configuration Management, Value Engineering** and become a forerunner for **Total Quality Management (TQM)** approach.

Moreover, **Information Technology (IT)** which embodies both telecommunications and information systems was identified during 1980s as an essential technique for organisational effectiveness. Morris (1994) cites that IT projects offered great research and development (R&D) and product development challenges and were highly related to competitive advantage of the corporations they were established. Although appropriate implementation of IT could conduct in major organisational benefits, project were often over budget or late in time, due to the fact that people did not use project management tools and techniques properly. At the end of 1970s a respectable effort was made to improve softer engineering and management. Thus system integration companies created system development procedures that utilized many project management tools. **Computer-aid Software Engineering (CASE)** tools were added to control and modify the development projects. In mid 1980 in UK more software were created for system development such as **Project in Controlled Environments (PRINCE)** that was identified as one of the most important method for covering the management, control and organisation of projects nowadays. **PRINCE2** has derived from **PRINCE**, which was initially developed in 1989 by the Central Computer and

Telecommunications Agency (CCTA) as a UK Government standard for information systems (IT) project management, however, it soon became regularly applied outside the purely IT environment.

In the beginning of 1980s, the need for a system to manage paper-based documents was essential. **Documentation Management (DM)** was developed and constituted a main system to effective Design Scheduling and Configuration Management. CAD-data tools were affected in a way that huge amounts of data were stored for a wide range of "product attributes" on projects, such as cost data, supplier information, physical characteristics, etc. By the 1990s most information about projects were kept in object-orientated database rather than in the traditional drawing-based file formats (Morris, 1994).

Moreover, **Knowledge Management (KM)**, a highly effective discipline which established in the mid-1990s, comprises a wide range of practices used by corporations for identifying, creating, representing, distributing and enabling adoptions of "what" the organisation knows and "how" it knows it. Knowledge Management programs are associated intimately with organisational objectives such as improved performance, competitive advantage, innovation, developmental processes, lessons learnt transfer (for example between projects) and the general development of collaborative practices. In general, it is related to learning organisation, lifelong learning and continues improvement (Stankosky, 2005).

To conclude, in the late 1990s Eliyahu M. Goldratt (1997) introduced a new method of planning and managing projects, that puts more emphasis on resources required to execute projects. **Critical Chain Project Management (CCPM)** conflicts to the traditional methods of CPM and PERT, due to the fact that it delivers projects faster and cheaper. It affects the planning, execution and monitoring phase of projects development cycle, where the latter is the CCPM's greatest advantage.

LITERATURE REVIEW

4.0 Literature Review

The present report intends to contribute to the study of the usefulness of project management tools and techniques which can conclude in the value of project management practice in general. Besner (2006) argues that successful projects improve the value of the corporation, additionally project management practices provide corporations with a strategic asset. When good project management practice is implemented and the choice of tools and techniques, which are being used in the undertaken projects, are appropriate, then value is created. This is a reason why managers are able to improve organisational performance and deliver projects successfully in terms of cost, time, quality, progress, satisfaction, and so forth.

The relevant literature is referred to several authors, such as Loo (2002), Wirth (1992), Crawford, Hobbs and Turner (2006), Milosevic and Patanakul (2005), Besner (2006), Payne and Turner (1999), Raz and Michael (1999), White and Furtune (2002) and Besner and Hobbs (2008), that have been analyzing different kinds of project, researching on the value of project management practice, the use and scope of project management tools and techniques and the importance of having different categories, at organisational level, of projects in order to manage them more efficient and effective.

Loo (2002) cites that there are three important areas that one can improve in order to have better project management practice in organisational base. The author suggests that those areas are: implement standard project management practices, improve scope management and the need for more managers and staff training. Some themes emerge from the last comment, which are the need for project management training and education, particularly training in planning tools, such as the need for project documentation and the sharing of project tools and techniques; the need to better manage resources; the need to promote effective communications and trust among all stakeholders and the need to improve interpersonal skills comprise an essential "guideline" for improving organisational performance and deliver project successfully.

Wirth (1992) has done an extensive research in various project management practices in different sectors, cites that project management content embody three components; core, tools and applications. The first two are generic, thus can be applied in a vast number of sectors, however applications depends on the type of industry the project is included. In particular, the core of project management includes aspects of knowhow that can be drawn

from Bodies of Knowledge – specifically PMBOK Guide, and be applied in every single type of project without any modification, even though PMBOK Guide does underline that in many projects adjustment is essential. Furthermore, Wirth suggests that tools are indispensible elements in the process of project management; still generic group as the core, however their function is necessarily in predicting, monitoring and controlling project's performance. The tools he refers to as the most important to the evolution of the project are **PERT, CPM,** the **Matrix Organisation** and the **Project Lifecycle Curve**. Contrary, applications of project management processes depends on the types of industry (as referred earlier) which are distinguished in two main categories: the product (e.g. construction, software, aerospace, etc) and the technology and production method (e.g. capital / labor intensiveness, size, etc), therefore according to the category the project belong, . Moreover, Wirth reports that Technical Management, which includes tools, techniques and processes, is essential for managing projects and has to be applied by specialized support staff. Therefore it is more programmable than any other kind of project management and it does not require grate investment of time by the project managers.

Crawford, Hobbs and Turner (2006) report that corporations need to allocate projects in different categories in order to apply the appropriate project management tools and techniques in different types of projects. The authors argue that having the right categories on projects can cause better function of the corporation at organisational level and improve its competence in the market. There are several benefits at organisational level while having the appropriate allocation of project in groups. The most important aspect of this distribution is that in each group explicit project management tools, techniques, methods and processes will need to be applied according to the group's specific requirements; which ensure employees to have better communication between them, to involve easier with projects of the same group because there will be no need in learning new processes in dealing with the projects and finally, to have a faster, more effective and efficient reaction on similar projects since they can develop databases on lesson learned and therefore manage knowledge better and increase the probability of success. In addition, an organisation that applies specific project management tools and techniques in each group of similar projects can create the appropriate competences to undertake more projects or to attach competencies to already undertaken projects in order to deliver them successfully and to claim grater market share.

Milosevic and Patanakul (2005) argue that nowadays companies tend to adopt a standardized project management (SPM) method in managing projects due to the fact that standardization can cause improvement in project performance. Standardization of projects became an important aspect of corporations nowadays because it is connected with project success. The Project Management Institute (PMI) published a new standard, the **Organisational Project Management Maturity Model (OPM3)**, which propose SPM to be a great strategy for managing development projects. Furthermore, the authors cite that project management tools and techniques can be adopted and be supported by an organisation however; the selection of those tools and techniques must be carefully chosen in order to avoid project failure. Despite the fact that SPM can result in project success, a contingency theory is needed, because it is highly essential to have the appropriate flexibility in SPM that can be adjusted and fitted in any strategy and any organisation.

