# Project Management Tools and Techniques for Effective Project Execution

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**Abstract:** The aim of the research was to identify the use of project management tools and techniques within generic project management structures. The researcher makes the assumption that project management is clearly distinguishable from other forms of management, i.e., general management and operations management. The difference therefore presupposes that the tools and the techniques required for effective project management inevitably differ from those necessary for the routine management reminiscent of other forms of functional management. Projects are known for their failure rate, this necessitates research into commonly used tools and techniques that contribute to the status quo in project management and execution. Structured instruments in the form of questionnaires were used to collect information from the project managers and project team members closely involved in project execution. Respondents were drawn from all forms of projects, but largely from IT and Construction industries as these were easy to identify and more readily accessible. The questionnaire started by identifying the role played by the respondents, their understanding of the key tools under survey, and their evaluation of the importance of these tools, namely; Gantt chart, work breakdown structures and critical path method. The findings will assist in the teaching of tools and techniques for effective project management in institutions of higher learning. Further to that, this research opens an opportunity for a possible follow up on why the respondents would prefer certain tools for effective project management. The research seems to indicate a strong link towards the use of certain tools in place of others.

**Key words:** tools; techniques; project management; Gantt chart; work breakdown structure and critical path method (analysis)

**JEL codes:** M00, M1

## 1. Introduction

The approach to this study presupposes that projects do not reside exclusively in the province of engineering and construction related operations. Knipe, van der Valt, van Niekerk, Burger and Nell (2008, p. 10) assert that a project is a change-creating human endeavor limited in time with mixed goals and objectives uniquely cutting across organizational structures, projects are not repetitive. This will comprise of activities like event management, and any other operations with a start and end date.

Project management therefore has common threads cutting through these temporary structures creating unique products. The unpredictability of the failure and success rate of these projects necessitates the need for research into what projects are and what tools and techniques are critical for their successful implementation

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(Papke-Shields, Beise & Quan, 2009, pp. 1-21). The execution of the project is a complex human endeavor, bringing with the change, mixed goals and objectives, quality expectations and a fixed cost within a specified time. Project management in the 1960s and thereabout focused on the development of tools and techniques, the profession has now developed to embrace the human element since projects are executed by human beings. This study is not focusing specifically on the human element, but rather the tools and techniques used by the project practitioners to execute their operations. The project is executed with use of specific tools and techniques because of its uniqueness and need for cross functional skills for successful execution (Dwivedula & Bredillet, 2009, pp. 1-8). The researcher takes the view that there are generic tools and techniques inherent in the execution of a project.

The Project Management Body of Knowledge as cited by Burke (2007, p. 17) posits that a project is a temporary endeavor undertaken to create a unique product or service with particular specifications. Mantel, Meredith, Shafer and Sutton (2005, p. 2) concur and add that a project is specific, timely, usually multidisciplinary and always conflict ridden. The conflicts emanate from many sources including the presence of an authority gap due to the presence of the matrix structure specifically for projects embedded in large organizational structures (Gray & Larson, 2008, p. 68). Projects are therefore unique non-repetitive once off undertakings aimed at producing a specific output or result in a unique environment within a given space of time. They are initiated to encompass a plan, and execute a specific intention or motive (Clements & Gido, 2004, p. 5).

According to Knipe et al. (2008, p. 97) the project plan comprises of; the project charter, description of the project management approach, the scope statement, work breakdown structure, cost estimates, major milestones and target dates, key risks, subsidiary management plans, issues and pending decisions relevant to the project. The project plan is a statement on how and when the project objectives are to be achieved (Burke, 2007, p. 71), it shows major products, milestones, activities and resources required on the project. The mission statement, detailed objectives, contractual aspects, schedules, resource requirements, personnel, evaluation methods and potential problems (Smith & Imbrie, 2004, p. 69) should be indicated.

Project management as a process ensures that the project has a scope and is delivered within a time frame, approved budget and must meet the expectations of the customers. Mantel and Meredith (2000, p. 10) posit that project management as a process includes optimization of resources to reduce the risk of project failure, as such it is imperative that certain operations necessitate the use of particular tools and techniques (Martin & Tate, 2001, p. 9). The primary purpose of a project is to meet or possibly exceed customer expectations by producing the intended results with little loss of time, resources and the quality as perceived by the customer. Chase, Jacobs and Aquilano (2006, p. 73) identify project management as a series of related jobs usually directed toward some major output and requiring a significant period of time to perform. The consequence for this quest for perfection in the execution of such a uniquely complex and unrepeatable undertaking is a need for the use of the right tools and techniques.

