World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

# PERFORMANCE MEASUREMENT PRACTICES IN ACCELERATED ELECTRICAL INFRASTRUCTURE RECOVERY: EVIDENCE FROM A REMOTE INFRASTRUCTURE RESTORATION PROJECT

James Kipchumba Tum *, Luhombo Adema Calistus and Onsarigo Thomas Gisemba

Department of Social Sciences and Development Studies, Faculty of Arts and Social Sciences, Catholic University of Eastern Africa, Nairobi, Kenya.
* Corresponding Author; Email : tumkjames@gmail.com

World Journal of Advanced Research and Reviews, 2026, 31(02), 1581–1590

Publication history: Received on 20 July 2026; revised on 26 August 2026; accepted on 28 August 2026

Article DOI: https://doi.org/10.30574/wjarr.2026.31.2.2244



## ABSTRACT

Accelerated restoration requires reliable performance information because deviations can compound quickly under compressed schedules and constrained operating conditions. This study examined the relationship between performance measurement practices and accelerated electrical infrastructure recovery performance in a remote setting. An explanatory sequential mixed-methods case design was used. All 150 eligible personnel were invited to participate; 114 directly involved participants provided complete and usable questionnaires, and eight key informants contributed explanatory interview data. Performance measurement recorded high agreement ($M = 3.97$, $SD = 1.00$) and had a very strong positive association with respondent-rated recovery performance ($r = .724$, $p < .001$). Performance data for operational adjustment recorded the highest indicator mean ($M = 4.04$), whereas definition of indicators at project commencement recorded the lowest ($M = 3.80$). The qualitative findings showed that performance measurement improved visibility of completed work, delayed activities, constraints, priorities, and required interventions. The study concludes that performance measurement supports accelerated recovery when information is timely, decision-oriented, traceable to approved targets, and adapted to the restoration context.

**Keywords:** Accelerated Recovery; Critical Infrastructure; Earned Value Management; Performance Measurement; Performance Visibility; Project Control

## 1 INTRODUCTION

Electricity restoration after a major disruption is both an engineering task and a project-control problem. Repair capability is essential, but restoration performance also depends on whether project leaders can establish actual status, compare progress with approved targets, identify emerging variance, and intervene before delay or technical risk becomes difficult to recover. These requirements become more demanding in remote settings where access restrictions, long supply routes, approval procedures, and compressed schedules can weaken the speed and reliability of project information (Karagiannis et al., 2017; Ofgem, 2022).

Performance measurement provides the sensing function of project control. It converts field activity into information concerning milestones, schedule variance, cost variance, resource readiness, constraints, technical status, and the remaining conditions for service restoration. Earned Value Management and variance analysis provide structured methods for comparing actual performance with approved baselines, while context-specific indicators can show access status, material readiness, testing requirements, unresolved defects, and decision deadlines (Fleming & Koppelman, 2016; Project Management Institute, 2020). In accelerated recovery, this information is valuable only when it reaches decision makers within the available intervention window.

Existing project-management literature establishes the value of performance measurement in planned project environments, but less is known about how its specific indicators operate during accelerated infrastructure recovery in remote and operationally constrained settings. Electricity-restoration research has shown that weak monitoring can limit early understanding of fault magnitude and impede resource allocation, while independently measured recovery information can reveal patterns that are otherwise difficult to identify (Ofgem, 2022; Román et al., 2019). However, limited empirical work connects these insights to project-level performance measurement during a bounded restoration project.

This study addresses that gap by examining how performance measurement practices contributed to accelerated electrical infrastructure recovery performance. It considers the timeliness and accuracy of information, schedule and cost variance analysis, Earned Value Management indicators, availability of data for operational adjustment, and definition of indicators at project commencement.

### *Study objective*

The study assessed the relationship between performance measurement practices and accelerated electrical infrastructure recovery performance in a remote and operationally constrained setting.

## 2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

### 2.1 Performance measurement in accelerated recovery

Performance measurement is the systematic process of collecting, comparing, and interpreting information about actual project performance. In conventional projects, measures commonly include milestone status, schedule variance, cost variance, resource consumption, quality observations, and forecast completion. Accelerated recovery requires these measures to be connected to operational readiness because activity completion alone may not demonstrate that essential service has been restored safely and within the approved scope (Project Management Institute, 2020, 2021).

