International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 03 | Mar 2025 www.irjet.net p-ISSN: 2395-0072

Influence of Project Management Techniques of Medium-Level Building on Project Productivity in Kirinyaga County, Kenya

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Abstract
Results from various studies have consistently shown that construction projects often times encounter cost overruns, time overruns and are not completed to the expected quality standards. These setbacks could be avoided by an improvement on how the projects are managed during execution phase. Studies also show that a sizeable group of project managers are not familiar with project management techniques and that only a few implemented them effectively. The objective of this study was therefore to determine the influence of project management techniques on medium-level building projects productivity. The management techniques considered were; Construction planning, Scheduling, Time control, Resource control and Cost control. Structured questionnaires were administered to seven categories of study participants considered key stakeholders. These comprised landlords/homeowners, architects, structural engineers, quantity surveyors, building contractors, construction project managers, and Ministry of Housing and Infrastructure officials. Descriptive and correlational analysis methods were used to analyze data. The three traditional factors of construction productivity i.e. time, quality and cost were emphasized.

The results from the study underscores the importance of construction planning through proper coordination between members and ensuring quality control at every stage. The importance of scheduling in managing time is also reinforced. Results reveal that poor time management negatively affects productivity while resource control is useful in ensuring that the right resources are available to the project manager at the right time and place. Lastly, it was found out that keeping track of the costs, delivering the project within scope and budget were critical cost factors affecting project productivity.

Keywords. Project management techniques, project productivity, Project completion time, Project quality, Project costs.

1 Background Information

Project management involves planning, organization, monitoring and control of all project aspects so as to achieve project goals on a safer manner, within agreed schedule, budget and performance criteria [11]. The role of a construction project manager is therefore to plan, coordinate, budget and supervise the project from the beginning to the end. The project manager should use project management techniques or tools to ensure successful completion of the project within the set time limits. Studies by [4 &25] reveal that though not all project management tools and techniques directly contributes to project success, literature review does not identify any project which has successfully been completed without utilization of basic management practices. Further, [25] found that only 50% of project managers are familiar with project management tools and techniques and that only 28% implement them effectively. Based on these findings, the question that therefore arises is not of whether to use but that of the extent of influence (i.e. optimization) of management techniques on project productivity. It is on that basis that this study sought to determine the influence of management techniques on project productivity. The factors studied are; construction project planning, scheduling, time control, resource control and cost control.

Poor or ineffective management practices have adverse effects on cost in terms of cost overruns in building construction projects. [23] argued that to avoid cost overruns, there should be effective project management inculcating integrated project planning and scheduling with comprehensive scope management, effective cost estimation with monitoring and control, and effective communication with timely risk identification and mitigation. [17] outlines the planning processes as consisting of those processes performed to establish the total scope of the effort, define and refine the objectives and develop the course of action required to attain those objectives. [15] noted that effective planning and scheduling ensures that projects are completed on time, within budget, and to the required quality standards.

Schedules are processes of fitting the work plan to a time frame indicating the start and completion of each activity and the sequence into which various activities are to be executed. They are also prepared for construction resources such as labor, material, machinery and money required at various stages of work. [24] found out that a schedule management plan helps in time management of each project along with providing the facility of

monitoring different tasks in a project. They argued that this aspect not only provides the benefit of optimal usage of resources, timely completion of projects, and effective results but also helps in enhancing the productivity of employees.

To complete a project within a stipulated time, time management is a vital technique so as to avoid problems such as the need for extension of time or to avoid time overruns. Some of the methods used in time management include Gantt charts, critical path method, PERT, among others [22]

The required resources for construction projects should be planned and procured in time so that the construction activities can be executed within scheduled time [14]. This is because the increase in activity duration also leads to increase in costs. [5] stated that improper resource utilization has impact on various costs, profit margins, quality of the projects and project completion time, amongst others. On their part, [10] did indicate that proper optimization of resources is very important to reduce the overall project costs. This could be achieved through resource allocation and resource levelling. For resource optimization, the resources involved in an activity and its cost awareness are required. The percentage variance between the estimated consumption and the actual consumption of resources is between 2 and 12%. Lean principles can be adopted for maximum utilization of resource [18]. Cost management is an important tool to control and improve cost performance of a construction project; it helps to keep the project within the budget. Critical ingredients of cost management are budgeting, estimating, cost planning and control, cash flow forecasting, cost code system, financial cost reporting and judgement [22].

2 Research Methodology

Descriptive and diagnostic research designs were used in this study. Seven categories/groups considered to be key stakeholders in the construction sector were selected as the target population. They included landlords/homeowners, architects, structural engineers, quantity surveyors, contractors, construction project managers, and Ministry of housing and infrastructure officials of Kenya.

The sampling technique adopted was stratified random sampling. The sample size comprised of 202 respondents subdivided into seven subgroups/subsets depending on the importance of each subgroup/subsets. Data was collected through questionnaires which were dispatched to the target population groups. The questionnaire was subjected to a rating on a Likert scale containing five factors, that is, **1**. Very little extent, **2**. Little extent, **3**. Neutral, **4**. Large extent and **5**. Very large extent. The data was analyzed through descriptive and correlational analysis methods. The management techniques assessed to show their effect on construction productivity were; construction planning, construction scheduling, construction time control, construction resource control, and construction cost control. Further, a scrutiny was carried out to determine how project completion time, project quality and project expenditure factors affected construction project productivity in each of the above mentioned management techniques.

3 Results and Discussion

The way a project is managed during the construction phase contributes a sizeable percentage of the extent to which project productivity is achieved.