Payne and Turner (1999) state that employees in corporations that undertake a portfolio of projects should use a common procedure in managing projects in the program regardless their type, size or resource used. Indeed people are operating more freely between projects without having to develop or adopt new techniques or procedures; however the research showed that they feel more comfortable and more productive when they adjust the procedures and techniques to each project separately. Using similar techniques and tools can be really effective when the projects within the program are homogeneous. Program Management is getting more complex when projects within it are inhomogeneous (such as projects in different size, type, etc). The authors suggest that each corporation should introduce a flexible strategic plan (divided in three stages: **integrative**, **Strategic** and **tactical**) based on common procedures, which is valid for every project; nevertheless it should give the freedom of altering the processes and adjusting them to different types of projects. For instance, on **Integrative** stage, the creation of a **Project Definition Report (PDR)** should be developed and applied in all projects on a common base. Therefore all projects will be defined in a common ground which allows comparison (in any level) to be made between them. On the **Strategic** stage, by applying **Milestone Plan** and **Project Responsibility Chart** the corporation will be able to make comparisons between the progresses of projects and would have a definite view of responsibility allocation. Finally on **Tactical stage**, employees should adopt control and planning methods according to the project they work on. Hence, the benefits of managing either homogeneous or inhomogeneous projects will obtain in any case.

Besner (2006) studied the perceived value and the potential contribution of project management pra ctice to project success. The author suggests that one of the paths in examining the value of a project management practice is to concentrate in investigation the tools and techniques extent use. A wide-range research took place in the field of project management that inferred in the most extendedly use of tools and techniques and the potential contribution of project management tools and techniques in project success (especially those tools and techniques that can result better performance with better use of tools and techniques). Besner (2006) suggests that tools relevant to organisational learning are the most useful in increasing project performance. Additionally, the author cites that in order to choose a set of tools to be applied in a specific organisation, an analysis of the current state of the organisation and the characteristics of the specific project being managed needs to be examined. He goes further with his research by distinguishing tools and techniques in two main categories: the value-orientated and those that adds to the value creation. Value orientated tools includes **Value Analysis (VA), Earned Value Management (EVA)** and **Cost/Benefits Analysis (CBA)**. Thereafter, the value-orientated tools are used in order to appraise and minimize the cost, schedule and optimize the performance of the projects and finally to measure organisational value. On the other hand the tools that create value have the ability to contribute to project success.

Raz and Michael (1999) examined the wide use of project management tools and techniques that are being applied in risk management process of the IT sector. According to the Software Engineer Institute and the authors' research, project risk management should divide project process in five main phases (such as identification, analysis, response planning, tracking and control). The survey showed that people do not usually apply tools on the identification phase of risk management, due to the fact that the recommended tools are either not effective or project managers are not able or willing to apply risk control tools because of their heavy work load and limited time. Moreover, project managers believe that using tools in identification phase is unnecessary however using them in analysis, planning, tracking and control, is more effective due to the fact that the later are more complicated issues to risk management. Furthermore, findings of the research shows that using a specific tool in a project management process can result in moving the corporation on a higher level, so that I could be distinguish from the current state of the practices in the field. By adopting the tools and techniques that best performing practices are using, then the organisation can achieve competitive advantage in a market level.

White and Furner (2002) researched several project managers' experience in how they administrate their projects. Project managers were asked to describe a project they were supervising and mention the methods, tools techniques and procedures they used in order to deal with it. Moreover, they were asked to rank the effectiveness of methods, techniques and tools they had used and to detect the drawbacks that they might have came across while dealing with the projects. The authors report that most of the project managers were using only a small number of tools techniques and methods, however they mentioned that **Gantt Charts** and **PM software** were the most commonly used tools. Furthermore, the criteria the responders used in judging whether their projects have been delivered successfully were the same as project management literature supports; those were the completion of projects on budget, on time and within schedule. However, there is one more criterion the project managers identified as important. This was the fit of the project in the organisation and the effects and consequences that the project "causes" at the performance of the organisation. Nevertheless, the responders identified as "unexpected side-effect" of managing their projects was the lack of awareness of the environment. White and Furner (2002) suggest that this may occur due to the fact that the methods, techniques and tools which have been used, were "poor" at modeling the real environment of projects, or that inadequate account was taken for the environment and the boundaries of them.

Besner and Hobbs (2008) did an extended research on the perception of project management practice in terms of using project management tools and techniques. Additionally, the authors investigated the level of support of using project management tools and techniques by organisations. Besner and Hobbs (2008) focused on the variations of practices according to project contexts; they state that many aspects of project management practice are common in the majority of projects of many contexts, however many aspects have significant differences between types of projects or between projects in different context. The finding of this research concluded that traditional tools and techniques are being used by large projects and mature corporations very often, however small projects are usually not treated by projects management tools or techniques. This may be happening due to the fact that the explicit project management tools and techniques, which are introduced by the Bodies of Knowledge, are probably orientated for large, well-defined projects. Therefore, it is essential to either develop new tools and techniques that can correspond to small projects, or adopt and modify the already existing tools and techniques in the needs of small projects. Either ways, project management practice needs to be implied and modified in order to suit better to their specific needs.

Considering the theoretical framework one can identify some methodologies, processed and procedures of managing projects that are applied today. Empirical evidence shows that their effectiveness is in issue due to the fact that not many organisations have adapted methods and processes to deal with projects successfully. The present dissertation addresses the following issues:

- According to the historical review, in 50's and 60's project management tools and techniques developed to solve issues for better planning and control of projects; in 70's major focus on evaluation and performance issues led to the introduction of m ore effective processes, tools and techniques and in 80's and 90's project management practice focused on IT, documentation and knowledge management. Nowadays, that the existence of project management tools and techniques is wide, **where does project management practice focus?**

- Even though bodies of knowledge suggest that each project needs to be treated with explicit tools and techniques, it does not recommend which are those that would be more beneficial for the successful accomplishment of each project. Therefore, this research will try to address **which tools and techniques posse the greatest potentiality for improving performance through better use, at organisational level.**

- Furthermore, many corporations developed a method of categorizing projects either by their type, or size or context, in order to use standardized procedures to each category for delivering successful projects and improve organisational performance. Nowadays, **do organisations use common procedures in categories of projects, or do they adjust the tools and techniques to each project separately according to their needs?**

METHODOLOGY

5.0 Methodology

5.1 Method Selection

In order to capture the experience of project managers of C&E and IT sector, a questionnaire was formed that would, in general, identify:

- the methods, methodologies, tools and techniques in current use in the field of project management of the two sectors
- the level of organisational support on the usage of project management tools and techniques
- the potential contribution of more or better use to project performance and thus success
- the benefits or drawbacks of the methods, tools, techniques and procedures being used

A pilot survey was conducted in modifying the project management tools and techniques list that was retrieved from the late research of Besner and Hobbs (2008). The modified list was distributed followed by a definition list of the chosen project management tools and techniques. The questionnaire was sent out either personal or via e-mail to a small sample of 20 project managers and project architects from the C&E and IT sector in United Kingdom during the July through August 2008.

5.2 Design of Questionnaire

The questionnaire embodies three **main sections,** where each of them includes a number of brief questions to be answered. On the **first section**, a demographical research on the respondents takes place; brief information about the organisational context and project characteristics in each corporation are gathered.

The **second section** of the questionnaire embodies a series of questions designed to investigate the 70 project management tools and techniques that have been chosen for this study. The objective here is to identify those tools and techniques that each organisation uses and which of them are perceived as being the most valuable by the respondents. Each tool and technique that has been checked on being used by the respondents has additionally been ranked on a 1 – 5 point Liker-scale, from high importance to low importance.