The most useful recovery indicators are decision-relevant. They show not only what has been completed, but also which constraints threaten the next restoration milestone, what materials or access arrangements are unavailable, whether inspection or testing prerequisites are satisfied, and what action is required before the next work period. This distinction separates performance measurement from ceremonial reporting. Information has control value when it is sufficiently timely, reliable, and specific to change a decision or resource allocation.

### 2.2 Timely and accurate performance information

Timeliness determines whether information reaches decision makers while intervention remains possible. Accuracy determines whether the intervention is directed toward the actual constraint. Under compressed restoration schedules, late or unreliable information can misallocate scarce labour, equipment, access windows, and logistical support. Storm-recovery reviews have linked limited network visibility to delayed understanding of fault scale and complexity, demonstrating that information quality directly affects initial coordination and resource deployment (Ofgem, 2022).

Timeliness is context dependent. A reporting interval suitable for routine construction may be too slow for restoration work in which field conditions change during a shift. Conversely, excessive collection can burden field personnel without improving decisions. The appropriate design therefore balances speed, accuracy, and operational usefulness.

### 2.3 Schedule and cost variance analysis

Variance analysis compares actual performance with approved targets and helps distinguish normal fluctuation from deviation requiring management action. Schedule variance is especially important in recovery because delayed activities can affect access, energisation, specialist availability, and service-continuity commitments. Cost variance can show the resource effects of acceleration, remobilisation, expedited logistics, rework, or changed work methods. The value of variance analysis lies not in the calculation alone, but in the management interpretation and action that follow (Fleming & Koppelman, 2016; Project Management Institute, 2020).

Recovery baselines may evolve as damage assessment and access information improve. Authorised baseline updates should therefore preserve traceability rather than conceal previous deviation. A measurement system that is too rigid may become irrelevant, while uncontrolled baseline changes can eliminate accountability. Effective recovery control requires both adaptability and a documented comparison basis.

### 2.4 Earned Value Management indicators

Earned Value Management integrates planned value, earned value, and actual cost to provide indicators of schedule and cost performance. Its strength is the disciplined comparison of scope accomplishment with the resources and time used to achieve it. In accelerated recovery, EVM can support early warning where work packages, milestones, and completion rules are sufficiently defined. However, its usefulness may be reduced where the restoration scope changes rapidly or progress measurement rules are unclear (Fleming & Koppelman, 2016; Project Management Institute, 2020).

For this reason, EVM should be interpreted alongside operational indicators. A favourable numerical result does not by itself confirm technical acceptance or readiness for service. Decision makers require a combined view of schedule, resource use, access, quality, safety, and outstanding conditions for restoration.

### 2.5 Performance data for operational adjustment

Performance measurement affects outcomes through action. Data can support resequencing of activities, mobilisation of additional labour, escalation of access constraints, prioritisation of materials, adjustment of work methods, and protection of critical milestones. If information is collected but not connected to authority and resources, the measurement system becomes descriptive rather than controlling. Project governance therefore requires a clear connection between performance evidence, decision rights, and response responsibility (Too & Weaver, 2014).

Remote settings make this connection more important because mobilisation and supply decisions may have long lead times. Early visibility can prevent a local constraint from becoming a project-level delay, while late visibility may leave no feasible recovery action within the remaining schedule window.

### 2.6 Definition of indicators at project commencement

Early definition of indicators establishes what will be monitored, how performance will be calculated, what tolerance triggers escalation, who owns the information, and how frequently it will be reviewed. Clear indicators reduce inconsistent interpretation across field, planning, engineering, quality, logistics, and operational roles. In emergency recovery, complete information may not be available at commencement, but organisations can still define indicator categories and formally refine them as the damage picture develops.

The comparatively lower rating for this indicator in the present study points to an important preparedness issue. Recovery measurement should be designed before disruption through templates, readiness metrics, milestone definitions, and escalation thresholds that can be tailored quickly to the event.

### 2.7 Control Theory and Contingency Theory

Control Theory provides the principal mechanism for the study. A managed system compares actual performance with a desired state and uses feedback to maintain or restore alignment (Wiener, 1948). Performance measurement represents the sensing function because it reveals status and variance. The theory predicts that timely and reliable measurement strengthens project control by enabling earlier, better-targeted intervention.