Project management makes use of different types of tools and techniques to effectively execute and complete the undertaking. Whilst there may be generic tools and techniques that may be utilized across all forms of management, the researcher acknowledges the differences between project management and other management disciplines (Gray & Larson, 2008, p. 65) and proposes the need to identify such generic techniques and tools specific to project management. In the broad sense the tools that can be used across the varying management disciplines encompass computers, software programmes and templates, performance standards tools and many other tools used without much thinking in the management of businesses.

## 1.1 Tools and Techniques

Tools and techniques are the systems and methods or the equipment and the methods used to execute an undertaking. The spade can be a good analogy for tools and techniques as required in project execution. The tool is only as good as its relevance to the task at hand as well as the expertise of the user of the tool. Tools are instruments through which the work is executed, and these may be listed in their vastness. The spade can be ideal for digging in the garden, but the dryness or wetness of the soil may render the tool relevant or not. Besides, the methods or techniques that will be used by the gardener, will determine the effectiveness of the spade.

Thus tools on their own may not be of much benefit, for this reason this survey seeks to identify the use of certain tools and techniques in project management. There are numerous tools that can be utilized, namely; the project plan, complimentary plans of the project, meeting and reporting structures, pre-agreed on performance standards, project and milestones schedules, progress reporting templates, computers and software programs used for effective delivery, and the list goes on.

Literature research records that project managers find that what determines the success of their projects is not merely correct sequencing of a critical series of activities, but the prioritizing of resources across the portfolio of multi-programs (Knipe et al., 2008, p. 65). Prioritization is difficult when the projects are large and of varying sizes and urgencies. The resultant experiential effect is the indispensability of relevant project management tools that can accommodate the project driven metaphor and a resource based metaphor simultaneously. There is a need for tools and techniques that may help with correct prioritization of these critical series of activities for proper project implementation.

Of particular interest in this study is the use of tools and techniques almost exclusive to project management, namely; Gantt charts, work breakdown structures, resource smoothing, critical path methods and milestone charts.

### 1.1.1 Gantt Charts

This is a graphic presentation of the project execution activities depicted as a time scaled bar line. Burke (2008, p. 277) refers to it as a scheduling tool where the time of each activity is represented as a horizontal bar with the length of the bar proportional to the duration of the proposed activity. The Gantt chart owes its origin to Henry Gantt in the early 1900s where it was used as a special project management tools. It was developed further in the aerospace projects of the 1950s and 1960s. It is believed that nearly all the project management tools and techniques used today were developed during the growth of the USA defence-aerospace industry. These include PERT and EV (Program evaluation and review technique and Earned value respectively).

A Gantt tool is an easy yet excellent program which allows for time, resource and cost analysis in one single spreadsheet. With the Gantt chart you can track up to eight tasks in one row and you can further create cost and resource analysis with a variety of summaries. With the modern use of Microsoft-Excel as an add on, the Gantt chart is pretty handy for the project planner. The advantages of the Gantt chart are numerous and can be listed as, namely; its ability to show activities, time scale for the project, start and finish dates for tasks or activities, actual activity progress, milestones, interdependency of the tasks and clearly stated resource requirements for the tasks.
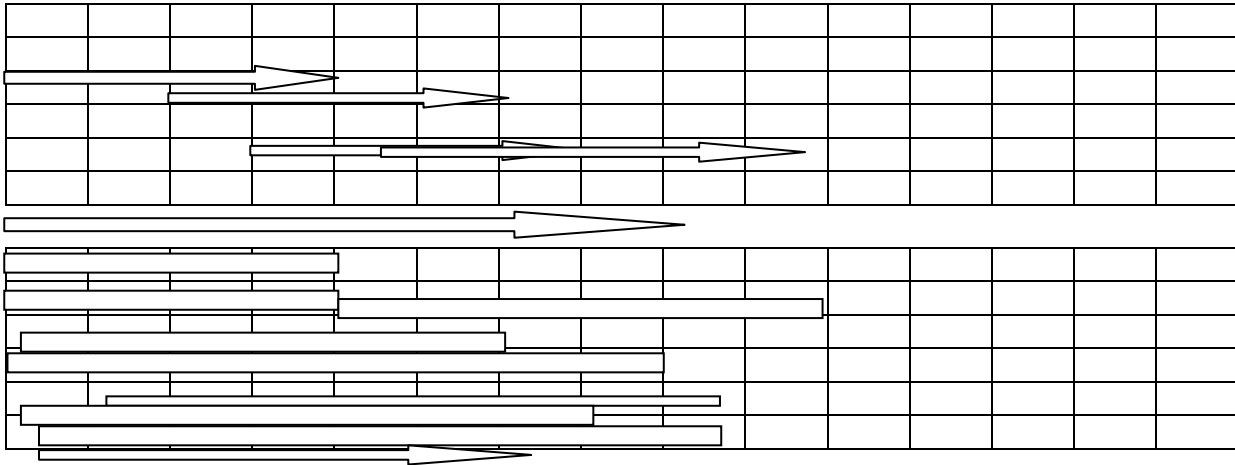
**Simple Gantt Chart Showing Project Activities**

