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RELATIONSHIP BETWEEN PROCESS VARIATIONS AND PROJECT OVERRUNS IN MANUFACTURING INDUSTRIES IN MACHAKOS COUNTY, KENYA

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ABSTRACT

This study sought to determine the relationship between process variations and project overruns by focusing on two variation elements, project design, and project planning. The study was guided by triple constraint Theory, and project performance Theory. This study employed a descriptive research design. The target population for this study was manufacturing industries in Machakos County. The unit of analysis was manufacturing industry in Machakos County (according to Kenya Association of Manufacturer 2021-2022 annual publication) while the unit of observation was key project team members representing different organizational functions namely; designated head of department for procurement, finance, technical and project manager. The study used Taro Yamane Formulae to come up with a sample size for research. Primary data was used in this study and it was collected to use of a questionnaire. After the data collected, it was subjected to editing, coding, categorizing and keyed into statistical package for social science computer software for analysis. Descriptive and inferential statistics was used in analyzing the data. The data was presented using tables, charts and graphs; subsequently findings were discussed, conclusions drawn, recommendations for the study made, and further research suggested. The study concludes that project design variation has a significant effect on project overruns in manufacturing industries in Machakos County. In addition, the study concludes that project planning variation has a significant effect on project overruns in manufacturing industries in Machakos County. Based on the findings, this study recommends that the management of manufacturing companies in Machakos County should ensures effective project design practices to minimize chances of project overruns. In addition, the management of manufacturing companies in Machakos County should ensure effective project planning practices to minimize chances of project overruns.

Key Words: process variations, project overruns, project design, project planning

Background of the Study

Manufacturing industry is one of the sectors that play essential role in the World economics. Throughout history, the manufacturing industry has transformed nations such as the United States, United Kingdom, Germany, Japan, China, and France which are some of the world's wealthiest. China for instance currently leads the world with its manufacturing output of over $2.01 trillion contributing to 27% of its overall national output (West & & Lansang, 2018). This translates to 20% of the world's manufacturing output. As a result, it is among the countries that have a proportion of the workforce employed in the manufacturing sector further explaining its economic gains.

During the last years of 20th century, Project Management focused on development of new methods, techniques, and tools to ensure project's success as well as competence of project team members (Maria, 2018; Pinyarat, Vicky, Ray, & Burns, 2018) . Still, the success rate of projects remained low as evidenced by several surveys and studies (Pinyarat et al., 2018). Sanderson (2016) identifies the main performance problems as process variations. Consistent with this, Khan Asadullah et al. (2019) indicates the unsatisfactory performance and failure of large-scale projects is due to process variations. Ralf Müller, Li Zhai, and Wang (2017) have recommended standardized approaches to Project implementation process for successful completion of the project and the project-based part of the organizations

An international survey of 333 projects by (Ata ul Musawir, Carlos Eduardo Martins Serra , Ofer Zwikael , & Imran Ali, 2017) revealed that effective Project implementation process is an important factor in project success and effective in improving project success and improving organizational strategy. In another empirical study in America, Europe, and Australasia, Joslin and Müller (2016) indicated that Project implementation process correlates with project performance. In particular, the researchers noted that project implementation process has a positive influence on project success. In Norway and United Kingdom, project implementation process is still a challenge (Williams et al., 2019a). In the United Kingdom, two Public Private Partnership (PPP) contracts between Metronet and London Underground Ltd (LUL) for the maintenance and upgrade of two thirds of the lines on the London Underground experienced costly changes and delays during implementation. This was mainly ascribed to process overruns (Anthony & Sena, 2019)

The launch of the African Continental Free Trade Area (AfCFTA) in March 2018 affirmed the importance of manufacturing since it aims at unlocking the manufacturing potential of Africa and driving sustainable growth and development (Signé, 2018). However, some African countries are yet to unlock their manufacturing potential. Despite the worrying trends in most of the developing countries, reports indicate that manufacturing in Africa has grown by 3.5% annually between 2005 and 2014 faster than it has in the rest of the world and this reflects in the economic leaps that Africa has made so far (Signé, 2018). These statistics indicate the vitality of this industry in economic development

