



The Effect of Real-Time Data Analytics on the Performance of the Amahoro National Stadium Renovation Project in Rwanda

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Abstract: This study examined the relationship between real-time data analytics and the performance of the Amahoro National Stadium renovation project in Gasabo District, Kigali, Rwanda. A mixed-method, descriptive cross-sectional case study design was used. The target population was 181 project personnel, from whom 125 were sampled using Slovin's formula and stratified random sampling; 120 questionnaires were returned (96%). Data were collected with a structured five-point Likert questionnaire and interviews with project managers, financial officers and contractors, and were analyzed in SPSS version 27 using descriptive statistics, Pearson correlation, simple linear regression and thematic analysis. Respondents rated real-time data analytics as moderate ($M = 3.72$) and project performance as moderate ($M = 3.44$), with cost efficiency rating lowest. Real-time data analytics correlated very strongly with perceived project performance ($r = .993$, $p < .001$) and, as a single predictor, accounted for 98.6% of its variance ($F(1, 118) = 8,368.29$, $p < .001$; $B = 0.984$). Interviewees reported faster decisions and earlier corrections of delays but also noted limited user skills and slow system integration. Because the design is cross-sectional and based on self-reports, the results show a strong association rather than proven causation. The study recommends extending dashboards to real-time cost tracking, training staff to interpret analytics, and integrating data platforms to remove manual re-entry.

Keywords: Analytics; Monitoring; Evaluation; Construction; Performance; Renovation; Rwanda

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1. Introduction

Large construction projects depend on timely information about schedule, cost, quality and stakeholder expectations. Globally, the sector has been adopting digital tools such as sensors, cloud platforms and dashboards that allow project data to be captured and analyzed as they are generated, rather than weeks later in periodic reports (World Bank, 2022). In principle, such real-time data analytics gives managers earlier warning of deviations and a firmer basis for reallocating Labour, materials and equipment.

Evidence from developing regions suggests that digital monitoring can support project outcomes but that its

benefits depend on adoption, skills and infrastructure. In Kenya, integration of information and communication technology in participatory monitoring was positively associated with the performance of water projects (Bulle & Muchelule, 2024). In Nigeria, monitoring technologies based on radio-frequency identification showed a significant positive relationship with sustainable building outcomes (Kineber et al., 2023). In Rwanda, national policy promotes systematic monitoring and evaluation (Government of Rwanda, 2019), yet research on construction technology shows that digital tools are still unevenly adopted and that training and network access remain barriers (Dosumu et al., 2023; Musabyimana, 2021).

Delays, cost overruns and weak oversight remain recognized concerns in Rwanda's public construction projects (Government of Rwanda, 2020). The renovation of Amahoro National Stadium in Kigali, which expands the national stadium to international standards, is one of the country's flagship infrastructure projects and therefore a useful case for examining whether real-time data analytics is related to project performance. Most earlier studies examined other technologies (for example building information modelling or radio-frequency identification), other sectors, or technology adoption rather than performance, and few used surveys evidence from a single large public construction project in Rwanda. This study addresses that gap by providing evidence that managers and policy makers can use when deciding how far to invest in real-time analytics for public infrastructure.

2. Literature Review

2.1 Real-time data analytics in construction

Real-time data analytics is the collection, processing and analysis of data at or near the moment they are produced, so that decisions rest on current rather than historical information. On construction sites the data typically come from site records, construction management software, financial systems and sensors, and are presented in dashboards that show progress, resource use and cost position. The expected pathway to performance is straightforward: earlier detection of schedule or budget deviations, faster corrective action and better coordination of resources (World Bank, 2022). Performance in this study is understood through three dimensions: scope performance, cost efficiency and timeliness.

2.2 Theoretical perspectives

Three theories frame the study. Systems theory regards a project as a set of interdependent subsystems that stay on course through feedback (Bertalanffy, 1968); real-time analytics can be read as the feedback mechanism that tells the project system when it is drifting. Resource dependence theory holds that organizations perform better when they manage their dependence on external resources and reduce uncertainty about them (Pfeffer & Salancik, 1978); analytics gives managers visibility of materials, Labour and funds. The technology acceptance model proposes that perceived usefulness and perceived ease of use determine whether technology is accepted and used (Davis, 1989); the benefits of analytics therefore depend on how readily project staff understand and use it.