The list of project management tools and techniques being used for this research has been selected from a research study of Besner and Hobbs (2008) who are its' creators. Despite the fact that the list is based on a survey of bodies of knowledge, OGC Guide for Managing Successful Projects and other sources, it has been further modified and adjusted to the sample of companies that are under consideration. On the list one can recognize that most of the tools and techniques are project-specific and well known. Moreover, the list includes a mix of general concepts and processes, such as training programs and overall performance measurements; and a variety of very explicit tools, such as project charters. Moreover, the tools and techniques stated on the list have been grouped according to 8 stages of project and product life-cycle (Table 1). A definition catalogue of each tool and technique on the list was provided to the participants under request and can be traced in **Appendix B**. The main source of the catalogue was Max Wideman's Comprehensive Glossary of Project Management Teams (2008) and the PMBOK Guide.

The **third section** of the questionnaire deals with the impact of the project management tools and techniques at organisational base. It includes questions that have to do with the effectiveness and efficiency of the project management tools and techniques an d their contribution to overall project success. In particularly, it's important to know about the differences in tool and techniques usage, between project managers who believe that tools and techniques are essential in developing projects and provide important benefits to organisations, and those who share the exact opposite opinion. Moreover, there are some questions that deals with the needs of each project in each organisation and to which extent can those requirements be achieved by using more extent project management tools and techniques.

5.3 Procedure and Analysis

At the end of the research period 16 out of 20 questionnaires were returned and were able to be used. All of the questions were answered in nearly every case, only 2 responders failed to evaluate and rank the tools and techniques and 2 more failed to identify the beneficial and problematic areas of the organisation they work in.

The responders work on project which's output is different kind of product. Such as:

- C&E organisations (50 %)

- IT sector of C&E organisations (33.3 %)
- IT organisations (16.7 %)

An extensive analysis takes place at the following chapter, where tables have been created, for better understanding of the data and a discussion has been made between the finding of the research and the theoretical framework. Finally a short discussion and comparison between the two industries close down the data analysis.

FINDINGS AND ANALYSIS OF INFORMATION

6.0 Findings and analysis of information

Before proceeding to the data analysis, it would be proper to state that due to the fact that the survey took place in a limited sample of 12 corporations, it would not be accurate to generalize the findings. However, in order to step with the dissertation, the data analysis has been based on the findings of this limited research and the comparison has been made according to the survey on the theoretical framework.

Moreover, some demographical elements are stated below, which aim to contribute in the better and more holistic understanding of the sample taken. Therefore:

- the sample includes organisations, whose activity is worldwide and employ more than 200 people at their practices,
- the organizations' annual turnover fluctuates between £10 and £300 millions,
- the organizations' operation exceed 10 years in both C&E and IT environments,
- the majority of the undertaken projects are large, however, the size of undertaking projects of IT sector rates from small to large and finally
- the organisational philosophy of the sample under consideration is to achieve service and quality, however there is a small percentage of C&E companies that aim to achieve greater share of the market place (33%) and of IT companies that intend to achieve modest grow (33%).

6.1 Level of usage of project management tools and techniques in organisations

On the table stated below (table 2), one can identify a ranking by decreasing level of the most commonly used tools and techniques. Through reviewing the table 2, one can identify that there are lot of tools and techniques that are not used either in C&E or in IT sectors. Indeed, 18 out of 70 tools and techniques are not used at all, despite the fact that their effectiveness is recognized by the bodies of knowledge.

High usage (100% - 70%)	**Medium usage** (69% - 30%)	**Low usage** (29% - 1%)	**No usage** 0%
Progress Report (91%)	Bid / Seller Evaluation (66%)	Requirements Analysis (25%)	Quality Inspection
Feasibility Study (91%)	Bottom – up Estimating (66%)	Statement of Work(25%)	Re-base lining
Financial Measurements (83%)	Client Acceptance Form (58%)	Milestone Planning (25%)	Project Charter

Bid Documents (83%)	PM Software for Monitoring of Schedule (58%)	Team Member Performance Appraisal (25%)	Self Directed Work Teams
Kick-off Meeting (83%)	Earned Value (41%)	PM Software for Resources Scheduling (25%)	Ranking Risk
Cost/Benefit Analysis (83%)	PM Software for Task Scheduling (41%)	Responsibility assignment matrix (25%)	Configuration Review
Scope Statement (83%)	Lesson Learned / Post-mortem (41%)	Communication Plans (16%)	PM Software for Resources Levering
Change Request (75%)	Baseline Plan (33%)	Top – down Estimating (16%)	Project Communication Room (War Room)
Work Breakdown Structure (75%)	Gantt Chart (33%)	Network Diagram (16%)	Bidders Conferences
Activity List (75%)	Risk Management Documents (33%)	Quality Plan (16%)	Parametric Estimating
Client Satisfaction Survey (75%)	Contingency Plans (33%)	Stakeholders Analysis (8%)	Graphic Presentation of Risk Information
Database of Cost Estimation (75%)	Critical Path Method & Analysis (33%)	PM software for Multi-project Scheduling / Levering (8%)	Quality Function Deployment
	Team Building Event (33%)	Product Breakdown Structure (16%)	Value Analysis
	Work Authorization (33%)	Probabilistic Duration Estimate (PERT Analysis) (8%)	Trend Chart or S – Curve
	PM Software for Monitoring of Cost (33%)	Learning Curve (8%)	Cause and Effect Diagram
	Project Web Site (33%)	Life Cycle Cost "LCC" (8%)	Critical Chain Method & Analysis
	Database of Historical Data (33%)	Database or Spreadsheet of Contractual Commitment Data (8%)	PM Software for Simulation
	PM Software for Cost Estimating (33%)	Control Charts (8%)	Monte – Carlo analysis
	Database of Risk (33%)	Decision Tree (8%)	
	Database of Lesson Learned (33%)	Pareto Diagram (8%)	

Table 2 Levels of use, on a decreasing ranking, of project management tools and techniques
source: Primary Data

Meanwhile, there is a wide variation of the usage among the project management tools and techniques of the above list. Table 2 provides information about which tools and techniques are more broadly, worldwide and frequently used, such as **scope statement** (83%), **cost/benefit analysis** (83%), **financial measurement tools** (83%), etc; which are not often used such as **earned value** (41%), **Gantt charts** (33%), **databases of risk** or **lesson learned** (33%), etc; which are rarely used such as **statement of work, quality plan** (16%), **life-cycle**

cost (8%), etc and finally which are not used at all, such as **project charters, bidders conferences, parametric estimations**, etc.

In addition, the list of the most extensively used tools and techniques embodies very popular and widely used tools, such as **progress report** or **work breakdown structure** that are both included in body of knowledge Guides and their extended use reaches 91% and 75% respectively. On the contrary, there are tools and techniques that are extensively used and are not included in any body of knowledge Guides, such as **kick-off meeting** (83%), which is, according to Hamburger (1992), one of the most important project management start-up tools for getting the project started on the right foot.