Statement of the Problem

The manufacturing industry is one of the key pillars of economic growth and development in Kenya. It contributes to the national output and plays a major role in the creation of jobs for semi-skilled and skilled workers. However, like many developing countries, Kenya has not developed a robust manufacturing sector and this is evidenced by the fact that the agricultural and service sectors have been the drivers of economic growth. It is also evidenced by the number of stalled manufacturing projects in the country. This has contributed to the country's premature deindustrialization as seen by the decline in the GDP which was at 9.2% in 2016 and dropped to 8.4% in 2017. Since Kenya seeks to boost its economic outcomes, improving the manufacturing sector remains an important strategy. Vision 2030, and the Big 4 Agenda were designed by the Kenyan Government to revamp the manufacturing sector in an attempt to improve the country's

economic prospects. Nevertheless, compared to other countries that are in a similar state of economic development, Kenya's manufacturing industry is relatively strong and well-diversified and therefore well-positioned to meet its economic needs (Signé, 2018).

There are significant challenges in the manufacturing sector that have contributed to its decline. The Kenya Association of Manufacturers (KAM) lists various challenges among them the high cost of industrial inputs and inadequate training and capacity building. These challenges are also linked to issues of schedule, scope, cost, and quality of projects. These have been evidenced in numerous cases of delayed or in extreme instances, stalled projects that are spread across the country. Machakos County has not been an exception as reports indicate that despite being home to numerous manufacturing industries, it has not met its full manufacturing potential due to project overruns. Research shows that more than 50% of projects in the county go beyond the stipulated completion time (Mue. P., 2015). According to (Ong'ondo, Gwaya, & Masu, 2019), 35-60% of projects in Kenya face cost variations and time overruns which impact the country's economic potential. For instance, the country's planned industrial parks that would have achieved all the goals set for the manufacturing sector have not been successful due to project delays. A specific example is Kinanie Leather Park in Machakos County which has been subjected to budget cuts and this has led to delayed returns on investments (Kamanu, 2020). Although various stakeholders such as the government have tried to address the issue of project overruns in the industry through policy and legislative framework, the challenges are still prevalent.

Process variation creates significant interruptions in the management of projects and thus reduces productivity. Standardized project management processes have proven to be more efficient in terms of saving time and minimizing errors. Process variations are sometimes inevitable since organizations and individuals are constantly reinventing themselves, yet the smallest variation can cause serious problems to a project. The need to critically analyze the relationship between process variations and project overruns within manufacturing industries in Machakos County arises from the desire to ensure that projects and the industry as a whole meet their economic potential. If this is not realized, there will be significant consequences such as escalation of costs and delays in the completion of projects and ultimately slow economic growth for the County and the Country at large. Research asserts that the failure of projects has far-reaching consequences on individuals, communities, and organizations, and in the case of Machakos County, it has negative impacts on its performance which costs taxpayers billions of shillings in losses (Gitonga., M. Nzulwa., & Kwena, 2017). Therefore, this study sought to assess the relationship between process variations and project overruns with specific considerations on design, project planning, cost, and scope within manufacturing industries in Machakos County

Objectives of the Study

The main aim of this study is to determine the relationship between process variations and project overruns within manufacturing industries in Machakos County.

i. To assess the extent to which project design variations contribute to project overruns in manufacturing industries in Machakos County.
ii. To determine the influence of project planning variation on project overruns in manufacturing industries in Machakos County.

LITERATURE REVIEW

Theoretical Review

Triple Constraint Theory

The triple constraint theory also referred to as the project management triangle was first developed by Israeli businessman Eliyahu M. Goldratt out of the Theory of Constraints (TOC). The main

idea behind TOC is that there is always at least one constraint in any system that has the potential of putting the project at risk (Cox III., CFPIM., & Schleier Jr., 2010). The concept of TOC began in the 1970s and focuses on removing the weakest point in the operation of a system (Kumar., Siddiqui., & Suhail). The triple constraint theory borrowed from this and holds that the success or failure of every project is tied to its scope, schedule, and budget hence the need for project managers to find a balance among the three constraints so that they can keep their projects on track.