1.1.2 Work Breakdown Structures

Gray and Larson (2008, p. 571) define the Work Breakdown Structure (WBS) as a hierarchical method that successively subdivides the work of the project into smaller detail. The WBS breaks the work into manageable work packages and checklists easier to manage, plan, control and allocate to specific individuals. It seeks to group similar tasks together to improve productivity and efficient use of resources. Cost-centre costing is more effective using WBSs as they allow for maximum focus on specific sections of the project. Burke (2008, p. 96) refers to the WBS as the backbone of the project. The main components of the WBS are essentially the structure, methods of subdivision and numbering or coding system. The purpose of the WBS is to subdivide the scope of work into manageable work packages, this is not a straightforward task and many new project managers seek to avoid. The WBSs is a summation of work packages which comprise of activities and checklists. The WBS can best be defined as the map of the project (Gray & Larson, 2008, p. 97) which ensures that all the work elements are identified. It helps integrate the project with the whole organization and thereby create a basis for control. It is essentially the deliverables beginning with the project that is divided into work packages divided according to the type of work at the most minimum sub-deliverable showing work progress, cost centers and responsibilities. The project is one large final activity made up of work breakdown structures which are a summation of work packages. The work package can be represented in hierarchical format to emphasize the structure and the process of work breaking down.
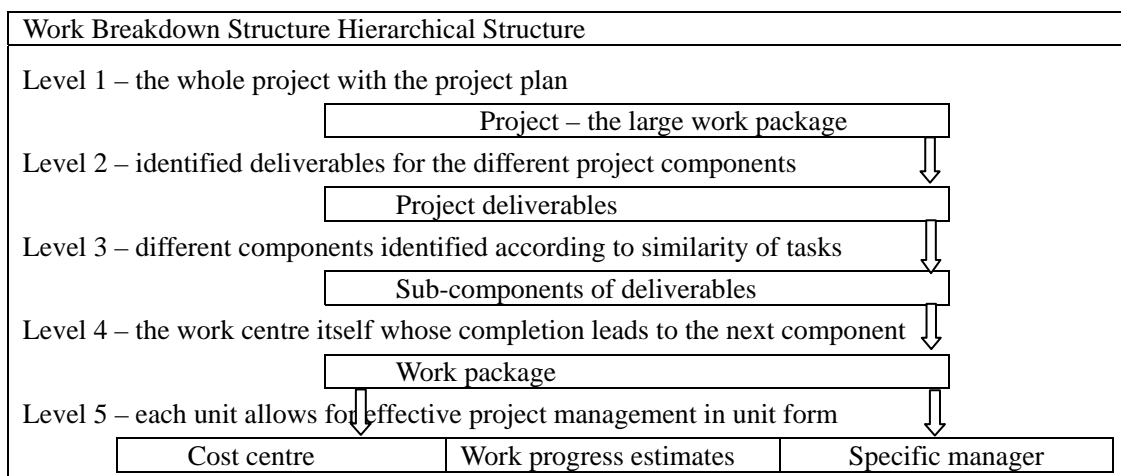
Work packages have the shortest duration or they are the minimum tasks or elements of the project with a definite start time and end time. At this point it is easier and more accurate to work out the costs, assign a specialized skill and monitor the progress of the execution. A work package manager therefore sees to the completion of the respective task within a specified time and budget according to customer expectations and technical specifications. It is important to note that there is a difference between the Work Breakdown Sub-deliverable and a work package. A work breakdown sub-deliverable includes the outcomes of more than one work package and may encompass two or more departments, and as such may not have a duration of its own. Thus the work package comprises the most basic unit for planning, scheduling, and controlling of the project. Gray and Larson posit that the ideal work package within a WBS is characterized by;