Contingency Theory complements this mechanism by explaining that the effectiveness of measurement depends on the environment (Donaldson, 2001). Remoteness, restricted access, long supply routes, security procedures, technical risk, and operational urgency influence what can be measured, how frequently information can be collected, and what response is feasible. The combined theoretical proposition is that performance measurement supports accelerated recovery when it provides decision-relevant feedback and is adapted to the project context.

### 2.8 Research gap

Existing literature establishes performance measurement as a central project-control function, but much of the evidence comes from comparatively stable project environments. Disaster and electricity-restoration studies demonstrate the importance of situational awareness, yet they often focus on network-level outage information rather than the project-level indicators used to manage a bounded restoration effort. There is limited mixed-methods evidence explaining how specific performance measurement indicators operate during accelerated electrical infrastructure recovery in remote and constrained settings. This article addresses that gap by linking indicator-level quantitative findings with participant explanations of performance visibility and operational adjustment.

# 3 METHODOLOGY

## 3.1 Research philosophy and strategy

The study adopted pragmatism because the research problem required numerical evidence of relationships and contextual explanation of how performance information operated in practice. Accelerated recovery performance could be assessed through structured measures, while the meaning and usefulness of the measures depended on participant experience of access, logistics, decision authority, technical risk, and operational urgency. A quantitative-dominant mixed-methods strategy was therefore used.

## 3.2 Research design and case context

An explanatory sequential mixed-methods design with a case-study orientation was employed (Creswell & Plano Clark, 2018; Yin, 2018). Questionnaire data were collected and analysed first, followed by semi-structured interviews that explained the observed quantitative pattern. The bounded case concerned restoration of cyclone-damaged electrical infrastructure in a remote island setting between October 2025 and May 2026. The precise location and organisational identity are withheld because of operational, security, and confidentiality considerations. This anonymisation does not affect the research design, analytical procedures, aggregated findings, or interpretation.

The case setting was analytically important because remoteness, restricted movement, long supply routes, approval procedures, and compressed timelines could affect the collection and use of performance information. Project records supported contextual understanding but were not analysed as an independent documentary strand.

## 3.3 Population, attempted census, and interview selection

The finite target population comprised 150 eligible persons associated with planning, engineering, supervision, technical execution, operations, safety, quality, logistics, documentation, and coordination. All 150 were invited under an attempted census. A screening question limited substantive responses to persons with direct involvement sufficient to assess the study variables. The achieved analytical base comprised 114 complete and usable questionnaires, representing 76.0% of the invited population. The remaining 36 invitations did not yield usable substantive responses, and available records did not permit a defensible distinction among complete non-response, screening exclusion, and materially incomplete returns.

Eight key informants were selected purposively after preliminary quantitative analysis. They represented project management, electrical engineering, site supervision, quality assurance, safety, technical execution, planning, and operations. Selection prioritised participants able to explain performance targets, progress tracking, variance information, operational adjustments, and contextual constraints.

## 3.4 Research instruments and operationalisation

The structured questionnaire contained demographic and screening items, five performance measurement items, and five accelerated recovery performance items. Responses used a five-point agreement scale from strongly disagree to strongly agree. Performance measurement was operationalised through timely and accurate information, consistent schedule and cost variance analysis, use of EVM indicators, availability of data for operational adjustment, and definition of indicators at project commencement. Accelerated recovery performance covered schedule adherence, technical quality, safety performance, scope completion, and overall effectiveness.

The semi-structured interview guide explored methods used to measure performance, definition and monitoring of targets, comparison of actual progress with schedule, scope, cost, and quality requirements, challenges in tracking performance, and the way measurement information influenced decisions. The guide provided consistent coverage while allowing clarification of operational mechanisms.

## 3.5 Validity, reliability, and pilot testing

Content validity was strengthened by aligning questionnaire items and interview questions with the study objective, conceptual framework, and relevant literature. Construct validity was supported through multiple related items rather than a single indicator. A pilot test involving 15 persons with relevant infrastructure or project experience assessed clarity, relevance, flow, and completion time. Pilot participants were excluded from the main analysis, and minor wording refinements were made before full administration.

The performance measurement scale achieved Cronbach's alpha of .886, and accelerated recovery performance achieved .835. Both exceeded the .70 criterion commonly used in applied social research. Standardised instructions, neutral wording, confidential coding, and a common interview guide supported reliability and objectivity.