According to the theory, managers need to define and document the project goals and requirements before they officially begin to work. Through this, every team member knows what is expected of them and that adding more features to a project later stretches the project's time and budget. When this is done, project managers discuss trade-offs and make necessary adjustments before the project takes off. Although the other project constraints are equally important, scope changes significantly influence the budget and the time that the project team takes to complete the project.

This theory helps managers to recognize the competing demands in every project so that they can decide the most important demand. Knowing the most important demand makes it easier for project managers to make adjustments to the other two demands and to balance the project (Baratta., 2006). It also recognizes that every stakeholder has an idea of what is most important to a project and thus gives everyone who is involved in a project a better understanding of the give-and-take relationship among the three. As a result, it becomes easier for the project team to adjust and adapt to any changes whenever they come up.

Research indicates that the triple constraint theory comes down to learning how to effectively manage the tradeoffs among the three project constraints and is thus a visual reminder that any decision made has a significant impact on a project. To make the theory work, it is important for project managers to work with their clients so that they clearly understand their expectations, clearly communicate the scope of the project, set achievable deadlines, allocate resources efficiently, and continuously monitor the projects to make tradeoffs and adjustments as required.

This theory is relevant to this study because it helps to understand project scope as an important element that can influence the failure or success of a project. The theory helps to understand that neglecting to accurately and effectively manage scope changes can severely condemn a project (Van Wyngaard. & Pretorius.,2012). Given that scope variations are inevitable, the theory can help the project team to adapt to all the changing conditions of their projects so that they complete them in time and within the set budget.

Project Performance Theory

Project performance analysis is very vital for any project since it is one of the best ways through which the stakeholders can analyze what is happening in the project.

The analysis of a project is based on the impact that the project has as at a given time and over a fixed timeframe. According to Parmenter, (2015), there are seven key performance indicators of any project: the indicators are subject to two common models, which are the index-based models and the project performance diagnostic models

The index-based model consists of indices, which dictate the successful implementation of a project regards to the project's time, cost, and quality objectives. The model includes six indices, all of which measure a particular parameter of the project's performance (Huang. & Li., 2012). The indices include the cost performance index (CPI), an indicator of the cost efficiency of any project, the billing performance index (BPI), which shows the company's ability to receive claims and demands, the Schedule Performance Index, the Safety performance index, Quality Performance index and the Environment Performance Index. The use of this model enables the

researcher to know the extent to which certain parameters have been met. The Project Performance Diagnostic Model, however, consists of an array of key performance indicators tailor-made to suit the functions of a particular project. The model, therefore, helps in the giving of feedback about the project performance in a particular context (Huang. & Li., 2012).

The two models enable the analysis of the project per the seven Key Performance Indicators, which are expounded by (Parmenter, 2015). They include direct impact, bottom line impact, return on investment, on time, on budget, and lastly stakeholder support and engagement. The direct impact is essentially the benefits/ lack thereof that the project exudes on the various stakeholders. Normally, the impact of the project is measured through the analysis of the benefits realized before the execution of the project and its comparison with the results after the completion of the project. The bottom line refers to the increase in revenue and the subsequent reduction of the overall costs and expenses of carrying out a project.

A project is considered successful if it does not exceed the budget and contributes to a favorable return on investment. Normally, the two indicators are measured after the completion of a project and the consequent analysis of how well they conform to the predetermined budget and timeline (Lacity. & Willcocks., 2015). The timeliness of a project is very important since it ensures that the operations do not lag against the set schedules and that the stakeholders get to benefit from the project as they had anticipated. Every project has a timeline, which when met, illustrates the height of success as well as the efficiency of the project operations. Completing the project as per the budget is an additional advantage since it illustrates the efficiency of all the processes in the project. Lastly, the stakeholder perception of the overall project is a factor that should be taken into consideration, since it illustrates their satisfaction levels/lack thereof, with the project. The more impressed and satisfied the stakeholders are the higher and more efficient the project is considered.