2.3 Empirical studies

At the global level, Xiang et al. (2024) built an integrated, data-driven measurement model for public safety risks in international construction projects using data from 49 countries and five projects, and reported significant relationships (standardized coefficients between .45 and .65) between threat levels and regional risk scores. Although the focus was safety risk, the study shows the value of systematic data analysis in assessing project conditions. In Nigeria, Kineber et al. (2023) found that monitoring technologies had a significant positive effect on sustainability outcomes in buildings ($\beta = .78$, $p < .01$), a larger effect than management technologies ($\beta = .45$, $p < .05$).

In East Africa, Bulle and Muchelule (2024) reported that ICT integration in participatory monitoring and assessment significantly predicted the performance of water projects in Wajir County, Kenya ($\beta = .463$, $p < .001$) and correlated strongly with performance ($r = .67$, $p < .01$). In Rwanda, Musabyimana (2021) found that awareness of building information modelling significantly predicted its use ($\beta = .61$, $p < .01$), although only 2D and 3D applications were common. Dosumu et al. (2023) similarly reported that adoption of Internet of Things technologies in the Rwandan construction industry was low, with limited training, poor network access and funding as the main barriers. Taken together, the studies indicate that digital monitoring is associated with better outcomes where it is adopted, but they do not test the effect of real-time data analytics on the performance of a major stadium renovation in Rwanda, which the present study investigates.

3. Methodology

3.1 Research design

The study used a mixed-methods, descriptive cross-sectional case study design. The quantitative strand measured respondents' perceptions of real-time data analytics and project performance at one point in time and tested the relationship between them; the qualitative strand used interviews to explain the statistical results. The case was the Amahoro National Stadium renovation project in Gasabo District, Kigali.

3.2 Population and sampling

The target population was the 181 personnel of the renovation project who work with monitoring and evaluation systems. Using Slovin's formula at a 5% margin of error, $n = 181 / (1 + 181 \times 0.05^2) = 124.6$, rounded to 125. Respondents were selected by random sampling within role categories (strata); the small categories of senior project manager, architects, surveyors and quantity surveyors were included in full (Table 1). Interview participants (project managers, financial officers and contractors) were selected purposively because of their direct involvement in

monitoring and evaluation. Of the 125 questionnaires distributed, 120 were returned fully completed, a response rate of 96%.

Table 1: Target population and sample by category

Category	Population	Sample
Senior project manager	1	1
Site managers	10	8
Site engineers	18	12
Architects	5	5
Surveyors	5	5
Quantity surveyors	5	5
Electrical engineers	17	11
Mechanical engineers	15	9
IT staff	15	10
Finance staff	12	8
Support staff	78	51
Total	181	125

3.3 Instruments, validity and reliability

Data were collected using a structured five-point Likert questionnaire. Real-time data analytics was measured using five items (Table 2), while perceived project performance was measured using nine items covering scope, cost efficiency and timeliness (three items each). An interview guide elicited participants' experiences with real-time information and project decisions. The research project reports expert review of the questionnaire by two project management specialists and the supervisor. It also describes assessing internal consistency using Cronbach's alpha and a .70 criterion; however, it does not provide numerical alpha coefficients or the supporting reliability output. Accordingly, reliability coefficients cannot be reported or independently assessed from the supplied research project.

3.4 Data analysis

Data were analyzed in SPSS version 27. Descriptive statistics (frequencies, percentages, means and standard deviations) summarized responses. Means were interpreted as very high (4.40–5.00), high (3.80–4.39), moderate (3.00–3.79), low (2.00–2.99) or very low (1.00–1.99). Pearson's correlation measured the strength and direction of the relationship between real-time data analytics and performance, and a simple linear regression, $Y = \beta_0 + \beta_1 X + \varepsilon$, estimated the association of real-time data analytics (X) on project performance (Y), tested at the 5% level. Interview data were analyzed thematically.

3.5 Ethical considerations

Access to the project site was obtained through an introduction letter from the university. Participation was voluntary, written informed consent was obtained, and respondents could withdraw at any time. Responses were anonymized and coded, used only for academic purposes, and stored securely in line with Rwanda's Data Protection Law (Law No. 058/2021).

4. Results and Discussion

4.1 Respondent profile

Of the 120 respondents, 75 (62.5%) were male and 45 (37.5%) were female. Most were aged 26–35 years (40.8%) or 36–45 years (30.0%); 15.0% were below 25 years and 14.2% were above 45 years. More than half held a bachelor's degree (52.5%), 25.0% a master's degree, 18.3% a secondary diploma and 4.2% a doctorate. Experience on the project was under one year for 24.2%, one to three years for 41.7% and over three years for 34.2%. The respondents represented varied educational and professional backgrounds relevant to assessing the technologies and perceived project performance.