As cited earlier, there are many tools that are not used at all in a product or project life-cycle by the companies under investigation. Many reasons clarify the allocation of a tool in the group of non-used tools and techniques. One of the most important factors might be that the responders ignore those tools due to the fact that they know little about them, about their use and their effectiveness on improving project performance. Furthermore, the support of organisations in acquiring and maintaining project management tools and techniques might be limited. According to the research, 60% of the organisations invest less than 1% of their total annual turnover, in technique systems and the rest 40% invests more than 3% in acquiring and maintaining technique systems.

Therefore, many organisations do not support the usage of tools and techniques, however individuals uses many specific tools that are not supported by their organisations due to the fact that those tools do not require any explicit resource or support, such as Gantt charts. Additionally, neither database tools require any special support by organisations, however apart from the **database of cost estimation** (75%), the rest tools have very low usage, like **database lesson learned** (33%), **database historical data** (33%), **database risk** (33%) and **database or spreadsheet of contractual commitment data** (8%) which have been allocated at the bottom layer of the medium list of table 2.

Moreover, there are some tools that are located at the non-used tools list of table 2, despite the fact that according the literature their effectiveness is well recognized (such as **critical chain method** or **quality function development**. An explanation of their limited usage might be their relatively recent arrival, since critical chain method only developed in 1997, compared to others that their time existence is longer. Therefore, people or organisations might not be familiar yet to their existence and their capabilities.

Additionally, there are tools that are neither on a high-rated nor on a non-used group. On this group, the vast majority are tools that have been established as effective and useful, since their first appearance. Tools, such as **milestone planning** (25 %), **quality planning** (16%), **PERT analysis** (8%), **Pa reto diagrams** (8%) or **decision tree** (8%), are frequently mentioned in body of knowledge guides, however their use is quite restricted.

Finally, the rare or non-used tools of the list might be explained by the fact that those tools are only used in specific contexts, or in specific product life-cycle phases or in different industries from those under investigation. Nevertheless, project management tools, which have been developed under specific circumstances or/and in a specific context, might be applicable only to the environment they have been created. Such tool is the **earned value**, which is successfully applied only in large projects of construction and engineering sector. Its usefulness is well identified by the PMBOK Guide, however its use is not as "popular" as the Guide suggests, due to the fact that only 41% of the sample uses it. On the other hand, taking into account that half the sample under consideration derives from construction industry, the 41% of usage of earned value is not as low as it seems. Therefore, among the sample of construction and engineering organisations, 83% uses earned value, however in IT sector no usage has been referred.

6.2 Nowadays, where do project management practices focus?

According to the stages of the product and project life-cycle, the responders proclaimed no use of explicit project management tools and techniques on all phases. Even though the participators believe that project management tools and techniques are valuable for the development of each practice, they do not use many either explicit tools to get their projects delivered successfully. Especially in smaller organisations, which occupy 20% of the sample, people consider that project management tools and techniques are not necessarily. However, according to the literature, small organisations do not use project management tools and techniques indeed, due to the fact that the practices are too small to maintain such technical support for their projects.

On the other hand, the survey shows that project management practices make limited use of tools in each project or product phase. On the table that follows (table 3) the scale 1 to 4 indicates the evaluation of project management tools and techniques on each project or product life-cycle stage; where 1 point out the non-beneficial system techniques and 4 the

most beneficial tools and techniques in C&E and IT sector. Moreover, it is important to mention that many tools and techniques of table 3 are not only used in the group they have been allocated. Lots of the under consideration tools can be applied in more than one phase, or in all phases of product life-cycle.

The Evaluation of the Usage of Project Management Tools and Techniques		C&E	IT
Scope and Requirements Definition (Initiate)			
	Statement of Work	1	-
	Scope Statement	2	2
	Requirements Analysis	-	1
	Project Charter	-	-
	Cost / Benefit Analysis	2	2
	Stakeholders Analysis	-	1
Contract Award (Initiate)			
	Bid Documents	3	2
	Bidders Conferences	-	-
	Bid / Seller Evaluation	1	2
Organizing (Plan and Execute)			
	Communication Plans (execute)	-	1
	Project Communication Room (War Room) (execute)	-	-
	Project Web Site (plan and execute)	-	2
	Kick – off Meeting (plan and execute)	2	2
	Responsibility assignment matrix (plan)	1	1
	Self Directed Work Teams (execute)	-	-
	Team Building Event (execute)	1	1
	Decision Tree (plan)	-	1
	Work Breakdown Structure (plan)	-	3
Planning and control			
	Metrics (Plan)		
	Financial Measurement Tools	2	3
	Estimating Cost (Plan)		
	Database of Cost Estimation	-	3
	Top – down Estimating	-	1
	Parametric Estimating	-	-
	PM Software for Cost Estimating	1	1
	Bottom – up Estimating	2	1
	Life Cycle Cost "LCC"	1	-
	Planning (Plan)		

	Activity List	**2**	**2**
	Feasibility Study	**4**	**1**
	Quality Plan	-	**1**
	Pareto Diagram (Quality Management)	-	-
	Baseline Plan	-	**2**
	Milestone Planning	-	**1**
	PM Software for Task Scheduling	-	**2**
	PM Software for Resources Scheduling	-	**1**
	PM Software for Resources Levering	-	-
	PM software for Multi-project Scheduling / Levering	-	**1**
	Critical Path Method & Analysis	**1**	**1**
	Critical Chain Method & Analysis	-	-
	Product Breakdown Structure	-	**2**
	Network Diagram (Time Management)	-	**1**
Control (Monitor and Control)			
	Progress Report	**4**	**2**
	Client Acceptance Form	**1**	**2**
	Change Request	**2**	**2**
	Configuration Review	-	-
	PM Software for Monitoring of Schedule	**2**	**1**
	PM Software for Monitoring of Cost	**1**	**1**
	Earned Value	**3**	-
	Trend Chart or S – Curve	-	-
	Quality Inspection	-	-
	Control Charts	**1**	-
	Work Authorization	**1**	**1**
	Re-base lining	-	-
	Probabilistic Duration Estimate (PERT Analysis)	-	**1**
	Gantt Chart	-	**2**
Design (Plan)			
	Quality Function Deployment	-	-
	Value Analysis	-	-
Risk (Plan and Monitor)			
	Risk Management Documents	**1**	**1**
	Graphic Presentation of Risk Information	-	-
	Contingency Plans	-	**2**
	Ranking Risk	-	-
	Monte – Carlo analysis	-	-
	Cause and Effect Diagram (for Quality Management)	-	-

	PM Software for Simulation	-	-
Evaluation (Close Out)			
	Team Member Performance Appraisal	-	**1**
	Lesson Learned / Post-mortem	-	**2**
	Learning Curve	-	-
	Client Satisfaction Survey	**2**	**2**
Databases (Close Out)			
	Database of Historical Data	**1**	**1**
	Database of Lesson Learned	-	**2**
	Database of Risk	**2**	-
	Database or Spreadsheet of Contractual Commitment Data	-	**1**
Total project management tools and techniques being used		**27**	**45**

Table 3, source: Primary Data

According to table 3, one can identify that on **initiate stage**, extensive usage of project management technical systems does not occur, even though **scope statement, cost/benefit analysis** and **bid documents** are on a sufficient high usage, project managers do not highly evaluate them, as one should expected. As opposed to literature review, on initiate stage of project development, the most frequently used tools are **project charters, project framework (or overview)** and **business case justification**, however, according to the research, those tools are rarely used by project managers in C&E and IT industry .