Conceptual Framework

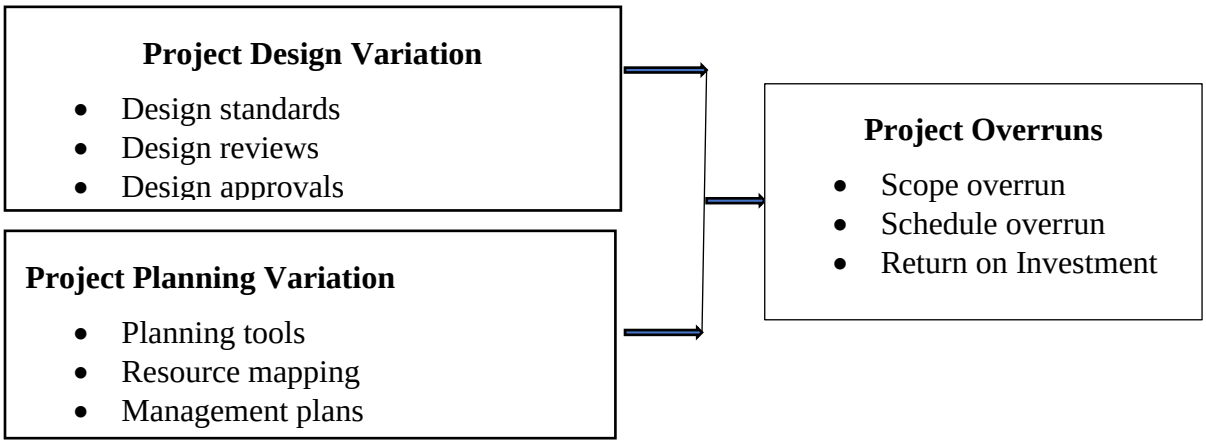

Figure 1: Conceptual Framework

Project Design Variations

A project design formally outlines the approved layout or sequence to meet the defined project goal. It covers the scope of the project while taking into consideration design applicable design standards and approvals (Ibn-Homaid N. T., 2011).The design is always linked to the usability of the project once completed and it considers the various interactions of material, process, and people. Many organizations consider this document as an essential part of project planning—although it's not the same thing as a project plan because it doesn't get into the details of individual tasks within the project.

An effective project design should; outline the overall layout, define the applicable standards both for material and construction, have battery limits, be a clear, single reference for all involved in a project and finally help project managers get the approval of stakeholders and statutory bodies. Project designs can vary depending on the type of project and organization, but the basic elements usually include the layout, material, process, and machines. The project design summary is the first section of a project design and will offer basic details such as the name of the project, approvers, and general layouts. It also explains the relevant external approvers. It should address how the result will look like.

At the point of coming up with the budget, you might not have all the design details, so you cannot put a full and detailed project budget together. However, you can note down any budget constraints or the high-level estimation of expected costs. All projects have risks. This section forms the early version of your project risk log. Document any risks that you know about at this point so that the management team can see what might affect the project going forward. The final section of the project design is the approvals section. The project manager and project sponsor (or the person who kicked off the work, if a longer-term sponsor has yet to be appointed) should sign and date the document (Reich, 2017).

Project Planning Variation

Project planning is a discipline that stipulates how to complete a project within a certain timeframe, usually with defined stages, and designated resources. Project planning plays an essential role in helping guide stakeholders, sponsors, teams, and the project manager through other project phases (Reich., 2007). Planning is needed to identify desired goals, reduce risks, avoid missed deadlines, and ultimately deliver the agreed product, service, or result. Without careful planning, project performance is almost certainly guaranteed to suffer. The Project Management Institute estimates that as of 2017, organizations were wasting an average of $97 million for every $1 billion invested, due to unsatisfactory project performance.

Project planning requires breaking down a larger project into tasks, assembling a project team, and determining a schedule over which the work is to be completed. During this phase, you create smaller goals within the larger project, making sure each is achievable within the period. Tools popularly used for the scheduling part of a plan include the WBS, Gantt chart, Network diagrams, and the PERT chart (Baratta., 2016)

Empirical Review

Project Design Variations Contribute and Project Overruns

CSFs therefore, as highlighted by Chen et al tell how best the project team is prepared to focus on the most crucial aspects of a project and how these factors are aligned to contribute to the achievement of the set goals. Globally, most organizations such as in China uphold critical success factors such as human resources and effective communication as a way of enhancing the success of their projects (Cao, 2017). According to Cao (2017), well-motivated and trained staff as well as proper information sharing will steer a project into success by ensuring that competency and professionalism are upheld among the employees. Since the employees are the main implementers of the projects, if they are well-catered for and appropriate information is shared at the right time and in an effective manner, their coordination is enhanced and is translated to project success (Cao, 2017).