4.2 Perceptions of real-time data analytics and project performance

Table 2 presents the responses on real-time data analytics. The overall mean was 3.72, a moderate rating. Agreement (agree plus strongly agree) was highest for the statement that analytics provides accurate and timely insights (73.3%, $M = 3.90$) and that it improves the

ability to identify and address issues promptly (74.2%, $M = 3.89$). Agreement was lowest for ease of use (56.7%, $M = 3.48$), where 28.3% of respondents disagreed or

strongly disagreed. This suggests that the tools were considered useful but that not all staff found them easy to use.

Table 2: Respondents' views on real-time data analytics

Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)	<i>M</i>	<i>SD</i>
Real-time analytics tools provide accurate and timely insights into progress and performance	7.5	10.0	9.2	31.7	41.7	3.90	1.26
Real-time analytics has improved our ability to identify and address issues promptly	8.3	8.3	9.2	34.2	40.0	3.89	1.26
Integrated real-time analytics has enhanced our decision-making capabilities	10.8	14.2	11.7	30.0	33.3	3.61	1.36
Our team finds the real-time analytics tools easy to use and understand	10.0	18.3	15.0	27.5	29.2	3.48	1.35
Real-time analytics has improved the efficiency and effectiveness of the renovation project	11.7	10.0	15.0	20.0	43.3	3.73	1.41
Overall mean						3.72	

Project performance was rated moderate overall ($M = 3.44$). Scope performance was rated high ($M = 3.94$), timeliness moderate ($M = 3.46$) and cost efficiency low ($M = 2.92$), with staying within budget ($M = 2.95$), efficient use of resources ($M = 2.83$) and effectiveness of cost-saving measures ($M = 2.98$) all below the neutral point. Cost control was therefore the weakest aspect of performance.

4.3 Effect of real-time data analytics on project performance

Pearson's correlation showed a very strong, positive and statistically significant relationship between real-time data analytics and project performance ($r = .993$, $p < .001$, $N = 120$). Simple linear regression (Table 3) showed that real-time data analytics significantly predicted performance, $F(1, 118) = 8,368.29$, $p < .001$, and accounted for 98.6% of the variance in performance ratings ($R^2 = .986$). A one-point increase in the analytics rating was associated with a 0.984-point increase in the performance rating ($B = 0.984$, $SE = 0.011$, $\beta = .993$, $t = 91.48$, $p < .001$). The null hypothesis H_{01} was therefore rejected: real-time data analytics was statistically significantly associated with the performance of the Amahoro National Stadium renovation project.

Table 3: Simple linear regression of project performance on real-time data analytics

Statistic	Value
R , R^2 , adjusted R^2	.993, .986, .986
Standard error of the estimate	0.156
ANOVA: $F(1, 118)$	8,368.29 ($p < .001$)
Constant: B (SE), t , p	0.024 (0.043), 0.56, .580
Real-time data analytics: B (SE)	0.984 (0.011)
Real-time data analytics: β , t , p	.993, 91.48, $< .001$

4.4 Insights from interviews

Interviewees explained the statistical result in terms of faster decisions. A project manager said, "Whenever we saw delays or cost deviations in the dashboard, we addressed them immediately instead of waiting for weekly reports," and a contractor added, "Without real-time tracking, we would have lost control during peak construction phases." Another contractor noted that real-time data "reduces guesswork" in allocating equipment and manpower. Interviewees also identified constraints that match the lower ease-of-use rating. A financial

officer observed that "some staff did not fully understand how to use" the tools, and a project manager reported that slow integration between systems meant data sometimes had to be transferred manually.

4.5 Discussion

The results show a striking contrast: respondents rated real-time data analytics only moderately, yet its relationship with performance was almost perfect. The moderate rating reflects uneven user experience, especially on ease of use, while the strong association

indicates that respondents who judged analytics favorably also judged project performance favorably. The finding is consistent with Bulle and Muchelule (2024), who found that ICT integration was significantly related to the performance of water projects in Kenya, and with Kineber et al. (2023), who found a strong positive effect of monitoring technologies on sustainability outcomes in Nigeria. The effect sizes here are much larger than those reported in those studies, which should be interpreted with the caution discussed below. The reported barriers of training and weak integration also echo Dosumu et al. (2023), who identified limited training and infrastructure as obstacles to digital technology adoption in Rwanda.