On the **planning stage**, despite the fact that most of the project management tools and techniques have been developed to be implemented on this stage, the responders do not quite use the variety of them. In order to organize the project, the majority of project managers have chosen to use **kick-off meetings**, which is not very highly evaluated (only 50% of the sample in both industries uses this tool), however its effectiveness is essential. Kick-off meeting is actually associated with initiate stage; however it is repeated for every new set of activities along the product life-cycle. Another tool that is being used is **work breakdown structure**, which is also more beneficial when applied to IT (75%) rather than to C&E projects, where no use has been reported. Furthermore, **financial measurement tools** are highly regarded as very supportive tools at organisational level, for the stage of organizing and planning, where their value has been rated with 50% and 75% by C&E and IT sector respectively.

Additionally, **activity list** and **feasibility study** are two kinds of tools that have contributed greatly on planning stage. **Activity list** is not as highly evaluated (the responders rated it on 50% value) as feasibility study, but it has been equally used on both sectors. On the other hand, **feasibility study** takes more effect and gives more credits to the C&E sector, where the responders have rated it as one of the most effective and useful project management tool in project life-cycle (it took full credit of 100% value at organisational level). The rest of the project management tools that have been identified on table 3 are rather unable to successfully fulfill the requirements of the projects. Still, there are eight tools whose value is rated less than 50%, 10 tools whose value is ranked in less than 25% and finally 6 tools that have never been applied by the responders, thus there is no ranking for them.

Furthermore, on **monitor and control stage**, the responders distinguished **progress report** as one of the most valuable tool in this area. Progress report has been rated and used highly (85% organisational value) by most of the project managers in both C&E and IT sectors. According to the participators, this stage includes many tools that conclude in medium impact at organisational performance, such as **change request** (50%), **PM software monitoring and scheduling** (33%) and **earned value** (33%).

Nevertheless, on **close out**, responders rarely use tools to deal with this stage, however the most valuable tools are the **client satisfaction survey** and the **database tools**. Client satisfaction survey, which is part of the evaluation phase of the project, is not favored to individuals, however organisations "oblige" project managers to use it due to the fact that its high effectiveness is generally accepted (Besner, 2006). Database tools are explored later on this chapter.

Meanwhile, there are two stages on product life-cycle, **risk and design phase**, where organisations under consideration use rarely project management tools and techniques to deal with the project during those stages. For instance, on the design stage, the research showed that neither companies of C&E nor IT sectors do use any project management tools or technique. Moreover, on risk stage, **risk management documentation** is the only tool that both sectors use, however infrequently; therefore its evaluation is very low (about 10%). According to the list of project management tools and techniques, at the risk stage 7 tools are applicable, of which only 2 are seldom used (contingency plan and risk management documentation as stated earlier) and 5 more are not used at all. Particularly in C&E industry, the survey has revealed that only risk management documentation is applicable and used, however, on IT sector both tools are implemented. Humphrey (1990) cited that only a small

number of project managers use risk assessment tools due to the fact that few tools can actually provide support for the management of risk. Humphrey's statement can provide the reason why only 21% of the responders use risk management tools.

To sum up, only **feasibility study** (planning stage), **financial measurements tools** (planning stage) and **progress report** (monitor and control stage) can be distinguished from the rest of project management tools and techniques, as the most valuable and precious. **Feasibility study** has been widely mentioned in PMBOK Guide, as one specific tool that can be effectively implied not only in the area of project life-cycle, but on a wider field. Despite the fact that feasibility study is not regarded as the most commonly or regularly used tool by PMBOK Guide, its effect has been identified by organisations, and its use and value is essential for the performance of the projects. **Progress report** represents one of the most valuable tools for the managing of project due to the fact that it is perceived as a multidimensional tool. In particular, the responders stated that progress report can cause positive impact in controlling cost, controlling budget, contingency planning, scope management, resource management, risk management, quality management and scheduling and controlling, if it is applied correctly. However its highest recognized value can be found in effective communications.

Therefore, the observations above indicate to the fact that more attention has been given to **planning, scheduling** and **monitoring and control stage** rather than on initiate or execution stage. Comparing to the literature, initiate stage is one of the most important stage to start a project on the right foot; otherwise wrong inception of a project might cause loss of time and cost increase that might probably conclude into "failure" of meeting the requirements of the project. Besides, the responders have stated that they adopt more or explicit project management tools only in cases where the client requests it.

6.3 Which tools and techniques are posing the greatest potentiality for improving performance through their better use, at organisational level?

In order to examine the variation of tools and techniques which provide improvement at organisational performance, it would be essential first to study which organisational or project areas the responders find beneficial or problematic. Table 4 stated below indicates the problematic and beneficial areas of the C&E and IT sectors when using project management tools and techniques.

Problematic areas of C&E	Beneficial areas of C&E	Problematic areas of IT	Beneficial areas of IT
Change management (83%)	Bid documentation (66%)	Time Management (83%)	Project execution (83%)
Communication management (66%)	Financial measurements (50%)	New client setup database (66%)	Cost baseline management (66%)
Time management (66%)	Initiate stage of projects (50%)	Stakeholder management (50%)	Risk management (33%)
Risk management (66%)	Milestone planning (50%)	Scope management (33%)	Project planning (33%)
Information flow (50%)	Time management (16%)	Documentation management (33%)	Change control (16%)
Allocation of responsibilities (33%)	Cost management (16%)	Design management (16%)	Communication management (16%)
Scope management (16%)	-	-	Organisation management (16%)

Table 4, source: Primary Data

Therefore, according to table 4, one can recognize that **time management** is a procedure that both C&E and IT sectors are trying to cope with effectively. Thus, some corporation succeed in managing with time, where according to the research, only 16% of the companies under consideration manage it; on the other hand, there are some organisations that need to focus more on time management, since 66% of the C&E sample and 83% of IT have failed.

Moreover, table 4 reveals that **risk management** in practice of C&E is not as effective, since 66% of the organisations have difficulty in managing it. According to the survey of Besner (2006) risk management tools can increase project management performance through more or better use. Reportedly to this research, a project manager commented that his organisation attempted to apply risk management tools, which however proved problematic. That comment corresponds to the findings of table 3, since risk assessment tools are not frequently used.

In addition, the most problematic areas in C&E are **change management** and **communication management**, as presented in table 4. Contrary, on IT sector **database for client information, documentation** and **stakeholder and design management** are under consideration by project managers, in terms of improving organisational performance. However, as stated by responders of IT sector, project managers do not use frequently neither design nor database tools due to the fact that they believe that the practice is already familiar with the procedures of coping with projects. Therefore they assume that

they do not need to apply those tools in each project, although they realize that the projects are not dealt correctly (as stated earlier).

Furthermore, the participators were asked to evaluate project management tools and techniques according to the contribution they provide. Table 5 presents the project management contribution index of C&E and IT industries. To interpret the following table, responders rated the project management tools and techniques by assuming that 1 is the rate for great contribution and 20 is the rate for very low contribution.