In Malaysia, (Ismael, 2016) shows that critical success factors were subject to factors both internal and external that influenced the success of the project and identified the involvement of the stakeholders and availability of the required resources such as financial resources and human resources as the major factors. The author adds that when the project management team has access

to adequate financial resources and the stakeholders are supportive, there is a high likelihood of the project succeeding hence identifying the two as the major critical success drivers.

Regionally, several critical success factors have been linked with project performance. In Zimbabwe for instance, (Emoh, 2011) indicates that the critical factors are mainly determined by the specification of the project as well as other external aspects outside the control of the project management. (Emoh, 2011).However, it is indicated that effective training of staff to deal with any risks concerning the project and ensuring that they are competent enough to carry along with the project are the main critical success factor in a modern project. This reaps support from (Nzekwe., Oladejo., & Emoh, 2015) who found that training employees is a major success factor in driving the project into a success. They argue that through training, employees can gain skills to solve everyday problems when executing the project. Organizational communication and the involvement of stakeholders are also major critical success factors that determine the performance of a project. According to (Nzekwe., Oladejo., & Emoh, 2015), most projects in Nigerian organizations have failed to meet their mandate due to the non-involvement of the stakeholders as well as lack of information sharing thus discouraging teamwork.

Locally, some researchers have pointed out aspects that they attribute to the success of projects. For instance, (Kariungi., 2014) indicated that the completion of projects in Kenyan state corporations was affected by a lack of critical success factors, one of them being availing funds to the projects timely and adequately. Mahamud., Muchelule., & Ogolla., (2019) on the other hand established that the involvement of stakeholders and communication within the organization had a hand to play in determining the success of the projects. According to Wilkina (2017), project success is determined by the skills possessed by the project team as well as the willingness of the stakeholders to support the projects and give it their best.

Project Planning Variation and Project Overruns

Project planning requires breaking down a larger project into tasks, assembling a project team, and determining a schedule over which the work is to be completed. These categories are similar to some of the delay-causing factors listed by the authors on the causes of schedule delays (Doloi., Sawhney., Iyer., & Rentala., 2012); (Lo et al., 2006); (Kumaraswamy., M., & Chan., 1998). Another study done on change orders (Alnuaimi., Taha., Al Mohsin., & Al-Harthi, 2010) found that the most important effect of change orders was the delay of the completion date of projects. The second most important effect was found to be that changes would result in claims and disputes. Thirdly, cost overruns were found to be another important effect of scope variations.

Muute (2019) conducted a study on the effects of project planning practices on performance of construction projects in Nairobi City County, Kenya. . The study findings indicated that majority of the firm accord human resource management function as an important role and that majority of the firms conduct training to its project team members. The results indicated that project completion was being done without much struggle and that the budgeted funds were enough to complete the project. The study further established that all material resources allocated were in use and that project output had been well defined. The study also found that quality projects planning was being carried out effectively. It was also clear that that activity duration had been well estimated, time schedules were well developed, and that project scope had been well specified during planning phase

Belout and Gauvreau (2016) studied the determinants of labor productivity in project performance. Descriptive analysis was used and the study targeted employees of various projects. The study found a positive association between planning of HR and project performance. The study recommended that organizations should put in place worker involvement program, which will

enable workers with opportunities to reflect their own work experiences and attitudes, and their own hopes for the future.

Guoli (2018) studied budget-planning effects on project performance. The descriptive research design was used, and the study targeted the stalled projects. The study deduced that a professional developed budget controls the project costs and creates favorable cash-flow conditions in the project. The study also found that insufficient cash flow consequence in a project is frequently associated with delays and large extra costs, since there is big threat for a temporary discontinuation of the entire project