3.1 Effect of Construction Planning Techniques

3.1.1 On Project Completion Time

The results of the effect of construction planning techniques on project completion time are shown in Table 3.1. By comparing the mean scores and the respective standard deviations, it is established that all the factors were ranked high implying that they were all important but the most important was factor 5, i.e., proper coordination between members, since it helps in avoiding of delays at various construction stages. This factor had a score of 3.96±1.016, and the view was supported by 48.8% of the respondents on a large extent. This factor had a low standard deviation of 1.016 implying that it had good stability of ideas. This finding was reinforced by another finding from a study conducted by [2], who found that difficulties of coordination between various parties working on a project to be highly significant at 62% in the ranking of factors influencing implementation of project planning.

Table 3.1: Effect of construction planning techniques on project completion time

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	49.0	Large extent	2.0	Very little extent	3.78	1.045
2	52.5	Large extent	5.0	Very little extent	3.77	1.065
3	48.0	Large extent	4.0	Very little extent	3.67	1.057
4	46.5	Large extent	4.5	Very little extent	3.86	1.098

5	48.8	Large extent	3.5	Very little extent	3.96	1.016
6	36.6	Large extent	3.0	Very little extent	3.67	1.075
7	40.3	Large extent	4.5	Very little extent	3.68	1.090

In the table: **1,** Preparation of a programme of work and planning methods of instruction; **2**, Planning to organize various activities of construction work; **3**, Scrutiny of specific details for the execution of the project; **4**, Good communication planning between stakeholders should be carried out; **5**, Proper coordination between members avoids delay at various stages; **6**, Use of alternatives to ensure proper utilization of resources materials; **7**, Shows information regarding date and time of start and completion of work. **Stdev**., standard deviation

Under descriptive statistics, a high mean implies that many respondents agreed with the variable while a low standard deviation indicates that there is good stability of ideas [21]. In quantitative surveys, the collected data can be ranked based on mean scores to reveal trends, averages and frequencies. The following ranking criteria according to [6], based on a 5 point Likert scale, was adopted in this study: **1**= Very low (≥1.00 and ≤ 1.79), **2**= Low (≥1.80 and ≤ 2.59) ,**3**= Medium (≥2.60 and ≤ 3.39), **4**= High (≥3.40 and ≤ 4.19), **5**= Very high (≥4.20 and ≤ 5.00). From the results in Table 3.1, it is noticed that all the construction planning techniques considered highly affected project completion time, as per [6].

3.1.2 On Project Quality

The achievement of quality at every stage was identified as the most important factor in project quality control based on the mean scores (Table 3.2). The achievement of project quality is a continuous process based on every stage and not a one-time measurement, as indicated by factor 4 in the table. This view was supported by 50.0% of the respondents on a large extent scale. The finding is in agreement with [19], who puts this matter into perspective by asserting that, 'Quality management is basically not an event but a process'. However, as per [6], all the construction techniques considered highly affected project quality as the mean scores lay between 3.40 and 4.19, with the lowest value being 73.4% of the upper limit of 5 scale

Table 3.2: Effect of construction planning techniques on project quality

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	49.0	Large extent	2.0	Very little extent	3.84	1.045
2	47.0	Large extent	2.5	Very little extent	3.83	1.023
3	49.5	Large extent	3.0	Very little extent	3.67	1.019
4	50.0	Large extent	10.4	Very little extent	3.97	0.903

In the table:1, Preparation of quality control plan and quality assurance plan; **2**, It is a plan that shows everything to be done to ensure quality; **3**, Shows that the defined objective of the product will be achieved; **4**, Quality can be achieved at every stage. **Stdev**., standard deviation

3.1.3 On Project Costs

Based on the mean scores, it was established that construction planning greatly contributes to project success by ensuring that the project runs as per planned scope and budget (factor 4). This factor had a mean of 4.11 and a low standard deviation of 0.945 (Table 3.3), and the view was supported by 42.1% of the respondents on a large extent. This finding agrees with the finding by [3], who emphasized the importance of a construction plan on project management as it provides a layout of how the project will be executed within the scheduled period of time so that cost and expenses are not exceeded and at the same time maintaining the specified quality. Once again, as per [6], all the construction techniques considered highly affected project cost as the mean scores lay between 3.40 and 4.19, with the lowest value being 78.8% of the upper limit of 5 scale.

Table 3.3: Effect of construction planning techniques on project costs

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	52.7	Large extent	2.0	Very little extent	3.94	0.949
2	46.0	Large extent	2.0	Very little extent	3.86	1.013
3	46.8	Large extent	2.5	Very little extent	4.05	0.931
4	42.1	Large extent	2.0	Very little extent	4.11	0.945

In the table: **1**, Preparation of a project plan, resource plan, finance plan, risk plan and procurement plan have a bearing on project expenditure; **2**, Saves resources and reduces cost; **3**, Ensures project success; **4**, Ensures that project runs as per scope and budget. **Stdev**., standard deviation

3.1.4 Total Variance Analysis of Project Planning Techniques on Project Productivity

It was established that the Kaiser-Meyer-Olkin measure of sample adequacy was 0.898 while the Bartlett's test of sphericity was 0.000. The KMO measure varies between 0 and 1; the closer the values are to 1 the better the results are, but the general acceptance index is 0.6. The Bartlett's test of sphericity should be significant at $p<0.05$[8].

Table 3.4: Total variance analysis of project planning techniques on project productivity

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.854	45.691	45.691	6.854	45.691	45.691	4.206	28.038	28.038
2	1.802	12.013	57.704	1.802	12.013	57.704	2.792	18.612	46.650
3	1.057	7.047	64.751	1.057	7.047	64.751	2.715	18.100	64.751
4	.879	5.861	70.612						
5	.677	4.513	75.125						
6	.595	3.966	79.091						
7	.551	3.676	82.767						
8	.486	3.240	86.007						
9	.446	2.974	88.981						
10	.380	2.535	91.516						
11	.333	2.217	93.733						
12	.274	1.828	95.561						
13	.238	1.590	97.151						
14	.222	1.478	98.629						
15	.206	1.371	100.000						
Extraction Method: Principal Component Analysis.									