PM Contribution Index	**C&E**	**IT**
Overall project success	2.5	1
Meeting project schedule	3	1.25
Meeting project budget	2.25	2
Meeting plan objectives	2.75	3
Achieveing Client Satisfaction	3.25	2.25
Success of Other Projects in your Organisation	2.5	1.25
Table 5, source: Primary Data		

According to table 5, one can comprehend that both industries evaluated project management tools and techniques highly. The responders from IT sector seem to appreciate more the contribution of project management tools and techniques; this belief has already been detected from table 3, since C&E responders uses only **27 tools** compared to **45 tools** that IT implements to projects.

Consequently, on the third section of the questionnaires, responders were asked to address those issues that organisations will face in the future, when managing with project management tools and techniques. The following table (table 6) shows where C&E and IT sectors are aiming to focus in the future in order to achieve better organisational performance. In particularly, the numbers on the right column of table 6 i ndicate the number of organisations that have identified the need of improving their performance in specific sectors within their corporations. Overall, 6 organisations of C&E and equal in number of IT sector have participated in this research.

Future targets	**C&E**	**IT**
Managing complexity and uncertainty	2	5
Managing new types of risk, such as latent risk, etc	2	-
Managing resources effectively	5	5

Managing benefits	-	-
Managing information (reporting and analysis)	4	-
Managing talents (finding the right people)	4	-
The skills of the senior management team when managing discontinuous changes	-	-
None, the organisation is well equipped for managing successfully new projects	-	1
Table 6, source: Primary Data		

The table 6 reveals that the majority or the responders (83%) will have to deal with better management of resources, while 58% focus on managing complexity and uncertainty. A lower percentage of 33% predicts that better managing of information will support organisational performance, furthermore recruiting the right persons and dealing with their skills can led to the same result. Finally, there is a small percentage of 19% that focus in managing new types of risk and 9% of the responders did not address any future target due to the fact that the organisations they work in, are well equipped for managing successfully new projects.

Moreover, the responders identified most of the **database tools** as those tools that shows great potentiality in improving project performance, thus organisational performance. According to Besner and Hobbs (2004), even though database tools, especially lesson learned and historical data, have limited use, they are perceived as the most beneficial and capable to increase project success rates. However, the implementation and usage of database tools require organisational support and commitment.

Furthermore, White (2002) states that **PM Software** is regarded as the tool that has the most limitations in usage and is considered as being particularly unsuitable for complex projects. Cotterell (1998) gave a possible explanation as to why this happens, by arguing that only a few number of software packages embody the facility to monitor shared resources, which limits the accurate modeling of complex projects. The responders stated that only 3 PM software (for monitoring of schedule, for task schedule and for resource schedule) could actually contribute to increase project performance.

Meanwhile, the practitioners of the survey suggest that the tools that have high usage levels usually have significant contribution in increasing project performance; however, those tools that are frequently used may not have the expected result due to the fact that they are not

applied correctly. On the other hand, the tools that have medium or low usage levels are assumed to have medium or low contribution respectively. Lastly, the tools that are not used at all, are supposed to contribute little to increase performance, due to the fact that the participators are not used to implement them on projects either because they have no knowledge around them, or they find them inapplicable to their undertaken projects; even though the list of table 1 is comprised by well known tools and techniques.

6.4 Do organisations use common procedures in categories of projects, or do they adjust the tools and techniques to each project separately according to their needs?

The findings of the survey, according to project managers' belief, showed that organisations tend to standardize tools and techniques applied to projects, only to a certain level, due to the fact that they also need to have certain flexibility in managing similar projects. However, according to Milosevic and Patanakul (2005), the standardization of projects and the application of specific project management tools and techniques to similar projects do not always contribute to improvement of performance or to project success.

Moreover, almost 80% of the responders do actually use specific project management tools to similar project, because t hey are already familiar with the procedure from previous experience, but they do not always report success. According to the survey of Milosevic and Patanakul (2005), four factors have to be addressed standardizing project management tools and techniques (as shown in table 7) in order to refer project success.

Example of best practices in standardized project management (SPM) factors	
Factors that may impact project success in SPM	**Examples of best practice**
Standardized PM Tools	Select mutually compatible tools that work in sync; use them constantly
	Balance simple and advanced tools
	Integrate tools with the standardize PM process; each process deliverable is supported by specific standardized PM tools
	Start off with template tools; adapt the template for use in a specific project
Table 7, source: Milosevic and Patanakul (2005)	

In addition, the research intimated that major project management tools are very similar among different context. The survey showed that there are common patterns organisations

apply, which are alike to the general context of bodies of knowledge, since no responder referred to using any other project management tool or technique apart from those stated on the list of table 1 – that have been retrieved from three bodies of knowledge (PMBOK, APMBOK, OGC).

On the other hand, there are important differences among tools and techniques that are implemented to different contexts. For instance, the majority of tools and techniques are applicable to large and long-duration projects, because they are better adapted to their requirements. Responders (about 20% of the survey)working at small organisations cite that they do not need to apply many or any project management tool or technique, due to the fact that small organisations run small and short-duration projects, where complexity and uncertainty are minimum.

6.5 Comparison between C&E and IT sectors

A comparison between C&E and IT sectors reveals many similarities and many differences, due to the fact that projects, which result in different products, enclose several features that distinguish them. For instant, C&E projects have usually higher monetary value and lasts longer than the IT products. Therefore, even though the tools and techniques that are applied derive from the same source (bodies of knowledge), they actually have important differences in usage level. According to table 3, tools that constitute the group of **scope and requirements definition** are more frequently used by IT sector than E&C; despite the fact that actually both industries value those tools highly.

Moreover, according to the literature, **awarding contracts by competitive bidding** is a stage of the project life-cycle that seems more important to C&E and much less useful to IT projects. However, this survey has revealed that biding tools are used by both industries and are equal in number and highly valued. The explanation of this conflict might be the fact that large IT organisations are participated in this survey. Those organisations embodies R&D disciplines, which undertake projects, therefore the implementation of contract award tools is equally important to both C&E and IT projects.

Furthermore, on organizing stage, IT applies more tools and techniques to projects, due to the fact that they need to ensure better coordination. Therefore, **communication plans** and **project communication room (war room)** are two tools that provide better communication,

therefore are applied more to IT projects. In addition, both C&E and IT sectors implement planning and control tools on equal base. However, each tool is applied in different type of project. Therefore only 7 out of 28 tools are common in both industries.

Meanwhile, another difference that derives from this comparison is related to the implementation of planning and control tools; where IT projects focuses on cost and estimations as C&E projects centers on cost and scheduling tools. The use of **client acceptance form** is higher in IT rather than C&E sector, which can be justified by Besner and Hobbs (2008) who stated that "the use of client acceptance form in IT projects is consistent with the progressive definition of requirements and multiple partial deliveries found in these projects".

Additionally, **database tools** are almost equally applied by both sector, however, C&E projects focus more on planning and controlling cost, rather than planning and controlling schedule, as stated by IT project managers. **Risk assessment tools** are treated equally by both industries and are implemented equally by both types of project, although IT presents greater interest than C&E.