RESEARCH METHODOLOGY

The study used a descriptive research design. This is a method in which quantitative data is collected and analyzed to describe the specific phenomenon in its current trends, current events, and linkages between different factors at the current time (Rutberg., 2018). The target population for this study comprised the manufacturing industries in Machakos County. The manufacturing industries include the diverse nature in both ownership structure i.e., family-owned private companies, private limited companies, and publicly listed companies, and sector of operation i.e., food, textile, metal, chemical etc. Project team members or equivalent were the respondents. According to Kenya Association of Manufacturer 2021-2022 annual publication, Machakos County has 79 manufacturing firms with the distribution as shown in the table below. The study focused on key project team members representing different organizational functions namely; designated head of department for procurement, finance, technical and project manager in all 79 firms thus bringing the target population to 316 (79*4). This population gave a broad and in-depth understanding of how process variations influence the overall delivery and productivity of projects in the manufacturing sector in Machakos County. Purposive sampling was used to select the projects that have been done within the last ten years by the targeted population. The sample size was determined using the Taro Yamane Formulae which was formulated by Tara Yamane in 1967. Therefore, the sample size was 176.

This study relied on both primary and secondary data. Secondary data was gathered from the established journals. On the other hand, primary data was collected using a semi structured questionnaire. According to McBurnley and White (2009), a pilot study can be done using between 5% and 15% of the sample size of the study. For this study, therefore, the pilot study was done using 10% of the sample size. This ensured that items consistently measure the variables in the study and produces reliable results. The research instruments were piloted on a representative sample identical to the group that was involved in the actual study.

Data collected from the respondents was coded and entered into the computer for analysis using SPSS. Descriptive and inferential statistics was used in analyzing the data. Qualitative data was analyzed using content analysis techniques such as narratives, explanations, and discussions

DATA ANALYSIS AND FINDINGS

Out of 176 questionnaires which were distributed, 171 were duly filled and returned. The drop-off and pick-up-later method yielded the high response rate of 97.2%. According to Babbie (2017), a response rate of 75 per cent is adequate for analysis as well as making conclusions and inferences about a population. This implies that the response rate of 97.2% was adequate for analysis, drawing conclusions and reporting.

Descriptive statistics

Project Overruns in Manufacturing Industries

The respondents were requested to indicate their level of agreement on various statements relating to project overruns in manufacturing industries in Machakos County. A 5-point Likert scale was

used where 1 symbolized strongly disagree, 2 symbolized disagree, 3 symbolized neutral, 4 symbolized agree and 5 symbolized strongly agree. The results were as presented in Table 1.

From the results, the respondents agreed that project design change affect overall project delivery. This is supported by a mean of 3.968 (std. dv = 0.905). In addition, as shown by a mean of 3.859 (std. dv = 0.885), the respondents agreed that seeking fresh approval due to project design change affect overall project delivery. Further, the respondents agreed that change in project plan affect overall project delivery. This is shown by a mean of 3.800 (std. dv = 0.605).

As shown by a mean of 3.785 (std. dv = 0.981), the respondents agreed that project planning tool influences overall project delivery. In addition, the respondents agreed that having a project communication plan affects overall project delivery. This is shown by a mean of 3.777 (std. dv = 0.878). The respondents also agreed that having a project risk management plan affects overall project delivery. This is shown by a mean of 3.678 (std. dv = 0.897).

From the results, the respondents agreed that project stakeholder management plan influences overall project delivery. This is supported by a mean of 3.657 (std. dv = 0.786). In addition, as shown by a mean of 3.643 (std. dv = 0.786), the respondents agreed that project procurement management plan influences overall project delivery. Further, the respondents agreed that periodic project cost review influences overall project delivery. This is shown by a mean of 3.598 (std. dv = 0.923). As shown by a mean of 3.535 (std. dv = 0.865), the respondents agreed that project cost formulation criteria affect overall project delivery.

Table 1: Project Overruns in Manufacturing Industries

	Mean	Std. Deviation
project design change affects overall project delivery	3.968	0.905
seeking fresh approval due to project design change affect overall project delivery	3.859	0.885
change in project plan affect overall project delivery	3.800	0.605
project planning tool influences overall project delivery	3.785	0.981
Having a project communication plan affects overall project delivery	3.777	0.878
having a project risk management plan affects overall project delivery	3.678	0.897
project stakeholder management plan influences overall project delivery	3.657	0.786
project procurement management plan influences overall project delivery	3.643	0.786
periodic project cost review influences overall project delivery	3.598	0.923
project cost formulation criteria affect overall project delivery	3.535	0.865
Aggregate	**3.798**	**0.821**

Project Design Variations and Project Overruns

The first specific objective of the study was to assess the extent to which project design variations contribute to project overruns in manufacturing industries in Machakos County. The respondents were requested to indicate their level of agreement on various statements relating to project design variations and project overruns in manufacturing industries in Machakos County. A 5-point Likert scale was used where 1 symbolized strongly disagree, 2 symbolized disagree, 3 symbolized neutral, 4 symbolized agree and 5 symbolized strongly agree. The results were as presented in Table 2.