### 3.6 Data collection and ethics

The questionnaire was administered first, followed by the explanatory interviews. Participation was voluntary, and individual responses were confidential. The study proceeded under the Catholic University of Eastern Africa academic approval process and authorisation from the relevant organisational authority. Findings were reported in aggregate, participant identities were coded, and restricted technical, access, security, and operational information was excluded. The precise location and organisational identity are withheld for operational, security, and confidentiality reasons.

### 3.7 Data analysis and integration

Quantitative analysis used construct and item means, standard deviations, Cronbach's alpha, Pearson correlation, and the existing four-predictor multiple regression model (Field, 2018). Performance measurement was the substantive predictor of interest, while the multivariable result assessed whether its contribution remained significant after adjustment for related monitoring and control practices.

Regression diagnostics supported interpretation. Tolerance values ranged from .433 to .512 and VIF values from 1.95 to 2.31, indicating no severe multicollinearity. The Breusch-Pagan test was not significant, $p = .756$, Cook's distances were below 1, and residual normality showed a slight departure, $p = .007$. The model was retained for its exploratory explanatory purpose given the sample size and absence of severe influential observations.

Interview data were analysed thematically through deductive coding (Braun & Clarke, 2021) based on the five performance measurement dimensions and inductive coding of recurring explanations. Integration compared the quantitative indicator pattern with participant accounts concerning visibility, variance, priorities, and operational adjustment.

## 4 RESULTS

### 4.1 Respondent profile and measurement reliability

The achieved response base included all major restoration functions. Technicians and line crews formed 27.2% of respondents; procurement, logistics, and stores 12.3%; project managers and planners, electrical engineers, and site supervisors 11.4% each; safety and QA/QC 10.5%; operations 7.9%; administrative support 4.4%; and liaison or coordination stakeholders 3.5%. A total of 58.8% reported seven or more years of professional experience. This distribution provided informed perspectives from field execution, planning, engineering, assurance, logistics, and operations.

The performance measurement scale achieved strong internal consistency, $\alpha = .886$. The construct mean was 3.97 with $SD = 1.00$, indicating high overall agreement that performance measurement practices were present and useful during the restoration.

**Table 1: Performance measurement indicator results**

| Performance measurement indicator | Mean | SD | Interpretation | Rank |
|---|---|---|---|---|
| Availability of performance data for operational adjustment | 4.04 | 1.17 | High agreement | 1 |
| Timely and accurate performance information | 4.02 | 1.21 | High agreement | 2 |
| Earned Value Management indicators supported decisions | 4.01 | 1.20 | High agreement | 3 |
| Consistent schedule and cost variance analysis | 3.97 | 1.23 | High agreement | 4 |
| Performance indicators defined at project commencement | 3.80 | 1.24 | High agreement | 5 |
| Overall performance measurement construct | 3.97 | 1.00 | High agreement | |

### 4.2 Timely and accurate performance information

Timely and accurate performance information recorded $M = 4.02$ and $SD = 1.21$. The high mean indicates that respondents generally agreed that the measurement system provided useful information within the restoration period. The dispersion suggests that visibility differed across functions, which is plausible because planners and managers had more direct access to consolidated performance information than some field or support roles.

Interview accounts explained that timely information helped the team distinguish completed work from claimed activity, identify emerging constraints, and direct attention to delayed or critical tasks. Participants also indicated that information quality depended on access to field updates and the speed of communication from work locations. The finding supports Control Theory because timely measurement strengthened feedback, and Contingency Theory because the reliability of that feedback depended on the operating environment.

### 4.3 Schedule and cost variance analysis

Consistent schedule and cost variance analysis recorded $M = 3.97$ and $SD = 1.23$. Respondents therefore perceived variance analysis positively, although the comparatively higher dispersion suggests uneven visibility or application. Interview evidence indicated that comparison against planned milestones was particularly useful where delay could affect resource mobilisation, access, or follow-on work. Cost information supported awareness of acceleration and resource effects, but schedule and readiness considerations were more immediate in the restoration setting.

The findings suggest that variance analysis was valuable when it led to interpretation and response. A variance figure without a defined owner, decision threshold, or feasible intervention had limited control value. This reinforces the need to connect variance measurement with escalation and operational adjustment.

### 4.4 Earned Value Management decision support

The usefulness of Earned Value Management indicators recorded $M = 4.01$ and $SD = 1.20$. Respondents generally agreed that EVM-related information supported decisions. The finding should not be interpreted as proof that EVM alone determined recovery performance. Rather, EVM contributed structured schedule and cost information within a broader restoration measurement system.