- clearly defined work, what is to be done
- specified time of start and completion of task
- specified budget for the completion
- identified and specific resources required
- specific individual to oversee and control the package
- specified standard performance to be measured against

To gain effective and efficient usefulness of a breakdown structure depends on an effective coding system. The codes assist in the identification, defining and allocation of levels and elements, work packages and cost information in the WBS. The codes allow reports to be consolidated at any level in the structure. The WBS is best for design and build projects with tangible and measurable outcomes that can be decomposed to major deliverables, sub-deliverables and finally to work packages. By inference therefore there are certain projects that do not lend themselves to effective use of the WBS and coding because they are less tangible and more process oriented type projects in which the final project is a result of a series of steps, phases and plans culminating in an end product without measurable end results or deliverables. Such projects may comprise of the development of an extranet web or arranging for a wedding.

### 1.2 Critical Path Method

The critical path of a project is the path that determines the longest duration through the project network that it takes to execute the project from start to finish. Cain and Wong (2007) define it as the estimated project duration whose period equals the longest path through which the project network passes. If there are more than one such "longest paths" with equal value, all of them are critical paths for the said project. The use of this technique is to decide on the duration of the project because the critical path method (CPM). Hillier and Lieberman (2010, p. 401) posit that the critical path is one of the routes through a project network following the arcs from the START to the FINISH node in a project. Project networks consists of activities to be completed in a particular sequence and are shown by the use of arrows to nodes (the activities to be completed) as indicated in the diagram below.
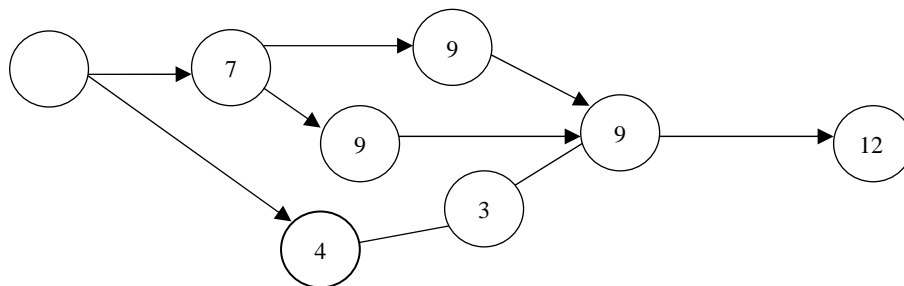
### 1.3 Possible Routes for A Project Network: The Longest Is the Critical Path

The critical path method shows the nodes or activities to be accomplished and the paths shown by arrows, some of which may be done simultaneously and others depend on the completion of the others. The duration is put as figures in the divers nodes, this represents the time which could be hours or days, or weeks or months or longer depending on the type of project. The project duration cannot be longer than the longest path, which is the critical path which in principle can be performed sequentially without interruption; otherwise this would not be the longest path. In the critical path method therefore the FINISH or completion equals the length of this path. The activities on this critical path are the bottlenecks or constraints to speedily executing the project. This tool is critical for effective project management, the critical path method therefore serves many critical functions in effectively executing a project, amongst which are, namely; the costing of the project is based on this path, the time estimation is based on this path. Any endeavors to crash the activity are based on the ability of the project manager to identify the number of activities that may be reduced to cut down on the time taken to complete the exercise. A trade-off is needed between the eventual cost and the cut in the time necessary for the completion of the project. Depending on the choices available to the project manager, crashing may be through; asking employees to work overtime, or employing extra temporary staff to expedite the work. Crashing of the activities at any level will give a combination of time and cost somewhere on the line segment as indicated in the theoretical graph below.

### 1.4 Relationship between Activity Cost, Crash Cost and Time Taken

The critical aspect of the critical path analysis is the ability of this method to assess the problems faced by the implementation of the project plan. There are essentially three sets of activities, the interdependent, the dependent and the independent activities. The dependant or sequential activities need to be completed in a sequence and their completion or commencement is dependent on the completion or the commencement of certain activities. Parallel activities are completed independent of the other activities as stand-alones in the process of execution. The CPM assists in identifying these different sets of activities and show their dependence and the duration therefore assisting in the proper estimation of the time required and the budget for the purpose.