3.1.5 Correlation Matrix for Project Planning Techniques on Project Productivity

In this study, the Pearson correlation type of correlation matrix was used. In Pearson correlation, a coefficient of 0.00 to 0.10 denotes a negligible correlation, 0.10 to 0.39 denotes a weak correlation, 0.40 to 0.69 denotes a moderate correlation, 0.70 to 0.89 denotes a strong correlation and 0.90 to 1.00 denotes a very strong correlation [20]. Results in Table 3.5 indicate that factor 3 -scrutinizing specific details in project execution is quite important when preparing a program of work and planning methods of instruction. This finding is as a result of correlating two variables (i.e., 1 &3). This aspect has an impact on project completion time. It had a moderate correlation index of 0.652, however, variables 3 and 4 had a similar correlation index but could not be correlated since they contained almost similar information. The study also reveals that by ensuring that the project runs as per planned scope and budget, the planning techniques ensures project success. This finding is as a result of correlating two variables (i.e., 14 & 15). A correlation index of 0.743 was used to arrive at this conclusion.

Table 3.5: Correlation matrix for planning techniques on project productivity

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.000	.733	.652	.489	.447	.409	.426	.416	.313	.347	.483	.430	.326	.291	.293
2	.733	1.000	.706	.593	.545	.482	.540	.514	.445	.399	.399	.490	.300	.317	.319
3	.652	.706	1.000	.652	.503	.519	.433	.465	.346	.319	.311	.464	.323	.301	.237
4	.489	.593	.652	1.000	.374	.390	.381	.413	.330	.271	.264	.414	.181	.205	.169
5	.447	.545	.503	.374	1.000	.564	.525	.391	.424	.317	.344	.445	.412	.451	.410

6	.409	.482	.519	.390	.564	1.000	.502	.364	.324	.338	.274	.306	.259	.286	.180
7	.426	.540	.433	.381	.525	.502	1.000	.419	.424	.467	.333	.441	.284	.323	.291
8	.416	.514	.465	.413	.391	.364	.419	1.000	.639	.574	.530	.484	.312	.375	.382
9	.313	.445	.346	.330	.424	.324	.424	.639	1.000	.675	.504	.378	.463	.431	.470
10	.347	.399	.319	.271	.317	.338	.467	.574	.675	1.000	.543	.395	.412	.380	.414
11	.483	.399	.311	.264	.344	.274	.333	.530	.504	.543	1.000	.368	.395	.477	.506
12	.430	.490	.464	.414	.445	.306	.441	.484	.378	.395	.368	1.000	.435	.369	.412
13	.326	.300	.323	.181	.412	.259	.284	.312	.463	.412	.395	.435	1.000	.579	.535
14	.291	.317	.301	.205	.451	.286	.323	.375	.431	.380	.477	.369	.579	1.000	.743
15	.293	.319	.237	.169	.410	.180	.291	.382	.470	.414	.506	.412	.535	.743	1.000

In the table: **1**, Preparation of a programme of work and planning methods of instruction;, **2**, Planning to organize various activities of construction work; **3**, Scrutiny of specific details for the execution of the project; **4**, Good communication planning between stakeholders should be carried out; **5**, Proper coordination between members avoids delays at various stages; **6**, Use of alternatives to ensure proper utilization of resources; **7**, It shows information regarding date and time of start and completion of work activities; **8**, Preparation of a quality control plan and quality assurance plan; **9**, It is a plan that shows/states everything to be undertaken to ensure quality of the project is achieved; **10**, It shows that the defined objective of the product will be achieved; **11**, Quality can be achieved at every stage; **12**, Preparation of a project plan, resource plan, finance plan, risk plan and procurement plan. They have a bearing on project expenditure; **13**, Saves resources and reduces cost; **14**, Ensures project success; **15**, Ensures that the project runs as per the planned scope and budget.

3.2 Effect of Construction Scheduling Techniques

3.2.1 On Project Completion Time

Based on the mean scores shown in Table 3.6, the results show that the most important factor in scheduling techniques is that they are used by the contractors to manage time and execute activities in a proper sequence (factor 5). This factor had a mean of 4.07 and a standard deviation of 0.946. The view was supported by 45.5% of the respondents on a large extent. The finding aligns with that of [13] who argued that contractors require scheduling to calculate the project completion date as well as to improve work efficiency, which in turn saves time and money. The least factor among those considered was that it shows sequential relationships among various activities. This factor had the lowest mean of 3.97 and a standard deviation of 0.897. However, as per [6], all the scheduling techniques considered highly affected project completion time as the mean scores lay between 3.40 and 4.19, with the lowest value being 79.4% of the upper limit of 5 scale.

Table 3.6: Effect of construction scheduling techniques on project completion time

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	54.5	Large extent	3.0	Very little extent	3.98	0.927
2	52.0	Large extent	2.0	Very little extent	3.97	0.897
3	45.5	Large extent	1.5	Very little extent	3.99	0.959
4	45.3	Large extent	3.5	Very little extent	3.99	0.997
5	45.5	Large extent	2.0	Very little extent	4.07	0.946

In the table: **1**, Helps you to fit work plan into a particular time frame; **2**, Shows sequential relationships among various activities; **3**, Used to show construction resources required at various stages of work; **4**, Used to monitor the actual progress of each activity; **5**, Used by contractors to manage time and execute activities in proper sequence. **Stdev.,** standard deviation

3.2.2 On Project Quality

The results in Table 3.7 show that scheduling techniques assist an individual do the right things in a better way and in a faster way in addition to increasing the project productivity. It was considered the most important factor affecting project quality with a higher mean of 4.01 and a standard deviation of 0.985. It is noted that according to [6], all the scheduling techniques considered highly affected project quality as the mean scores lay between 3.40 and 4.19, with the lowest value being 78.2% of the upper limit of 5 scale. This view was supported by 43.1% of the respondents on a large extent.