Qualitative explanations indicated that formal indicators were most useful when combined with practical information about work-package status, resources, access, and technical readiness. This reflects the limitations of relying exclusively on numerical performance indices in a changing recovery environment. EVM strengthened discipline, but contextual interpretation remained necessary.

### 4.5 Performance data for operational adjustment

Availability of performance data for operational adjustment achieved the highest indicator mean, $M = 4.04$, $SD = 1.17$. This result identifies the principal practical mechanism linking measurement to performance. Participants described using performance information to adjust labour, resequence activities, escalate material or access constraints, and focus managerial attention on restoration priorities.

The indicator's leading rank shows that respondents valued measurement primarily for its capacity to change action, not for documentation alone. The finding supports the argument that performance visibility is the mechanism through which measurement can strengthen accelerated recovery. Data that are current, trusted, and linked to authority enable earlier and more targeted intervention.

### 4.6 Definition of indicators at project commencement

Definition of performance indicators at project commencement recorded the lowest mean, $M = 3.80$, $SD = 1.24$, although it remained in the high-agreement range. This result suggests that measurement occurred effectively but that initial indicator design or role clarity could be improved. Accelerated recovery may commence before the full damage picture is available, but organisations can still predefine indicator categories, templates, milestone rules, tolerances, review frequency, owners, and escalation triggers.

The indicator represents the clearest improvement opportunity. Preparedness should include a restoration measurement framework that can be activated and tailored when disruption occurs. Early indicator definition would reduce inconsistent interpretation and improve traceability when baselines are revised.

### 4.7 Relationship with accelerated recovery performance

Performance measurement had a very strong positive relationship with respondent-rated accelerated recovery performance, $r = .724$, $p < .001$. Respondents who reported stronger performance measurement practices also tended to report stronger schedule adherence, technical quality, safety performance, scope completion, and overall recovery effectiveness. Because the study was cross-sectional and perception based, the relationship indicates association rather than causation.

In the full regression model, performance measurement retained the largest significant unique contribution after progress reporting, inspection and testing, and corrective action were controlled: $B = .327$, $SE = .067$, $\beta = .387$, $t = 4.88$, $p < .001$, 95% CI [.19, .46]. The four-predictor model was significant, $F(4, 109) = 50.340$, $p < .001$, and explained 64.9%

of the observed variance in respondent-rated recovery performance. The adjusted result indicates that performance measurement remained substantively important within the wider monitoring and control system.

**Table 2: Relationship between performance measurement and recovery performance**

| Statistic | Result | Interpretation |
|---|---|---|
| Performance measurement mean (SD) | 3.97 (1.00) | High agreement |
| Cronbach's alpha | 0.886 | Strong internal consistency |
| Correlation with recovery performance | r =0 .724, $p < 0.001$ | Very strong positive association |
| Adjusted regression coefficient | B = 0.327, β = 0.387, $p < 0.001$ | Largest significant unique contribution |
| 95% confidence interval for B | [0.19,0 .46] | Positive interval excluding zero |
| Full model explanatory power | $R^2$ =0 .649 | 64.9% of observed variance explained by four practices |

### 4.8 Integration of quantitative and qualitative findings

The quantitative and qualitative evidence converged around performance visibility. The indicator means showed that respondents valued timely information, variance analysis, EVM, data availability, and defined indicators. The correlation and regression findings showed that the broader performance measurement construct was strongly associated with recovery performance. Interviews explained that measurement mattered because it made completed work, delayed activities, constraints, and priorities visible enough to support operational adjustment.

**Table 3: Integrated interpretation by measurement dimension**

| Measurement dimension | Quantitative pattern | Qualitative explanation | Integrated meaning |
|---|---|---|---|
| Timely and accurate information | M = 4.02 | Clarified current status and emerging constraints | Feedback must arrive within the decision window |
| Variance analysis | M = 3.97 | Highlighted slippage and priorities | Comparison supports targeted intervention |
| EVM decision support | M = 4.01 | Provided structured schedule and resource information | Formal indices require contextual interpretation |
| Data for operational adjustment | M = 4.04, highest | Supported labour, sequencing, escalation, and resource decisions | Actionability is the principal mechanism |
| Indicators defined at commencement | M = 3.80, lowest | Initial criteria could be clearer | Preparedness should include adaptable measurement templates |

## 5 DISCUSSION

### 5.1 Performance measurement as a visibility mechanism

The central finding is that performance measurement supported accelerated recovery by creating performance visibility. Measurement did more than record activity. It enabled the project team to compare actual progress with intended recovery milestones, identify variance, distinguish urgent constraints, and determine where intervention was required. This interpretation is consistent with Control Theory, in which sensing and feedback are prerequisites for corrective response (Wiener, 1948).