From the results, the respondents agreed that in their organization they develop and share project designs at the onset of projects. This is supported by a mean of 3.944 (std. dv = 0.989). In addition, as shown by a mean of 3.917 (std. dv = 0.805), in their organization design standards are defined in the project design. Further, the respondents agreed that in their organization there is project designs review process. This is shown by a mean of 3.855 (std. dv = 0.981). The respondents also

agreed that project designs are approved by key stakeholders. This is shown by a mean of 3.849 (std. dv = 0.923).

Table 2: Project Design Variations and Project Overruns

	Mean	Std. Deviation
In our organization we develop and share project designs at the onset of projects	3.944	0.989
In our organization design standards are defined in the project design	3.917	0.805
In our organization there is project designs review process	3.855	0.981
project designs are approved by key stakeholders	3.849	0.923
Aggregate	**3.865**	**0.922**

Project Planning Variation and Project Overruns

The second specific objective of the study was to determine the influence of project planning variation on project overruns in manufacturing industries in Machakos County. The respondents were requested to indicate their level of agreement on various statements relating to project planning variation and project overruns in manufacturing industries in Machakos County. A 5-point Likert scale was used where 1 symbolized strongly disagree, 2 symbolized disagree, 3 symbolized neutral, 4 symbolized agree and 5 symbolized strongly agree. The results were as presented in Table 3.

From the results, the respondents agreed that in their organization we develop a project charter or equivalent for their projects. This is supported by a mean of 3.967 (std. dv = 0.897). In addition, as shown by a mean of 3.920 (std. dv = 0.815), the respondents agreed that their organization incorporates project planning tools in the project management process. Further, the respondents agreed that their organization has a defined procurement process for projects. This is shown by a mean of 3.888 (std. dv = 0.901). The respondents also agreed that their organization has a designated and defined project team for the projects. This is shown by a mean of 3.835 (std. dv = 0.793). From the results, the respondents agreed with a mean of 3.813 (std. dv = 0.884) that their organization has established effective communication plans for their projects. Further, as shown by a mean of 3.798 (std. dv = 0.786), the respondents agreed that stakeholders are adequately updated on scope change requests.

Table 3: Project Planning Variation and Project Overruns

	Mean	Std. Deviation
In our organization we develop a project charter or equivalent for our projects	3.967	0.897
Our organization incorporates project planning tools in the project management process	3.920	0.815
Our organization has a defined procurement process for projects	3.888	0.901
Our organization has a designated and defined project team for the projects	3.835	0.793
Our organization has established effective communication plans for our projects	3.813	0.884
Stakeholders are adequately updated on scope change requests	3.798	0.786
Aggregate	**3.828**	**0.897**

Correlation Analysis

The present study used Pearson correlation analysis to determine the strength of association between independent variables (project design variations, project planning variation,) and the dependent variable (project overruns within manufacturing industries in Machakos County). Pearson correlation coefficient range between zero and one, where by the strength of association increase with increase in the value of the correlation coefficients.

Table 4: Correlation Coefficients

		Project Overruns	Project Design Variations	Project Planning Variation
Project Overruns	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	171		
Project Design Variations	Pearson Correlation	.881**	1	
	Sig. (2-tailed)	.000		
	N	171	171	
Project Planning Variation	Pearson Correlation	.805**	.289	1
	Sig. (2-tailed)	.003	.061	
	N	171	171	171

From the results, there is a very strong relationship between project design variations and project overruns within manufacturing industries in Machakos County (r = 0.881, p value =0.000). The relationship was significant since the p value 0.000 was less than 0.05 (significant level). The findings are in line with the findings of Cao (2017) who indicated that there is a very strong relationship between project design variations and project overruns.