It is important to mention here that there are further tools and techniques available to the project manager to crash the activities to reduce the time and possibly cut costs. The manager has to choose the least expensive method of crashing the activities and he may use tools such as; marginal cost analysis or linear programming. The choice as to whether or not to crash the activities must be balanced between any possible negative effect on quality specifications as expected by the customer, the cost benefit to the project stakeholders and the time schedules for the use of the product should there be any such constraints or pressure.

1.4.1 Milestone Charts

Efficiency means optimization of the resources to achieve maximum intended results (Parnaby & Wearne, 2003, p. 15). Project management tools are the guide that supports the process to deliver as dictated by the firm's strategy for competitiveness and profitability, and techniques are what to use in order to achieve those (Milosevic, 2003, p. 20). It is important to have workable business practices and procedures in place (Van der Walt, 2000, p. 58), for this, the facilitators need to be both managers and individual contributors on a variety of projects. This tool is critical for time management by the project manager.

Verwey (2001, p. 50) postulates that effective project management practices encompass use of methodologies, procedures and standards to determine the roles and responsibilities of the project team. Because project management differs from operations management in terms of the benefits (Chase, Jacobs & Aquilano, 2006, p. 9),

operations management is about designing, operating and improving of the system that creates and delivers the firm's primary products and services, Vonderembse and White (2004, p. 5) describe it as the decision making process involving the design, planning, and management of the many factors that affect operations. Where then is project management and what tools are appropriate for the effective execution of projects given their difference from other forms of management operations.

## 2. Problem Statement

Welman, Krugger and Mitchell (2008, p. 14) posit that the research problem refers to difficulty that the researcher experiences in the context of either a theoretical or practical situation and to which he wants to obtain a solution. The first step in research therefore is the construction of the problem statement, this includes explanation or interpretations which have not been tested as research hypothesis, but is the main theme of the study.

Essentially defining the problem statement involves narrowing down the general interest in a research topic in order to focus on a particular research problem. From the topic of study, there is a need to identify critical core project management tools and techniques that contribute to effective project management. Hofstee (2006, p. 85) suggests that if there is no problem, then there will be no need for research. In this paper, the problem is the need to identify the critical tools and techniques that are central to effective project execution. Project management as a profession continues to attract more students, and *projectification* of the industry is increasing. There is a need for a full comprehension of the tools used most, these will form the critical components of the training syllabus for the industry. As alluded to in the preceding literature review, there is a distinct difference between general management and project management thereby implying or necessitating a survey on the types of tools and techniques specific to project management.

### 2.1 Objectives

To identify the core critical tools and techniques ideal for effective project management. The tools and techniques identified will form part of the syllabus for training and lecturing in the development of professional project practitioners.

### 2.2 Research Methodology

The literature reviewed included published books, professional journals in project management, and other peer reviewed research documents. Much use was made also from previous work experience in project management, and numerous discussions with professionals within the industry.

### 2.3 Target Population

The target population was project managers and project team members who assist in decision making in the places where they work with projects. The respondents were not restricted to one particular industry as the research focused on generic requirements for project management. Only current practitioners were interviewed and a total of 67 responses were used for the analysis. Welman et al. (2008, p. 71) site Huysamen as suggesting that a sample size should not be less than 15 units but preferably more than 25 units. The size of the sample affects the accuracy of the results, the larger the sample the smaller the margin of error. Blumberg (2008, p. 237) postulates that the best way to decide on a sample size is by considering factors such as; relevance of the population, parameters of interest, the sampling frame, the type of sample, sample size required and the cost.

The guide below (Maree, 2008, p. 179) was used to determine the sample size and the sampling technique.

**2.4 Sample Size Factors Used**

Eight factors

Type of research

- correctional research/30 subjects
- campaigning groups/15 + per group
- major research 100 respondents

Research hypothesis

- if small differences are expected

Financial constraints

Importance of the results

Number of variables to be studied [the larger the sample]

## 3. Research Findings

Below are the empirical findings and the interpretation, the research questions asked and the results are recorded in the following paragraphs.