Table 3.7: Effect of construction scheduling techniques on project quality

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	47.0	Large extent	1.5	Very little extent	3.91	0.970
2	45.0	Large extent	2.0	Very little extent	3.93	1.141
3	47.0	Large extent	1.0	Very little extent	4.00	0.946
4	43.1	Large extent	2.0	Very little extent	4.01	0.985

In the table: **1**, The project is completed within time, within budget and to the required quality standards; **2**, Omissions, errors and mistakes and reworks are significantly reduced or eliminated; **3**, Enables you to prioritize important tasks and identify potential time wasters; **4**, Helps you to do the right things better, faster and also increase productivity. **Stdev**., standard deviation

3.2.3 On Project Costs

Based on mean scores and standard deviations, the results in Table 3.8 show that the most important cost factor in scheduling is that it helps the client and the contractor to plan their finances (factor 2 with a score of 4.17±0.847). This view was supported by 50.5% of the respondents on a large extent. This finding aligns with that of [14] who indicated that one of the needs of having a construction schedule is to predict and calculate the cash flow. Equally, [24], examined the impact of schedule management on project management effectiveness and listed economic factors as one of them. In it, they argued that along with financial benefits, other benefits included generation of employment and regional economic development of the location of the project. However, as per [6], all the scheduling techniques considered highly affected project costs as the mean scores lay between 3.40 and 4.19, with most of them (83.3%) scoring above 79.2% of the upper limit of 5 scale.

Table 3.8: Effect of scheduling techniques on project costs

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	53.5	Large extent	3.5	Very little extent	3.63	1.015
2	50.5	Large extent	0.5	Very little extent	4.17	0.847
3	52.5	Large extent	0.5	Very little extent	4.05	0.842
4	46.0	Large extent	2.5	Very little extent	4.04	0.958
5	53.0	Large extent	1.5	Very little extent	4.10	0.864
6	44.1	Large extent	3.0	Very little extent	3.96	1.026

In the table: **1**, You prioritize only the important tasks; **2**, It helps the client and the contractor to plan their finances; **3**, It allows the contractor to track and speed up on the construction activities; **4**, Concurrent tasks can be done at the same time while critical path must be followed at all times; **5**, Helps contractor to monitor cash flow issues; **6**, Helps the client to verify payments. **Stdev**., standard deviation

3.2.4 Total Variance Analysis of Construction Scheduling Techniques on Project Productivity

It was established that the Kaiser-Meyer-Olkin measure of sample adequacy was 0.911 and Bartlett's test of sphericity was 0.000. Results for data loadings for the construction scheduling technique factors are as shown in Table 3.9. Based on these results, three principal components were extracted and renamed as follows. Component 1 was renamed 'construction project planning tasks sequencing factor'. It is the first major component and lays emphasis on sequencing of the most important tasks to be undertaken. Results show that the most important aspect of scheduling is that it is used by the contractors to manage time and also execute activities in a proper sequence. It has a variance of 47.52%. The second component was renamed 'construction project payment verification factor'. It lays emphasis on helping the client verify the payments. It has a variance of 9.76%. Component 3 was renamed 'construction project prioritizing factor'. It lays emphasis on prioritizing only the important tasks. It has a variance of 7.43%.

Table 3.9: Total variance analysis for construction scheduling techniques on project productivity

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.128	47.519	47.519	7.128	47.519	47.519	4.049	26.993	26.993
2	1.463	9.757	57.275	1.463	9.757	57.275	3.140	20.931	47.924
3	1.114	7.430	64.705	1.114	7.430	64.705	2.517	16.781	64.705
4	.806	5.375	70.080						
5	.646	4.306	74.385						
6	.584	3.894	78.280						
7	.536	3.576	81.856						
8	.483	3.219	85.075						
9	.449	2.991	88.066						
10	.391	2.608	90.674						
11	.357	2.379	93.053						
12	.326	2.176	95.229						
13	.258	1.723	96.951						
14	.236	1.576	98.527						
15	.221	1.473	100.000						
Extraction Method: Principal Component Analysis.									

3.3 Effect of Construction Time Control Techniques

3.3.1 On Project Completion Time

The results in Table 3.10 show that the most critical time factor affecting project completion time was poor time management (factor 2 with a mean score of 4.32±0.840). Poor time management often leads to extension of time, conflict between parties involved in a construction project and failure in project delivery. The factor was supported by 48.0% of the respondents on a very large extent. Often, poor time management leads to delay either in some particular tasks or to the entire project. This finding is in line with that of [7] who found that scheduling and control was one of the causes of delays in building construction projects in Egypt. It was established that, according to [6], all the construction time control techniques considered highly affected project completion time as the mean scores lay between 3.40 and 4.19, with most of them (75.0%) scoring above 80.8% of the upper limit of 5 scale.

Table 3.10: Effect of construction time control techniques on project completion time

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	54.5	Large extent	0.5	Very little extent	4.17	0.767
2	48.0	Very large extent	0.5	Very little extent	4.32	0.840
3	31.7	Large extent	3.5	Very little extent	3.62	11.114
4	45.5	Large extent	1.5	Very little extent	4.04	0.919

In the table: **1**, Helps to analyze what has been planned against what has been achieved; **2**, Poor time management often leads to time extension, conflict and failure in project delivery; **3**, Sometimes can lead to project abandonment, **4**; Time is considered to be a planning, identifying and evaluating level of achievement tool in construction projects. **Stdev**., standard deviation

3.3.2 On Project Quality

The results in Table 3.11 show that to a very large extent, 45.5% of the respondents had a view that poor time management has a negative impact on the project quality. This factor was considered to be important and had a mean score of 4.04±0.956. This finding could be reinforced by the understanding of factor 2, i.e., 'each task on a schedule is allocated some specific amount of time and therefore any reduction of this time without proportional addition of labour leads to haphazard execution of the task which ultimately leads to a lower quality product', which was supported by 51.0% of the study respondents. However, as per [6], all the construction time control techniques considered highly

affected project quality as the mean scores lay between 3.40 and 4.19, with all of them scoring above 78.4% of the upper limit of 5 scale.

