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Project Risk Management and Implementation of Water and Sanitation Projects in Nyanza Region, Kenya

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Abstract: *Water and sanitation projects are subject to various risks that hinder their timely implementation. Such vulnerabilities frequently result in delays, cost overruns, and unsustainable outcomes. This highlights the need for proper risk management for desirable outcomes. Nonetheless, there are challenges with the implementation of water and sanitation projects in Kenya. Nyanza Region in particular, the challenge is particularly acute: 85% of the population lacks access to clean water, while 76% is without sanitation facilities, exposing communities to serious health and environmental hazards. The projects are associated with frequent delays, cost overruns, and even premature termination. Against this problem, the current study examined the effect of project risk management on the implementation of water and sanitation initiatives in Nyanza Region, Kenya, drawing on Resilience Theory. A total of thirty-five respondents from seven projects were involved. Data was collected through closed-ended questionnaires and analyzed using descriptive and inferential methods with the aid of SPSS v.26. Results revealed a correlation coefficient of 0.415, significant at the 1% level. The R Square value of 0.172 indicated that project risk management accounted for 17.2% of the variation in implementation. These findings underscore that the implementation of water and sanitation projects is significantly affected by project risks management. The study concludes that proactive risk management through systematic identification, analysis, and mitigation strengthens project resilience, prevents disruptions, and ensures sustained implementation. It is recommended that water works development agencies adopt comprehensive risk management frameworks with regular contingency planning and a culture of accountability to enhance projects implementation.*

Key Words: *Project Risk Management, Project Implementation, Water and Sanitation Projects*

I. Introduction

Projects are conducted in environments associated with risks, which some extent determine outcomes (Mutula, Omwenga, & Kimathi, 2023). These vulnerabilities often interact in ways that create barriers to achieving intended goals. When risks are not adequately managed, projects encounter budget escalations and prolonged timelines. In addition, weak monitoring and oversight allow inefficiencies to persist, further eroding performance. Effective risk management therefore requires structured approaches that anticipate potential disruptions and provide avenues for mitigation. This involves systematic identification of vulnerabilities, assessment of their likelihood, and development of tailored responses. Such practices promote adaptability and foster accountability across project teams. Ultimately, embedding risk considerations into project governance strengthens resilience and ensures continuity even under volatile conditions (Project Risk Management and Implementation of Integrated Infrastructural Projects in Government Agencies in Kenya, 2025). In water and sanitation projects, risk management carries amplified importance due to the essential nature of these services and their direct link to human health and well-being (Ireri & Mungai, 2024). These projects often operate in resource-constrained contexts, where weak institutional arrangements and fragmented planning heighten exposure to disruption. Furthermore, premature project terminations are frequently observed when risks are overlooked during the planning and execution phases. Effective management requires embedding contingency planning, monitoring mechanisms, and structured inspections throughout the project lifecycle (Munyugi & Nteere, 2023). It also demands consistent engagement with stakeholders to build trust and minimize potential resistance.

Kenyan Government has made efforts in improving access to water and sanitation, but the implementation of these projects has continued to face serious, ongoing challenges. According to the 2025 impact report by the Water Services

Regulatory Board (WASREB), although national piped water coverage rose from 65% to 70%, non-revenue water is still at 45%, resulting in major financial losses estimated at KSh 11.9 billion annually. Additionally, only about 15% of the population is connected to formal sewerage systems, while vast numbers still rely on pit latrines and informal sanitation means. The 2023–24 Annual Progress Report under Kenya's Medium-Term Plan also identified delays in project completion, late disbursement of funds, and insufficient budget allocations as key impediments to achieving targets for improved sanitation, especially in underserved and informal settlements. In Nyanza region, the Oyugis Water and Sanitation Project was initiated in 2017 to enhance services for about 40,000 residents, while the Kendu Bay Water and Sanitation Project was also launched the same year to benefit approximately 35,000 people. In 2019, the Ugunja-Ukwala-Sega Water and Sanitation Project began, targeting over 60,000 people with improved access to clean water and sanitation. In 2021, the Keroka Last Mile Connectivity Water and Sanitation Project was introduced to extend essential services to remote towns. That same year, the Siaya-Bondo Last Mile Connectivity and the Migori-Isebania Last Mile Connectivity projects were launched, with the aim of improving access for nearly 250,000 people. Despite the numerous initiatives undertaken across Nyanza to expand water and sanitation services, persistent challenges continued to undermine their effectiveness. Implementation hurdles such as limited capacity, delays, and sustainability concerns were evident across many of these projects.