To sum up, both C&E and IT sectors extensively apply project management tools and techniques. Even though there are specific differences between their actual implementation. As stated earlier, C&E uses only 27 project management tools and techniques, out of the 70 listed in appendix 1, when IT projects implement almost 45 tools to all kinds of project. Therefore, it would be accurate to say that project management toolbox is more applicable to IT projects than to C&E.

CONCLUSION

7.0 Conclusion

This research has shown an empirical study of managing project in C&E and IT sector of UK industry, by using explicit project management tools and techniques, which have retrieved from the bodies of knowledge (PMBOK Guide, APMBOK and OGC) and formed a list of 70 well-known tools and techniques (Appendix 1). An extend research on the value and applicability of tools and techniques showed that the current context of the list is more applicable to large, long duration projects, rather than small and short-term, because tools are better adapted to project requirements of large-scale projects; due to the fact that a large number of organisations (dealing with small projects) deliver "unsuccessful" projects, therefore an effort has to be made in creating new tools and techniques or modifying the existing that focuses on small projects.

Additionally, an extent survey presents the level of implementation of project management tools in both C&E and IT sectors. This research has revealed that usually more tools and techniques are applied to IT projects rather than C&E. An explanation might be the fact that IT projects need ensure better coordination (and thus better communication) due to the nature of projects. Moreover, there are certain tools that seem to be more suitable for implementation on C&E projects, however, the research revealed the opposite. In the case of contract award tools, IT implements these tools equally often as C&E does. This might be logically explained by the fact that the responders are part of large organisations, which embodies R&D department, which in its turn undertake projects. Therefore, the implementation of several tools is equally important to both C&E and IT projects.

Moreover, an analysis has been made that focused on project management practice in each face of project and product life-cycle. The results indicate that more attention has been given to planning, scheduling and monitoring and control stage rather than to front-end stages. Explicit tools and techniques are more frequently applied to the middle stages of projects, even though literature reveals that greater use should be on initiate stage due to the fact that in the beginning of each project, is more important to choose the right tool or technique, rather than having the project started on the wrong foot.

Furthermore, this research has explored standardized procedures that organisations adopt, to deal with similar types of projects (same size, same characteristics, same context, etc). The survey has identified that a "common recipe" of practicing project management is frequently used by a vast amount of different types of organisations. However, the

standardization of projects does not always contribute to improvement of performance or to project success due to the fact that certain flexibility is essential in managing similar projects.

Meanwhile, a comparison between C&E and IT sectors reveals many similarities and many differences, because projects enclose several features that distinguish them. For instant, C&E projects have usually higher monetary value and lasts longer than the IT products. Therefore, despite the fact that project management tools and techniques, being applied, derive from the same source (bodies of knowledge), they have important differences in usage level. Moreover, research has shown that IT projects focuses on cost and estimation tools whereas C&E projects centers on cost and scheduling tools. While the focus on planning and control of cost in C&E has been replaced by scheduling and resource allocation in IT projects. Besides, IT sector implements more extensively project management tools than C&E sector.

The aim of this dissertation is to contribute to a better understanding of project management tools and techniques regarding the advantages acquired by their implementation and their future development, on different types of organisations and especially to different types of projects or to different types of context.

Overall results shows that project managers are able to identify ways to increase and improve their project management practices by studying tools and techniques that have been identified in the present research as those posing the greatest potentiality for improving performance through their better use, at organisational level. For instance, this survey recognized that database (such as lesson learned database) and risk assessment tools as a group of tools that can show great improvement of better performance. However, both tools need organisational support and commitment.

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APPENDICES

APPENDIX A

List of Project Management Tools and Techniques			
1	Activity list	36	Parametric Estimating
2	Baseline Plan	37	Pareto Diagram
3	Bid Documents	38	PM Software for Cost Estimating
4	Bid/Seller evaluation	39	PM Software for Monitoring of Cost
5	Bidders Conferences	40	PM Software for Monitoring of Scheduling
6	Bottom – up estimating	41	PM Software for Multi-project Scheduling – Levering
7	Cause and Effect Diagram	42	PM Software for resource Levering
8	Change Request	43	PM Software for resource Scheduling
9	Client Acceptance Form	44	PM Software for Simulation
10	Communication Plans	45	PM Software for task Scheduling
11	Configuration Review	46	Probabilistic Duration Estimate (PERT Analysis)
12	Contingency Plans	47	Product Breakdown Structure
13	Control Charts	48	Progress Report
14	Cost / Benefit Analysis	49	Project Charter
15	Critical Chain Method and Analysis	50	Project Communication Room (war room)
16	Critical Path Method and Analysis	51	Project Web Site
17	Client Satisfaction Surveys	52	Quality Function Deployment
18	Database for Cost Estimating	53	Quality Inspection
19	Database of Historical Data	54	Quality Plan
20	Database of Lessons Learned	55	Ranking Risk
21	Database of Risks	56	Re-base lining
22	Database of Contractual Commitment Data	57	Requirements Analysis
23	Decision Tree	58	Responsibility assignment matrix
24	Earned Value	59	Risk Management Documents
25	Feasibility Study	60	Scope Statement
26	Financial Measurement Tools	61	Self Directed Work Teams
27	Gantt Chart	62	Stakeholders Analysis
28	Graphic presentation of Risk Information	63	Statement of Work
29	Kick – off Meeting	64	Team Building Event
30	Learning Curve	65	Team ember Performance Appraisal
31	Lesson Learned / post – modern	66	Top-down Estimating
32	Life Cycle Cost ("LLC")	67	Trend Chart or S-Curve
33	Milestone Planning	68	Value Analysis
34	Monte – Carlo Analysis	69	Work Authorization
35	Network Diagram	70	Work Breakdown Structure
Source: Besner & Hobbs (2008)			

APPENDIX B

Definition of Project Management Tools and Techniques

	Tools & Techniques Definition
1	**Activity list** All activities that will be performed on the project. Organized as an extension to the WBS to help ensure that it is complete, and that it does not include any activities that are not required as part of the project scope
2	**Baseline Plan** The initial approved plan to which deviations will be compared as the project proceeds
3	**Bid Documents** A set of documents issued for purposes of soliciting bids in the course of the acquisition process
4	**Bid/Seller evaluation** Formal review and analysis of response to determine supplier's ability to perform the work as requested
5	**Bidders Conferences** (also called contractor or pre-bid conferences) Meetings with sellers prior to reparation of proposal. Used to ensure that all prospective sellers have a clear, common understanding of the procurement
6	**Bottom – up estimating** This technique involves estimating the cost of individual activities or work packages, then summarizing or rolling up the individual estimates to get a project total
7	**Cause and Effect Diagram** Also called Ishikawa diagrams or fishbone diagrams, which illustrate how various factors might be linked to potential problems or effects
8	**Change Request** Form to log, assess and agree on, before a change to the project can be made. Changes may affect the scope, quality, time and/or cost of the project and/or other planned aspects of the project
9	**Client Acceptance Form** Form to be signed by the person or organization for whom a project is implemented
10	**Communication Plans** A statement of project stakeholders' communication and information needs
11	**Configuration Review** A check to ensure that all deliverable items on a project conform with one another and to the current specification
12	**Contingency Plans** A plan that identifies alternative strategies to be used to ensure project success if specified risk events occur
13	**Control Charts** Graphic displays of the results, over time and against established control limits, of a process. They are used to determine if the process is "in control" or in need of adjustment
14	**Cost / Benefit Analysis** The analysis of the potential costs and benefits of a project which allows comparison of the returns from alternative forms of investment
15	**Critical Chain Method and Analysis** Analysis of the task network to determine the longest path considering task constraints combined with resources constraints and the management of that path
16	**Critical Path Method and Analysis** A network analysis technique used to predict project duration by analyzing which sequence of activities (which path) has the least amount of scheduling flexibility (the least amount of float)
17	**Client Satisfaction Surveys** Surveys used to evaluate customer satisfaction