Table 3.11: Effect of construction time control techniques on project quality

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mea	Stdev
1	43.1	Large extent	3.0	Very little extent	3.92	1.085
2	51.0	Large extent	1.5	Very little extent	4.00	0.938
3	45.5	Large extent	2.0	Very little extent	4.04	0.956

In the table: **1**, Quality is hinged on three factors namely scope, time and cost; **2**, Each task on schedule is allocated some specific amount of time and therefore any reduction of this time without proportional addition of labour leads to haphazard execution of the task which ultimately leads to a lower quality product; **3**, Time management directly impacts on the project quality, scope and cost. Good management of time helps secure a projects completion on time and on budget and also clarifies on how much time a project requires. **Stdev**., standard deviation

3.3.3 On Project Costs

Table 3.12 show that to a large extent, poor time controls often leads to project delays and cost overruns (factor 4). This aspect was considered to be critical in controlling project costs. It was supported by 49.0% of the study participants with a mean score of 4.34 and a standard deviation of 0.814. Nevertheless, according to [6],75.0% of the construction time control techniques considered highly affected project cost as the mean scores lay between 3.40 and 4.19.

Table 3.12: Effect of construction time control techniques on project costs

Factors	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	51	Large extent	1.5	Very little extent	3.97	0.956
2	30.2	Large extent	12.4	Very little extent	3.38	1.338
3	42.1	Large extent	3.5	Very little extent	3.85	1.045
4	49	Very large extent	1.0	Very little extent	4.34	0.814

In the table: **1**, Quality is hinged on three factors namely scope, time and cost; **2**, If some tasks are speeded up(crashed), then there is increased project expenditure/costs; **3**, If the tasks are executed as per the plan and schedule, then the project costs remain as budgeted for; 4; Poor time controls lead to project delays which further leads to cost overruns. **Stdev**., standard deviation

3.3.4 Total Variance Analysis of Time Control Techniques on Project Productivity

It was found that the Kaiser-Meyer-Olkin measure of sample adequacy was 0.911 and the Bartlett's test of sphericity was 0.000. The results for data loadings for the time control techniques are presented in Table 3.13. The results show that two principal components were extracted and renamed as follows. Component 1 was renamed 'construction project time factor'. This is the first component and lays emphasis on the effect of use of time in relation to project completion time, quality and cost. With a variance of 44.48%, the importance of time controls on project productivity is greatly reinforced. Component 2 was renamed 'construction crashing factor'. In it, the emphasis is on crashing the activity. The result indicates that crashing an activity leads to increased costs. It had a variance of 11.34%.

Table 3.13: Total variance analysis of time control techniques on project productivity

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.892	44.475	44.475	4.892	44.475	44.475	3.638	33.074	33.074
2	1.247	11.337	55.812	1.247	11.337	55.812	2.501	22.739	55.812
3	.943	8.576	64.388						

4	.818	7.440	71.828						
5	.670	6.095	77.923						
6	.558	5.069	82.992						
7	.531	4.828	87.820						
8	.433	3.932	91.753						
9	.377	3.425	95.178						
10	.289	2.630	97.808						
11	.241	2.192	100.000						
Extraction Method: Principal Component Analysis.									

3.4 Effect of Construction Resource Control Techniques

3.4.1 On Project Completion Time

As per Table 3.14, out of the three variable factors considered, on a large extent 45.0% of the study respondents indicated that good resource control techniques help to ensure that the right resources are available to the project manager at the right time and place (factor 3). This aspect was considered to be a very important resource control factor affecting project completion time. It had a higher mean score of 4.18 and a standard deviation of 0.885. It was established that 53.0% of the study respondents, on a large extent indicated that a resource management software can be used by a manager to keep track of resource availability, utilization, allocation and tracking to ensure project completion on time. [26] opined that optimizing resources utilization can help reduce time and cost. However, as per [6], all the construction time control techniques considered highly affected project completion time as the mean scores lay between 3.40 and 4.19, with all of them scoring above 75.2% of the upper limit of 5 scale.

Table 3.14: Effect of construction resource control techniques on project completion time

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	53.0	Large extent	3.0	Very little extent	3.76	1.028
2	48.0	Large extent	2.0	Very little extent	4.04	0.935
3	45.0	Large extent	0.5	Very little extent	4.18	0.885

In the table: **1**, A resource management software can be used by a manager to keep track of resource availability, utilization, allocation and tracking; **2**, Poor resource scheduling causes delays in individual tasks and a subsequent delay in the entire project; **3**, Good resource control techniques help ensure that the right resources are available to the project manager at the right time and place. **Stdev**., standard deviation

3.4.2 On Project Quality

From Table 3.15, it was found that the allocation of the right personnel for the right tasks to be the most critical resource control factor affecting project quality (factor 2). This factor had a mean of 4.18 and a standard deviation of 0.863. Equally also, 56.4% of the study respondents indicated that the techniques allow the right tools and equipment to be used for the right tasks. Nevertheless, according to [6], all the construction resource control techniques considered highly affected project quality as the mean scores lay between 3.40 and 4.19, with all of them scoring above 79.2% of the upper limit of 5 scale.