About 60% of water and sanitation projects encountered major delays (Wainaina & Pedo, 2023). These setbacks extended project timelines and led to estimated annual losses of roughly KSh 250 million, with several initiatives stretching over multiple years. For example, the Asembo Water Treatment Plant Extension struggled with financial and technical constraints for years, while the Kisumu Sanitation Improvement Initiative, the Rural Siaya water access program, and the Nyando Water and Sanitation Project all experienced prolonged delays linked to land acquisition, community consultations, resource shortages, and funding gaps. Such challenges not only escalated project costs but also contributed to a reported 12% increase in waterborne diseases and a 10% rise in diarrheal cases, underscoring both the financial burden and long-term public health consequences (Muchiri, Were, & Simiyu, 2021). Several studies have examined different project management practices in relation to successful implementation. For instance, Otieno and Mutiso (2021) investigated agricultural project risk management and performance, while Njuguna (2019) explored the link between risk management practices and project performance; both studies established that project risk management was a significant predictor. However, these studies did not sufficiently address project risk management within the specific context of water and sanitation projects. The present study assessed the influence of project risk management on implementation of water and sanitation projects in Nyanza Region, Kenya

II. Objective of the Study

To establish the influence of project risk management on implementation of water and sanitation projects in Nyanza Region, Kenya.

III. Literature Review

Project risks are embedded in events or conditions that alter the trajectory of outcomes, often stemming from management inefficiencies, contractual disputes, or organizational limitations (Kountur, 2023). Risk identification is critical because it shapes the ability to recognize exposures that may not be immediately visible but hold the potential to disrupt project continuity. This recognition extends beyond obvious external pressures such as regulatory shifts and market volatility to include hidden vulnerabilities within governance, resource availability, and stakeholder alignment (Kheir, 2022). Identifying such risks ensures that projects are not blindsided by elements that could otherwise escalate into crises. Risk analysis provides depth by distinguishing between risks of varying severity and understanding the scale of their implications (Acebes, 2024). It highlights the differential effects of risks by considering their probability, intensity, and speed of onset. This interpretive effort allows managers to discern which risks carry systemic consequences capable of compounding across multiple areas of the project (Glette-Iversen, 2023). Through analytical lenses, it becomes possible to forecast how risks interact and where pressure points may emerge, enabling organizations to address threats not as isolated issues but as interconnected challenges that can shift the balance of performance.

Risk control reflects the deliberate effort to influence outcomes once risks have been recognized and interpreted (Cheimonidis, 2025). It involves shaping exposure in ways that either suppress negative consequences or amplify beneficial ones. Control is achieved by ensuring accountability is clearly defined, strategies are proportional to the level of risk, and mechanisms for adjustment are integrated into the project environment (Goswami, 2024). This perspective positions control not as rigid containment but as a dynamic safeguard that protects continuity while creating avenues for resilience and opportunity. Risks rarely remain static over the lifespan of a project, which makes their identification, analysis, and control a continuing necessity (Shishehgarkhaneh, 2024). As conditions evolve, earlier assumptions may lose

relevance, rendering previous interpretations insufficient (Song, 2025). Sustained attention to risks therefore ensures that emerging dynamics are captured and responses remain aligned with shifting realities. In this way, risk management practices extend beyond protection, reinforcing adaptability and cultivating long-term value even in demanding environments.