The theoretical perspectives help to explain the pattern. From a systems perspective, dashboards served as a feedback loop that allowed managers to correct deviations before they accumulated, as interviewees described (Bertalanffy, 1968). Consistent with resource dependence theory, real-time visibility of materials, Labour and funds reduced uncertainty in managing resources (Pfeffer & Salancik, 1978). The lower ease-of-use rating and interview comments on skills illustrate the technology acceptance model: perceived usefulness was high, but benefits depend on staff being able to use the tools (Davis, 1989). A further point concerns cost: although analytics was strongly related to overall performance, cost efficiency was the lowest-rated dimension ($M = 2.92$). Visibility of cost deviations does not by itself control costs; it must be combined with timely financial decisions.

Several limitations qualify these results. The study covers one project, uses self-reported perceptions from a single survey, and is cross-sectional, so it cannot establish causation or temporal order. A correlation of .993 is unusually high and suggests that analytics and performance items may overlap or share common-method variance. The four technologies studied in the wider research were also highly inter-correlated ($r = .957$ between real-time data analytics and the Internet of Things sensors, .962 with automated reporting tools and .959 with risk management software), so the effect reported here is not independent of the other tools. Future work should combine the technologies in one multivariable model with diagnostic checks and use documentary indicators of cost, time and quality. The magnitude of the association warrants checking the underlying dataset, scale construction, and model assumptions before journal submission.

5. Conclusions and Recommendations

5.1 Conclusion

Real-time data analytics showed a statistically significant positive association on the performance of the Amahoro National Stadium renovation project, as shown by a very strong correlation ($r = .993$) and a regression in which

analytics accounted for 98.6% of the variance in perceived performance. The relationship is an association in self-reported ratings and should not be read as proof of causation. Interview accounts suggest that timely detection of delays and improved resource allocation may help explain the observed association.

5.2 Recommendations

Based on the findings of this study, the following recommendations are made:

1. **Strengthen Real-Time Financial Monitoring:** Project managers should extend real-time dashboards to financial tracking to ensure continuous comparison of actual expenditures against the allocated budget, as cost efficiency was identified as the weakest dimension of project performance.
2. **Enhance Staff Capacity in Data Analytics:** Project management should provide training to staff on interpreting and effectively utilizing real-time analytics to support informed decision-making, given that ease of use received the lowest rating.
3. **Improve Data Systems Integration:** The project management team should integrate existing data platforms to eliminate manual data re-entry, improve information accuracy, and enhance operational efficiency.
4. **Strengthen Policy and Institutional Support:** The Ministry of Infrastructure should incorporate real-time data analytics requirements and staff capacity-building initiatives into national guidelines for managing public construction projects.
5. **Future studies should incorporate documentary project performance records, examine multiple construction projects, and adopt longitudinal research designs to provide stronger evidence regarding the effects of real-time data analytics on project cost, timeliness, and quality.**

References

- Bertalanffy, L. von. (1968). *General system theory: Foundations, development, applications*. George Braziller.
- Bulle, M. A., & Muchelule, Y. (2024). Participatory monitoring and evaluation practices and performance of water projects in Wajir County, Kenya. *International Journal of Social Sciences Management and Entrepreneurship*, 8(1).

- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- Dosumu, O. S., Mahame, C., Niyitegeka, S., & Hahiirwuwambaza, J. A. (2023). Applications and challenges of adopting the Internet of Things (IoT) in the Rwandan construction industry. *Journal of Construction in Developing Countries*, 28(2), 81–100. <https://doi.org/10.21315/jcdc-05-22-0098>
- Government of Rwanda. (2019). *National monitoring and evaluation policy*. [Publisher/Ministry and URL to be added]
- Government of Rwanda. (2020). *National construction policy*. [Publisher/Ministry and URL to be added]
- Kineber, A. F., Oke, A. E., Ali, A. H., Dosumu, O. S., Fakunle, K., & Olanrewaju, O. I. (2023). Critical application areas of radio frequency identification (RFID) technology for sustainable construction in developing countries: The case of Nigeria. *Journal of Engineering, Design and Technology*. Advance online publication. <https://doi.org/10.1108/JEDT-05-2023-0191>
- Musabyimana, E. (2021). *Adoption of building information modelling (BIM) in construction projects delivery in Rwanda* [Master's thesis, Jomo Kenyatta University of Agriculture and Technology]. <http://ir.jkuat.ac.ke/handle/123456789/5567>
- Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. Harper & Row.
- World Bank. (2022). *Effective project monitoring and evaluation*. [URL to be added]
- Xiang, P., Yang, S., Yuan, Y., & Li, R. (2025). Integrated measurement of public safety risks in international construction projects in the Belt and Road Initiative. *Engineering, Construction and Architectural Management*, 32(7), 4673–4699.