Table 3.15: Effect of construction resource control techniques on project quality

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	56.4	Large extent	1.5	Very little extent	3.96	0.891
2	48.5	Large extent	1.0	Very little extent	4.18	0.863
3	50.2	Large extent	0.5	Very little extent	4.09	0.834
4	48	Large extent	0.5	Very little extent	4.16	0.845

In the table: **1**, It allows the right tools and equipment to be used for the right tasks; **2**, It allows allocation of the right personnel for the right tasks hence quality workmanship; **3**, Allows allocation of sufficient funds for each task/activity; **4**, Procurement of quality materials for each task is carried out hence quality Product. **Stdev**., standard deviation

3.4.3 On Project Costs

The allocation of tasks to the right human resource personnel was considered to be the most critical resource control factor affecting project costs (factor 2 in Table 3.16). This factor had a mean score of 4.08 and a standard deviation of 0.908. The view was supported by 45.0% of the respondents on a large extent. It is important to note that though factor 4 had a higher mean than factor 2, it did not have stability of ideas since its standard deviation was very high, i.e., 2.975. According to [6], 80% the construction resource control techniques considered highly affected project completion time as the mean scores lay between 3.40 and 4.19, with most of them (75.0%) scoring above 80.0% of the upper limit of 5 scale.

Table 3.16: Effect of construction resource control techniques on project costs

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	44.1	Large extent	2.0	Very little extent	4.06	1.001
2	45.0	Large extent	0.5	Very little extent	4.08	0.908
3	41.1	Large extent	2.0	Very little extent	3.86	1.058
4	42.6	Large extent	1.0	Very little extent	4.28	2.975
5	39.6	Large extent	1.5	Very little extent	4.00	1.027

In the table: **1**, Wastage of materials is reduced since only the required materials are procured for the tasks/activities involved; **2**, Tasks are allocated to the right human resource personnel; **3**, Theft of resources is greatly reduced; **4**, Right tools/equipment's are either hired or bought for the right tasks; **5**, Items of plant are fully utilized hence reduction of idle time for those resources. **Stdev**., standard deviation.

3.4.4 Correlation Matrix and Total Variance for Resource Control Techniques

The results in Table 3.17 show that there is a strong correlation of 0.720 between poor resource scheduling and availability of resources to the project manager at the right time and place. Poor resource scheduling is responsible for delays in individual tasks and subsequent delay in the entire project.

Table 3.17: Correlation matrix for resource control techniques

		1	2	3	4	5	6	7	8	9	10	11	12
Correlation	1	1.000	.553	.528	.462	.390	.445	.389	.577	.491	.435	.174	.419
	2	.553	1.000	.720	.392	.467	.353	.483	.547	.566	.390	.146	.457
	3	.528	.720	1.000	.384	.425	.431	.395	.509	.561	.364	.236	.534
	4	.462	.392	.384	1.000	.648	.618	.460	.411	.456	.423	.027	.371
	5	.390	.467	.425	.648	1.000	.560	.439	.470	.461	.374	.038	.418
	6	.445	.353	.431	.618	.560	1.000	.537	.499	.505	.492	.132	.438
	7	.389	.483	.395	.460	.439	.537	1.000	.455	.510	.413	.109	.357
	8	.577	.547	.509	.411	.470	.499	.455	1.000	.680	.527	.020	.602
	9	.491	.566	.561	.456	.461	.505	.510	.680	1.000	.539	.062	.666
	10	.435	.390	.364	.423	.374	.492	.413	.527	.539	1.000	.199	.524
	11	.174	.146	.236	.027	.038	.132	.109	.020	.062	.199	1.000	.209
	12	.419	.457	.534	.371	.418	.438	.357	.602	.666	.524	.209	1.000

In the table: **1**,a resource management software can be used by a manager to keep track of resource availability, utilization, allocation and tracking **2**,poor resource scheduling causes delays in individual tasks and a subsequent delay in the entire project; **3**,Good resource control techniques help ensure that the right resources are available to the project manager at the right time and place;**4**, , it allows the right tools and equipment to be used for the right tasks; **5**, it allows the allocation of the right personnel for the right tasks hence quality workmanship ; **6**, allows allocation of sufficient funds for each task/activity; **7,** procurement of quality materials for each task is carried out hence quality product; **8**,wastage of materials is reduced since only the required materials are procured for the tasks/activities involved; **9**,tasks are allocated to the right human resource personnel; **10**,theft of resources is greatly reduced; **11**,right tools/equipment are either hired or bought for the right tasks; **12**, items of plant are fully utilized hence reduction of idle time for those resources.

It was established that the Kaiser-Meyer-Olkin measure of sample adequacy was 0.892 and the Bartlett's test of sphericity was 0. 000., The data loadings for the construction resource control factors are as shown in

Table 3.18. Two principal components were extracted and renamed as follows. Component 1 was renamed 'construction project resource allocation factor'. It has a variance of 48.93%. It is the first component and lays emphasis on allocation of resources for particular tasks. Component 2 was renamed 'construction project tools/equipment factor'. In this component, the emphasis is on source of the tools/equipment's, i.e., either hiring or buying. It has a variance of 9.67%. considered.

Table 3.18 Total variance analysis for resource control techniques on project productivity

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.872	48.934	48.934	5.872	48.934	48.934	4.124	34.370	34.370
2	1.160	9.665	58.599	1.160	9.665	58.599	2.907	24.228	58.599
3	.950	7.919	66.517						
4	.824	6.865	73.383						
5	.623	5.194	78.577						
6	.595	4.958	83.535						
7	.449	3.743	87.278						
8	.402	3.352	90.630						
9	.360	2.998	93.628						
10	.289	2.411	96.039						
11	.256	2.136	98.174						
12	.219	1.826	100.000						
Extraction Method: Principal Component Analysis.									