### 3.1 Biography

The first section dealt with the biography and general information on the respondents and the distribution of their functions was indicated as provided below. They had to choose between the positions; general manager, operations manager, project manager, supervisor, line manager and production manager.

4% of the respondents were general managers, 8% were line managers and 88% were project managers. The respondents were requested to indicate their years of experience in the industry regardless of the firms they worked in. Of the respondents; 23% had under 5 years experience, 42% have worked for between 6 and 10 years, 23% between 11 and 15 years, and 12% in excess of 21 years.

**Research Question**: Please indicate your position in the firm.
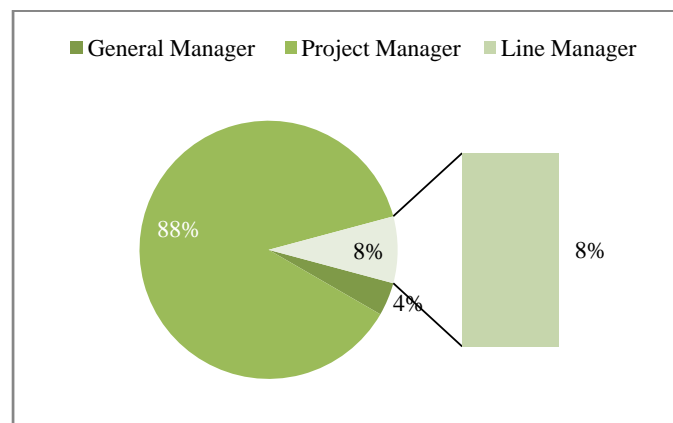


**Figure 1    Respondents**

The target population for the research was people who are directly involved in the real management of the projects, this included team member, the project managers and other direct stakeholders. It was comparatively more convenient to meet project managers, mostly during their lunch breaks or by appointment. As indicated above, the respondents were 4% general managers or owners of the projects, 8% was from line managers who

were themselves team members, and the majority of 88% were project managers. The findings are therefore largely a reflection of the tools that the project managers either use regularly or prefer to use. No investigation was carried out on the reasons for the choices, this is an opening for future surveys.

**Research question**: How long have you held this position including from other firms?

|     | 0-5 yrs | 6-10 | 11-15 | 16-20 | 26+ |
|-----|---------|------|-------|-------|-----|
| Exp | 23%     | 42%  | 23%   | 0     | 12% |

Part of the survey sought to derive a relationship between the years of experience in the industry against the use of certain tools, assumptions were made that with experience project managers tended to utilize tools they knew produced the required results. 23% of the respondents were managers who had been involved in the industry for five years and below. This is a small number, possibly of young project managers who had recently entered the project industry. The largest number of respondents, 42%, were managers who had been in the industry for 11-15 years, signaling a good pull of experience, possibly in their mid or late 30s. The specific ages of the project managers was not given as a requirement in the survey.

**Research question**: For how long has your firm been in existence?
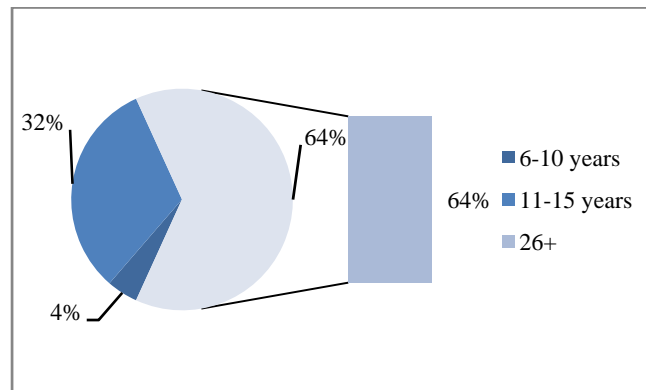


**Figure 2    No. of Years Company in Operation**

None of the firms visited had less than six years of existence, most of the organizations were well known large companies. As shown in the Figure 2 above, 4% of the firms visited were between the ages of 6-10 years, 32% were between 11-15 years, no firms were between the ages 16-25 years, with 64% of these having existed for more than 26 years. This had an influence firms develop traditions in the way they do things. New managers are baptized into existing tools and techniques.