Moreover, the results revealed that there is a very strong relationship between project planning variation and project overruns within manufacturing industries in Machakos County (r = 0.805, p value =0.003). The relationship was significant since the p value 0.003 was less than 0.05 (significant level). The findings conform to the findings of Muute (2019) that there is a very strong relationship between project planning variation and project overruns.

Regression Analysis

Multivariate regression analysis was used to assess the relationship between independent variables (project design variations, project planning variation) and the dependent variable (project overruns within manufacturing industries in Machakos County)

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.931	.867	.868	.10428

a. Predictors: (Constant), project design variations, project planning variation, project duration variation and project cost variation

The model summary was used to explain the variation in the dependent variable that could be explained by the independent variables. The r-squared for the relationship between the independent variables and the dependent variable was 0.867. This implied that 86.7% of the variation in the dependent variable (project overruns within manufacturing industries in Machakos County) could be explained by independent variables (project design variations, project planning variation, project duration variation and project cost variation).

Table 6: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	141.081	4	35.270	812.68	.000[b]
	Residual	7.254	167	.0434		
	Total	148.335	171			

a. Dependent Variable: project overruns within manufacturing industries
b. Predictors: (Constant), Project Design Variations, Project Planning Variation,

The ANOVA was used to determine whether the model was a good fit for the data. F calculated was 812.68 while the F critical was 2.426. The p value was 0.000. Since the F-calculated was greater than the F-critical and the p value 0.000 was less than 0.05, the model was considered as a good fit for the data. Therefore, the model can be used to predict the influence of project design variations, project planning variation, project duration variation and project cost variation on project overruns within manufacturing industries in Machakos County.

Table 7: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.154	0.039		3.949	0.001
	project design variations	0.377	0.105	0.379	3.590	0.000
	project planning variation	0.462	0.108	0.463	4.277	0.001

a Dependent Variable: project overruns within manufacturing industries

The regression model was as follows:

$Y = 0.154 + 0.377X_1 + 0.462X_2 + \varepsilon$

According to the results, project design variations has a significant effect on project overruns within manufacturing industries in Machakos County, $\beta 1=0.377$, p value= 0.000). The relationship was considered significant since the p value 0.000 was less than the significant level of 0.05. The findings are in line with the findings of Cao (2017) who indicated that there is a very strong relationship between project design variations and project overruns.

The results also revealed that project planning variation has significant effect on project overruns within manufacturing industries in Machakos County, $\beta 1=0.462$, p value= 0.001). The relationship was considered significant since the p value 0.001 was less than the significant level of 0.05. The findings conform to the findings of Muute (2019) that there is a very strong relationship between project planning variation and project overruns.

Conclusions

The study concludes that project design variation has a significant effect on project overruns in manufacturing industries in Machakos County. The study findings revealed that design standards, design reviews and design approvals influence project overruns in manufacturing industries in Machakos County.

In addition, the study concludes that project planning variation has a significant effect on project overruns in manufacturing industries in Machakos County. The study findings revealed that planning tools, resource mapping and management plans influences project overruns in manufacturing industries in Machakos County.

Recommendations

The study found that project design variation has a significant effect on project overruns in manufacturing industries in Machakos County. This study therefore recommends that the management of manufacturing companies in Machakos County should ensures effective project design practices to minimize chances of project overruns.

In addition, the study found that project planning variation has a significant effect on project overruns in manufacturing industries in Machakos County. This study therefore recommends that the management of manufacturing companies in Machakos County should ensures effective project planning practices to minimize chances of project overruns.

Suggestions for Further Studies

The main objective of the study was to determine the relationship between process variations and project overruns within manufacturing industries in Machakos County. Having been limited to project overruns within manufacturing industries in Machakos County, the study findings cannot be generalized to other sectors. The study therefore suggests further studies on the relationship between process variations and project overruns within other sectors in Kenya.

Further, the study found that the independent variables (project design variations, project planning variation) could only explain 86.7% of project overruns within manufacturing industries in Machakos County. This study therefore suggests further research on other factors affecting project overruns within manufacturing industries in Machakos County.

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