3.5 Effect of Construction Cost Control Techniques

3.5.1 On Project Completion Time

Based on the mean scores and standard deviations, it was established that the most critical cost control factor affecting project completion time is that it is useful in helping keep track of the costs, i.e., the actual costs against what was planned for (factor 2 in Table 3.19). To a large extent, this view was supported by 50.0% of the study respondents, and it had a score of 4.07±0.828.[22]observed that cost management is useful in keeping the project within the budget. [12] attributed poor performance of project costs to inadequacies of project control systems since they are responsible for monitoring project costs. As per [6], both construction cost control techniques highly affected project completion time as the mean scores lay between 3.40 and 4.19, with both of them scoring above 79.6% of the upper limit of 5 scale.

Table 3.19: Effect of construction cost control techniques on project completion time

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	55.0	Large extent	1.0	Very little extent	3.98	0.878
2	50.0	Large extent	0.5	Very little extent	4.07	0.828

In the table: **1**, During the planning stage, prepare a budget whereby each step/activity is allocated its budget and then leave an allowance for adjustments; **2**, Keep track of the costs i.e. the actual costs against what was planned for. This could be weekly, monthly or yearly depending with each project. **Stdev**., standard deviation

3.5.2 On Project Quality

With a mean score of 3.97 and a standard deviation of 0.925, factor 2 in Table 3.20 shows that cost control techniques are necessary for ensuring that the project is delivered with the scope. This view, to a large extent was supported by 48.0% of the study respondents. It is important to note that performance standards relate to achievement of quality. This finding aligns itself with the findings by [1] who underscored the importance of project control by indicating that it is based on three levels whereby one of the three levels is optimizing performance standards. It is noted that, according to [6], both construction cost control techniques highly affected project quality as the mean scores lay between 3.40 and 4.19, with both of them scoring above 77.4% of the upper limit of 5 scale.

Table 3.20: Effect of construction cost control techniques on project quality

Factor	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	52.5	Large extent	1.5	Very little extent	3.87	0.976
2	48.0	Large extent	1.0	Very little extent	3.97	0.925

In the table: **1**, By avoiding cost overruns, there is sufficient funds for each task/activity; **2**, Ensures that the project is delivered with the scope. **Stdev**., standard deviation

3.5.3 On Project Costs

Based on mean scores and standard deviations, it was established that the most important cost control factor affecting project costs was that it helps to keep the project within its budget (factor 3 with score of 4.08±0.992, Table 3.21). The view was supported by 44.8% of the respondents on a large extent. This finding is in agreement with that of [9] who noted that the project expenditure costs should be tracked and monitored over the entire project. That is in all stages from design to construction so as to ensure the increased expenditures are aligned with the anticipated targets. Also, [16] explained that cost controls measures entail the practice of managing project expenses using optimal procedures so as to avoid exceeding the budget. From the results, it established that as per [6], all construction cost control techniques highly affected project costs as the mean scores lay between 3.40 and 4.19, with all of them scoring above 76.4% of the upper limit of 5 scale.

Table 3.21: Effect of construction cost control techniques on project costs

Factors	Highest score (%)	Ranking	Lowest score (%)	Ranking	Mean	Stdev
1	54.0	Large extent	4.0	Very little extent	4.01	0.980
2	48.5	Large extent	2.0	Very little extent	3.82	1.008
3	44.8	Large extent	3.0	Very little extent	4.08	0.992

In the table: **1**, Poor cost control techniques cause cost overruns and hence poor profits on the contractor in addition to causing other problems to other stakeholders; **2**, Enables lowering of overall company's expenses through managing and analyzingfinancial data;**3**, Helps in keeping the project within its budget. **Stdev**., standard deviation

3.5.4 Total Variance Analysis of Cost Control Techniques on Project Productivity

It was found that the Kaiser-Meyer-Olkin measure of sample adequacy was 0.805 and the Bartlett's test of sphericity was 0.000. The results for data loadings for the construction cost control factors are presented in Table 3.22. Two principal components were extracted and renamed as follows. Component 1 was renamed 'construction project budget factor'. It has a variance of 52.91%. It is the first component and lays emphasis on tightening cost control to avoid cost overruns, deliver the project within the scope and stick to the project budget. Component 2 was renamed 'construction project costs tracking factor'. In this component, the emphasis is on budgeting and tracking the costs of each activity. It has a variance of 15.14%.

Table 3.22: Total variance analysis of cost control techniques on project productivity

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.703	52.905	52.905	3.703	52.905	52.905	2.859	40.836	40.836
2	1.060	15.143	68.049	1.060	15.143	68.049	1.905	27.213	68.049
3	.794	11.342	79.391						
4	.488	6.976	86.367						
5	.379	5.416	91.783						
6	.306	4.370	96.153						
7	.269	3.847	100.000						
Extraction Method: Principal Component Analysis.									

3.6 Conclusion

This study was commissioned to determine the influence of project management techniques of medium-level building projects productivity, a case study of Kirinyaga County, Kenya. Results derived from this study as per section 3.1 indicates that critical factors affecting construction planning were proper coordination between members, ensuring quality control at every stage and that construction planning techniques should be applied to ensure project success. Equally in section 3.2, the results show the importance of the use of scheduling techniques by contractors in management of time, executing activities in a proper sequence, ability to assist individuals to do the right things in a better way and in a faster way and helping the contractors plan their finances. Results of the study show that poor time management was a critical factor affecting project productivity (section 3.3). Section 3.4 outlines the importance of resource control techniques in ensuring that the right resources are available to the project manager at the right time and place; allocation of right personnel for the right tasks and the use of the right tools/equipment's. Lastly, Section 3.5 spells out the most important cost control factors affecting project productivity as keeping track of costs, delivering the project within scope and budget.