**Research question**: Your level of education

|           | No Education | Primary School | High school | Technical college | Varsity of Tech | Varsity |
|-----------|--------------|----------------|-------------|-------------------|-----------------|---------|
| Education | 0            | 0              | 0           | 17%               | 13%             | 70%     |

The level of education meant to draw a relationship between the level of education and some of the tools used in the industries. 70% had university qualification, no request was made to identify areas of specialization. It appears that employers tend to go for project managers with a high level of education, a few came from technical colleges. Surprisingly, very few came from universities of technology were industry related qualifications are expected to be taught. The research findings should be understood in the context of the biography of the project managers and the history of the firms concerned.

### 3.2 Project Management Tools

Tools are the equipments that are used by the project manager to effective and efficiently execute the project. In this paper the tools that were investigated are; the project charter, the Gantt chart, the critical path method and resource smoothing. The purpose was to identify tools that project managers use more frequently and their important in project management processes. A Linkert scale type measurement system was used to identify project managers' preferences according to how they valued these tools.

The questionnaire clarified the use of the scale, thus; 1 = has some value, 2 = once in a while, 3 = important, 4 = very important, and 5 = critically important. Percentages were thus computed from the data collected, and are illustrated as tables and graphs below. Each is preceded by the research question, and a brief explanation.

**Research question**: Rate the importance of the Project charter in project management.

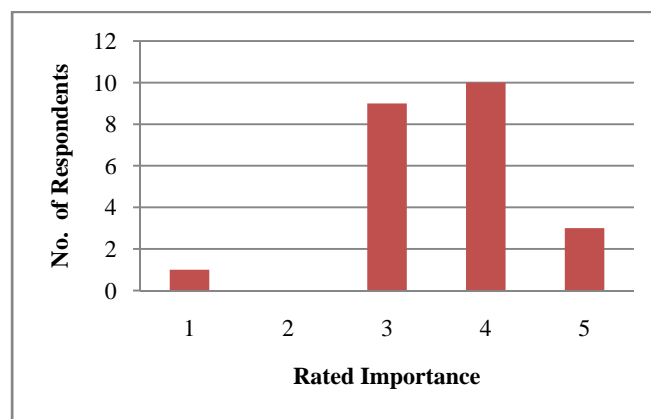| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 5% | 0 | 16% | 65% | 14% |



**Figure 3    Importance of the Project Charter**

65% of the respondents feel that the project charter is very important, but not critically important, not indispensable, this contrasted to 5% of the respondents that think that it has some value. The project charter is also referred as the statement of works (SOW) and primarily includes amongst other items; project objectives, list of deliverables, milestones, technical requirements, limits and exclusions and regular reviews with the customer. The project charter was therefore judged overwhelmingly as very important with only 14% thinking of it was indispensable.

**Research question**: Rank the importance of the Gantt chart according to the scale below.
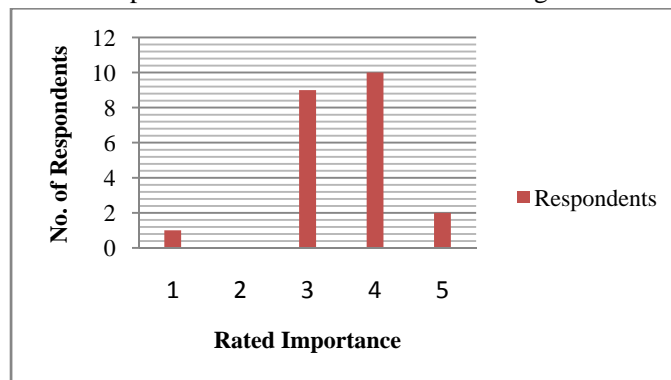


**Figure 4    Importance of Gantt Chart**

The Gantt chart, as a tool is ideal for monitoring and communicating project schedule status towards milestones, it is referred to in literature as the most favored and well understood tool (Gray & Larson, 2008, p. 422), yet the survey does not show an overwhelming choice of this tool by the project managers. 40% of the project managers consider it to be important, 32% consider it to be very important with 23% thinking of the Gantt chart as critically important.