The very strong correlation and significant adjusted coefficient indicate that performance measurement carried information not fully represented by the other monitoring and control practices. Reporting communicates information, inspection verifies technical conformance, and corrective action responds to deviation; measurement provides the initial evidence concerning status and variance. Its statistical strength is therefore theoretically coherent.

### 5.2 Timeliness, accuracy, and the decision window

The strong rating for timely and accurate information demonstrates that measurement quality depends on both correctness and speed. In accelerated recovery, information that arrives after a mobilisation, access, or sequencing decision has limited control value. Similarly, a rapid but inaccurate update can direct resources toward the wrong problem. Measurement arrangements should therefore define collection responsibilities, validation procedures, reporting intervals, and exception triggers that fit the rate at which restoration conditions change.

### 5.3 Variance analysis and adaptable baselines

Variance analysis supported awareness of departure from the plan, but recovery baselines require disciplined flexibility. Initial restoration plans may be revised when damage, access, or material information becomes clearer. The appropriate response is not to abandon baseline control, but to establish authorised update procedures that preserve the history and rationale of changes. This allows managers to distinguish new information from weak execution and maintain accountability without using an obsolete plan.

### 5.4 EVM and contextual performance indicators

The favourable EVM indicator result shows that structured schedule and resource measures can support recovery decisions. Nevertheless, a remote restoration project cannot be managed through EVM indicators alone. Numerical indices should be integrated with milestone status, access, material readiness, inspection status, safety holds, unresolved defects, and test readiness. This combined approach preserves the discipline of formal measurement while recognising the operational conditions that determine whether reported progress is genuinely recoverable and technically acceptable.

### 5.5 From measurement to operational adjustment

The highest-rated indicator concerned availability of data for operational adjustment. This is the most important practical result because it identifies the pathway from information to performance. Measurement contributed when it supported resequencing, labour allocation, resource escalation, constraint removal, or protection of critical work. Organisations should therefore evaluate measurement systems by the decisions they improve, not by the volume of data they collect.

### 5.6 Indicator definition as a preparedness requirement

The lowest item mean concerned definition of indicators at project commencement. Although respondents still reported high agreement, the result identifies the clearest opportunity for improvement. Recovery organisations should prepare adaptable measurement frameworks before disruption. These should define minimum readiness indicators, milestone rules, data owners, reporting frequency, variance tolerances, escalation thresholds, and review forums. Event-specific details can then be added as the damage and restoration scope become clearer.

### 5.7 Theoretical, methodological, and practical implications

Theoretically, the findings strengthen Control Theory by showing that performance measurement is the sensing mechanism that makes accelerated recovery controllable. They also support Contingency Theory because the usefulness of measurement depended on remoteness, access, logistics, authority, and urgency. Methodologically, the explanatory sequential design added value by revealing not only the statistical strength of measurement but also the practical mechanism of visibility and operational adjustment.

Practically, organisations should implement restoration scorecards that prioritise decision-critical information. A concise scorecard could include approved milestone status, critical work-package completion, schedule variance, resource and material readiness, access limitations, test readiness, safety holds, unresolved defects, decision owner, and next action. The tool may be a controlled spreadsheet or digital dashboard, provided that it is current, trusted, and reviewed at an appropriate frequency.

### 5.8 Limitations and future research

The findings arise from a single-project case and should not be statistically generalised to unrelated settings. Questionnaire data were cross-sectional and perception based, and the same respondents assessed performance measurement and recovery performance. Common-method variance may therefore have strengthened the observed relationship. Project records were used for context but not analysed as an independent documentary strand. Security and confidentiality restrictions also limited disclosure of technical and operational detail. The results indicate association and explanatory contribution, not causation.