18	**Database for Cost Estimating** An organized body of related information for cost estimating
19	**Database of Historical Data** An organized body of historical data
20	**Database of Lessons Learned** An organized body of information on lessons learned, for the purpose of improving future performance
21	**Database of Risks** An organized body of information on risks
22	**Database of Contractual Commitment Data** An organized body of information on all obligations or commitments that pledge actions of project participants or payment of goods or services
23	**Decision Tree** A diagram that describes the implications of choosing one or another of the available alternatives. It incorporates probabilities or risks and the costs or rewards of each logical path of events and future decisions
24	**Earned Value** A measure of the value of work performed so far. Earned value uses original estimates and progress-to-date to show whether the actual costs incurred are on budget and whether the tasks are ahead or behind the baseline plan
25	**Feasibility Study** The methods and techniques used to examine technical and cost data to determine the economic potential and the practicality of project applications
26	**Financial Measurement Tools** Techniques to evaluate the financial performance of project eg. ROI, NPV, Pay-back, etc
27	**Gantt Chart** A graphic display of schedule-related information. Activities or other project elements are listed, dates are shown across the top, and activity durations are shown as date-placed horizontal bars
28	**Graphic presentation of Risk Information** Graphical methods to represent risk information
29	**Kick – off Meeting** A workshop type meeting in which the principle stakeholders and participants in the project are briefed on the goals and objectives of the project, how it will be organized, etc
30	**Learning Curve** A concept that recognizes the fact that productivity by workers improves as they become familiar with the sequence of activities involved in the production process
31	**Lesson Learned / post – modern** A tool to learn from the process of performing the project. Lessons learned may be identified at any point. Also considered a project record
32	**Life Cycle Cost ("LLC")** The total cost of a system or facility over its full life, including the cost of development, acquisition, operation, support and disposal
33	**Milestone Planning** A summary-level schedule that identifies the major milestones, which are significant events in the project, usually completion of a major deliverable
34	**Monte – Carlo Analysis** A technique that performs a project simulation many times to calculate a distribution of likely results
35	**Network Diagram** (Task network) Any schematic display of the logical relationships of project activities. Often referred to as a PERT or PDM or CPM chart
36	**Parametric Estimating** An estimating technique that uses a statistical relationship between historical data and other variables (e.g. square footage in construction, lines of code in software development) to calculate an estimate

37	**Pareto Diagram** A histogram, ordered by frequency of occurrence, that shows how many results were generated by each identified cause
38	**PM Software for Cost Estimating** Use of a project management software for cost estimating
39	**PM Software for Monitoring of Cost** Use of a project management software for monitoring of cost
40	**PM Software for Monitoring of Scheduling** Use of a project management software for monitoring of schedule
41	**PM Software for Multi-project Scheduling – Levering** Use of a project management software scheduling and leveling on multiple projects
42	**PM Software for resource Levering** Use of a project management software for resources leveling
43	**PM Software for resource Scheduling** Use of a project management software for resources scheduling
44	**PM Software for Simulation** Use of a project management software for developing alternatives schedules, to simulate risk events or other circumstance
45	**PM Software for task Scheduling** Use of a project management software for task scheduling
46	**Probabilistic Duration Estimate (PERT Analysis)** Method using durations that are computed by a weighted average of optimistic, pessimistic, and most likely duration estimates
47	**Product Breakdown Structure** (Also called bill of materials) Breakdown of the deliverable into the components of the final product
48	**Progress Report** Report on the partial completion of a project, or a measure of same. Also, the act of entering progress information for a project
49	**Project Charter** A document consisting of a mission statement, including background, purpose, and benefits, a goal, objectives, scope, assumptions and constraints
50	**Project Communication Room (war room)** A central location where vital project information is displayed for all to see. Sometimes referred to as a War Room
51	**Project Web Site** The information concerning the project is made available via a website
52	**Quality Function Deployment** Also referred to as the House of Quality. A method for translating customer needs into product/service technical requirements for design, development, implementation, and delivery of a product
53	**Quality Inspection** An inspection carried out to determine whether or not a deliverable or product, whether intermediate or end product, meets the specified quality criteria
54	**Quality Plan** A document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, service, contract or project
55	**Ranking Risk** Indicate the overall risk position by comparing the risk scores. It can be used to assign resources to projects, to make a cost-benefit analysis or to support a recommendation for initiation, continuation, or cancellation
56	**Re-base lining** Development of a revised baseline plan. Re-baselining is required in response to changed contract requirements, funding changes, change in the project's objectives, etc. Re-baselining should only be undertaken with justification and the proper approvals
57	**Requirements Analysis**

	An analysis of measurable customer wants and needs.
58	**Responsibility assignment matrix** A structure that relates the project organization structure to the work breakdown structure to help ensure that each element of the project's scope of work is assigned to a responsible individual
59	**Risk Management Documents** Documents to record various information relative to risk identification or risk mitigation measure, etc
60	**Scope Statement** A documented description of the project's outputs or deliverables
61	**Self Directed Work Teams** Teams whose members are sufficiently motivated and capable, and knowledgeable of their project objectives, that they are able to perform under self-supervision, or with minimal management supervision
62	**Stakeholders Analysis** Tool to help identification of stakeholders and the analysis of the needs of the various stakeholders
63	**Statement of Work** A narrative description of the work to be performed
64	**Team Building Event** An event organised to influence a group of diverse individuals, each with their own goals, needs, and perspectives, to work together effectively for the good of the project such that their team will accomplish more than the sum of their individual efforts could otherwise achieve
65	**Team member Performance Appraisal** Technique or template to evaluate project team members, can be linked to the process by which the project team or team members receive recognition for their accomplishments
66	**Top-down Estimating** The preparation of a cost estimate by using judgment and experience to arrive at an overall total amount, usually done by an experienced estimator or manager making a subjective comparison of the project with similar previous projects
67	**Trend Chart or S-Curve** Graphic display of cumulative costs, labour hours, percentage of work, or other quantities, plotted against time
68	**Value Analysis** An activity devoted to optimizing cost performance. It identifies the required functions of an item, establish values for those functions and provide the functions at the lowest overall cost without loss of performance
69	**Work Authorization** A form to authorize work before it is performed on the project
70	**Work Breakdown Structure** A deliverable-oriented grouping of project elements that organizes and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work
Source: PMBOK GUIDE (2004), Max Wideman's Comprehensive Glossary of Project Management Terms (2008) and Lester (2005)	