**Research question**: Rank the importance of the product breakdown structure below.
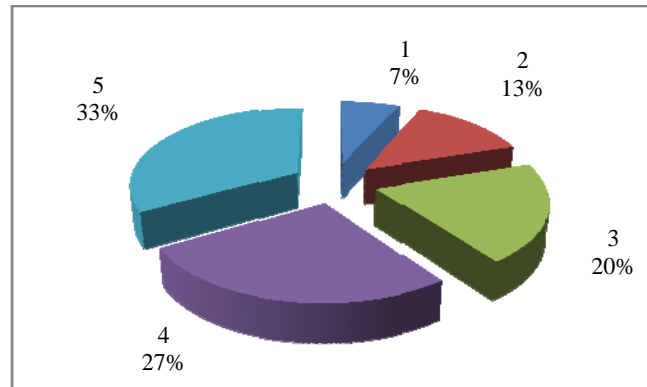


**Figure 5    Production Breakdown Structure**

Product breakdown structure (PBS) is essentially the same as the Work Breakdown Structure, the difference in literature is referred as the extent to which a WBS is properly done. 50% of the project managers felt that it is critically important for the purposes of effective project execution, this figure compared to the percentage score of the foregoing tools on this ranking. It would therefore appear that project managers seem to have a higher dependence on this tool than they do on the other tools above. No reason was required from the respondents, but assumptions were made that the PBS may be comparatively easier to construct and to monitor, and possibly easier to understand. This raises yet another research question; Is there any specific interests in the use of certain tools in relation to the type of project?

**Research question**; Rank the importance of the critical path method in project management.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
|  | 0 | 24% | 47% | 29% |

The Critical Path Method is a modeling process that defines all the critical activities of the project to be completed within the limits of the iron triangle of project management; time, cost and quality. This method helps identify the slacks (activities that can be postponed without delaying the completion of the project) of the project, it shows the order. It is ideal to introduce this at the planning phase, and carry it through the implementing phase. The start and finish dates are clearly stated, and many times most of the activities are outside the skills-scope of the project manager, the designers therefore make the predictions that are used by the manager. 29% of the project managers considered this as critical to effective project management, against 47% who think it is important. Again, there should have been a classification of the industries to allow for an informed analysis identifying particular industries that may be prone to use of certain tools, influenced by the nature of their operations.

**Research question**: Rank the importance of resource smoothing in project management

This is the process of assigning resources to critical areas or activities to avert any delays to the execution of the project. This process seeks to maximize the use of resources and minimize the demand and reduce wastage of

both time and material resources. For an effective resource smoothing activity to take place, there is a need for adequate resource planning. 33% of the respondents considered use of resource smoothing as very important in project execution, 27% thought it was important, and 20% thought it was average, but necessary. See the diagram below.
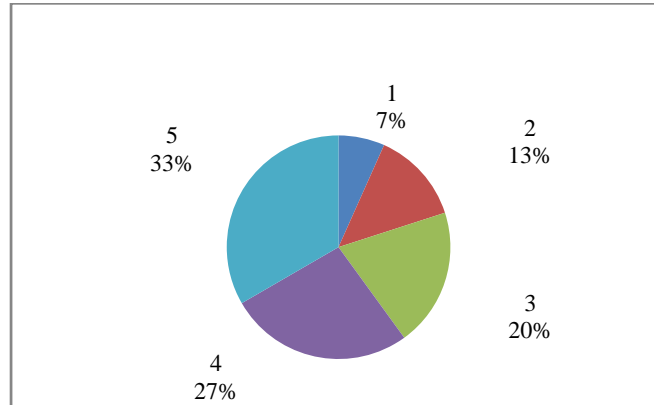


**Figure 6    Resource Smoothing**

### 3.3 Limitation of the Study

Despite the effort to be as comprehensive as possible, the survey did not differentiate between the industries to identify possible differences in application of certain tools according to the industry. The questionnaire had to be as short as possible because of the nature of operations in project environments. There is extra sensitivity to time and most interviews were carried out during tea and lunch breaks, that too with too much disgruntlement from the respondents who felt their personal time was used for things that had nothing to do with their duties. The greatest limitation therefore stems from the investigation of the use of these tools as more in a generic sense and not focused on specific industries.

## 4. Conclusion

Tools are closely related to techniques, techniques are systematic procedures that the project manager uses in the process of using tools for effective project execution. The foregoing data suggests to us that there are certain tools that project managers; give preference to, consider more valuable, are expected to use because of either the type of industry or the tradition of the firm or merely because there is nothing else they may know and intend to use.

Contrary to what is recorded in most literature, it would appear therefore that project managers would generally prefer to use the WBS (50%), this is followed by the CPM (29%) before Gantt chart at 23%.

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