Future research should compare multiple recovery projects and combine respondent evidence with authorised schedules, progress records, EVM reports, work-package completion data, material-delivery records, and decision logs. Longitudinal research could examine how measurement quality changes from damage assessment through mobilisation, execution, technical acceptance, and close-out. Further studies should also test whether timely reporting and corrective response mediate the relationship between measurement and recovery performance.

## 6 CONCLUSION

This study examined performance measurement practices in accelerated electrical infrastructure recovery. The findings showed high agreement across all indicators and a very strong positive association between performance measurement and respondent-rated recovery performance. Performance measurement also retained the largest significant unique contribution in the wider monitoring and control regression model.

The highest-rated indicator was availability of performance data for operational adjustment, confirming that measurement is most valuable when it changes decisions and action. Timely and accurate information, EVM indicators, and variance analysis were also rated strongly. Definition of indicators at project commencement recorded the lowest mean and represents the principal improvement opportunity.

The study concludes that performance measurement strengthens controlled acceleration by making actual status, variance, constraints, and restoration priorities visible. Effective systems should be timely, accurate, decision-oriented, traceable to approved targets, and adaptable to the project environment. Recovery preparedness should therefore include predefined indicator categories, milestone rules, data ownership, variance thresholds, and escalation arrangements that can be tailored rapidly when disruption occurs.

## STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

### *Acknowledgments*

The author acknowledges Dr. Luhombo Adema Calistus and Dr. Onsarigo Gisemba Thomas for their academic supervision, guidance, and constructive review during development of the master's thesis from which this article was derived. The supervisors are acknowledged for their contribution to the thesis process and are not listed as authors of this manuscript.

### *Disclosure of conflict of interest*

The author declares no competing interests.

### *Statement of ethical approval*

The study proceeded under the Catholic University of Eastern Africa academic approval process and authorisation from the relevant organisational authority.

### *Statement of informed consent*

Participation was voluntary, responses were confidential, and findings were reported in aggregate. The precise project location and organisational identity are withheld because of operational, security, and confidentiality considerations.

### *Data availability*

The underlying data are not publicly available because they relate to a security-sensitive infrastructure setting and remain subject to organisational, confidentiality, and operational restrictions. Aggregated findings supporting the conclusions are reported in the article. Requests for additional information would be subject to applicable institutional and organisational approval procedures.

### *Originality and related outputs*

This manuscript reports original analysis derived from the author's 2026 master's thesis submitted to the Catholic University of Eastern Africa. This submission complies with the journal's policies on originality, disclosure, overlap, and concurrent consideration.

*Author contribution*

James Kipchumba Tum conceived the study, designed the instruments, collected and analysed the data, interpreted the findings, and prepared the manuscript.

## REFERENCES


[1] Braun, V., & Clarke, V. (2021). Thematic analysis: A practical guide. Sage.

[2] Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). Sage.

[3] Donaldson, L. (2001). The contingency theory of organisations. Sage.

[4] Field, A. (2018). Discovering statistics using IBM SPSS statistics (5th ed.). Sage.

[5] Fleming, Q. W., & Koppelman, J. M. (2016). Earned value project management (4th ed.). Project Management Institute.

[6] Karagiannis, G. M., Chondrogiannis, S., Krausmann, E., & Turksezer, Z. I. (2017). Power grid recovery after natural hazard impact (EUR 28844 EN). Publications Office of the European Union.

[7] Ofgem. (2022). Final report on the review into the networks' response to Storm Arwen. Office of Gas and Electricity Markets.

[8] Project Management Institute. (2020). The standard for earned value management. Project Management Institute.

[9] Project Management Institute. (2021). A guide to the project management body of knowledge (PMBOK Guide) (7th ed.). Project Management Institute.

[10] Román, M. O., Stokes, E. C., Shrestha, R., Wang, Z., Schultz, L., Sepúlveda Carlo, E. A., Sun, Q., Bell, J., Molthan, A., Kalb, V., Ji, C., Seto, K. C., McClain, S. N., & Enenkel, M. (2019). Satellite-based assessment of electricity restoration efforts in Puerto Rico after Hurricane Maria. PLOS ONE, 14(6), e0218883. https://doi.org/10.1371/journal.pone.0218883

[11] Too, E. G., & Weaver, P. (2014). The management of project management: A conceptual framework for project governance. International Journal of Project Management, 32(8), 1382–1394.

[12] Wiener, N. (1948). Cybernetics: Or control and communication in the animal and the machine. MIT Press.

[13] Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). Sage.