References

1. Acebes F, Pajares, J, Manuel, J.G and Lopez-Paredes, ''A new approach for project control under uncertainty. Going back to basics,''. International Journal of Project Management. 32(3): 2014, PP.423-434.

2. Akinola, A.G., Ogunde, A.O., Ogundipe, K.E and Akuete., E, ''Factors Influencing Construction Project Planning and Implementation. Lessons from South Western Nigeria,'' *International Journal of Mechanical Engineering and Technology, 10(4), 2019, pp. 1031-1042*

3. Akinradewo, O., Aigbavboa, C., Ikuabe, M., ''Project Planning: A Determinant of Project Delivery to Time and Cost,'' *Production Management and Process Control, Vol.36, 2022, 91-97. https://doi.org/10.54941/ahfe1001623*.

4. Al-Hajj, A & Sayers, A: Project Management Performance in the UAE Construction Industry. Conference, 2014, ICCCBE/ASCE/CIB W078. At Orlando, USA

5. Balaji, V & Venugopal, P, (2017): Resource Utilization in Construction Projects and its Impacts of High Ranked Variable during Time Overrun. International Journal of Current Engineering and Scientific Research, 2017, Vol (4), Issue (7), PP. 31-35

6. Çelik, G.T., Oral, E.L., ''Big Five and Organizational Commitment- The Case of Turkish Construction Professionals,'' Hum. Resour. Manag, 2016, Eco, 30, 903-914.

7. El- Razek, A.B.D, Bassioni, H.A and Mobarak, A.M, ''Causes of Delay in Building Construction Projects in Egypt,''Journal of Construction Engineering and Management, 2008, @ ASCE/Nov. 2008/831

8.Hoque, A.S.M.M & Awang, Z, ''Exploratory Factor analysis of entrepreneurial Marketing: Scale development and validation in the SME Context of Bangladesh,'', 2016, Proceedings of the international social sciences and tourism research conference, 2016.

9. Hwang B.G., Shan M., Zhu L, Lim W.C, ''Cost Control in Megaprojects: Efficacy, tools and techniques, key knowledge areas and project comparisons,'' International Journal of Construction Management, 2018; 20(5): PP. 437-449.

10. Maruthi, S., Patil, J.R., and Rohit S. Agawane, R.S, ''Optimization for Fluctuation in Resource Demands in Construction Projects,'' International Research Journal of Engineering and Technology, June 2015, Vol.2, Issue 3, PP.1289-1296.

11.Mladen R. & Mariela, S, ''Project Management Success Factors,'' Creative Construction Conference, CCC 2017, 19-22 June 2017, Primosten, Croatia. Procedia Engineering 196(2017) PP. 607-615.

12.Montasser, E, M., Khodeir, L.M & Fatema, F, ''Practices and techniques for construction projects cost control – a critical review,'' HBRC Journal, 2024, 20:1, 525-552.

13. Mubarak, S.A, Construction Project Scheduling and Control, 2nd Ed. John Wiley & Sons, Inc, 2010.

14. Nagaraju S.K, Reddy, B.S, & Chaudhuri, A.R, ''Resource Management in Construction Projects. A Case Study. Engineering Science and Technology: An International Journal(ESTIJ), August 2012, ISSN: 2250-3498, Vol.2, No.4.

15. Oluwatosi, E.A, ''Best Practices for Efficient Project Planning and Scheduling in Construction Management. International Journal of Research Publication and Review,'' 2024, Vol 5, no 7, pp. 440-449.

16. Otim, G., Akacwa, F & Kyakula M, "Cost control techniques used on building construction sites in Uganda. Conference: Advances in Engineering and Technology, Second international conference; Entebbe, Uganda, 2011 pp. 443-449

17. Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", Fourth Edition, ©2008, 14 Campus Blvd., Newton Square, PA 19073- 3299 USA.

18. Ramajogi, J. & Asadi, S.S., (2017): Optimal Resources Utilization in Construction Industry. International Journal of Civil Engineering and Technology, January 2017, Vol.8, Issue 1, pp.273-280.

19. Rocha, A., Romero, F, Miranda, D, Marlene Amorim, M, "Quality Management Practices to direct and Control the accomplishment of project objectives in R&D units", Procedia *Computer Science, 2023, 219(2023) pp. 36-45.*

20. Schober, P, Boer, C, and Schwarte, L.A (2018): Correlation Coefficients: Appropriate Use and Interpretation. Anesthesia & Analgesia, May 2018, 126(5): pp. 1763-1768,

21. Sediqi, Sayed. (2022). Re: What Does a Higher Mean Indicate in Spss? Retreaved from, https://www.researchgate.net/post

22. Shanmuganathan, N & Baskar, G, "Effective Cost and Time Management Techniques in Construction Industry. International Journal of Advanced Engineering Technology," April-June, 2016, E-ISSN 0976-3945. Vol.VII/Issue II, pp. 743-747

23. Shar, F.H, Bhatti, O.S & Ahmed, S, "A Review of the Effects of Project Management Practices on Cost Overrun in Construction Projects," *Engineering Proceedings, 3 August 2023.*

24. Suresh, D & Sivakumar, A, "Impact of Schedule Management Plan on Project Management Effectiveness," International Journal of Engineering and Advanced Technology, October 2019, Volume-9 Issue-1.

25. Thamhain, H.J, "Emerging Project Management Techniques: A Managerial Assessment, Portland International Conference on Management of Engineering and Technology, Oregon, USA. 1999.

26. Tiwari, S., Ranjendra B. Magar, R & Honnutagi, A.R, "Resource Optimization for Sustainable Construction: A State of Art", International Advanced Research Journal in Science, Engineering and Technology, February 2018, Vol.5, pp. 69-73.