Holling's resilience theory, emerging in 1973, lays the groundwork for comprehending how systems navigate and absorb disruptions while safeguarding their fundamental functions and structures. Its correlation with sustainable development, as underscored by Muriana and Vizzini (2017), aims to foster the establishment and sustenance of functional social, economic, and ecological systems. However, these systems grapple with an array of internal and external threats, necessitating adept risk management during project execution for greater chances of success. The theory's core emphasis lies in the pivotal role of risk management, shifting focus from attempting to control changes in presumed stable systems towards managing the capacity of socio-ecological systems to not just endure but dynamically adapt and potentially influence change.

Cagliano, Grimaldi, and Rafele (2015) elaborate on a central tenet of effective risk management, advocating for the proactive minimization of hazards as they arise to curtail their potential impact. They argue that a well-executed risk mitigation strategy often yields a decrease in adverse effects. Moreover, they emphasize that a meticulously planned and executed risk management approach replaces the uncertainty of an incident with a more regulated and predictable response. Ultimately, the essence of resilient systems lies in their inherent ability to confront challenges and navigate changes while sustaining their functionality. Hence, integrating robust risk management practices becomes an alignment with the fundamental principles of resilience, fortifying systems' capacities to withstand perturbations and adapt dynamically to evolving circumstances. This theory's significance transcends the mere management of unforeseen events; it underscores the proactive stance necessary to build and maintain resilient systems. By acknowledging the unpredictable nature of disturbances and prioritizing the preparedness to adapt and recover, organizations can foster a culture that not only responds to challenges but also actively shapes and influences change. Consequently, the integration of resilient principles into project implementation becomes integral, enabling systems to not just survive but thrive amidst uncertainty, ultimately contributing to their sustained functionality and viability in the face of ever-evolving environments. Figure 1 presents the conceptual framework illustrating the relationship between project risk management and the implementation of water and sanitation projects. The framework emphasizes how the dimensions of risk identification, risk analysis, and risk control determine the efficiency, timeliness and quality of projects.

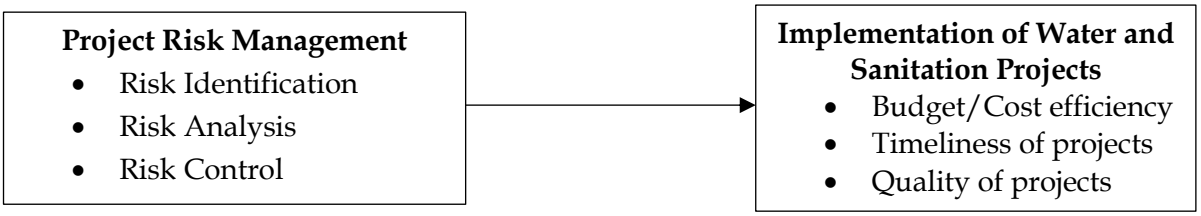

Figure 1: Conceptual Framework

Empirical studies related to project risk management and project implementation have been reviewed to establish how different dimensions of risk particularly risk identification, risk analysis, and risk control. In Nigeria, Bukar and Ibrahim (2021) examined how risk management practices influence construction project outcomes. Using a quantitative approach with data from 84 respondents, their study revealed that both internal and external risks significantly affect project performance, and that effective management of these risks plays a critical role in achieving desired results. A key challenge highlighted was the lack of a comprehensive regulatory framework to guide risk practices in the construction industry. To address this gap, the current research integrated mechanisms such as risk audits, reassessment procedures, reserve analysis, technical performance reviews, and regular status meetings into its design. In doing so, the study strengthened risk identification by embedding structured audit and review practices, improved risk analysis through systematic reassessment and evaluation of reserves, and advanced risk control by linking technical issues checks with continuous monitoring activities. In a different setting, Al-Hashimi and Masuri (2022) examined the influence of project risk management on the performance of construction companies in the United Arab Emirates. Their quantitative study involved 1,270 project and departmental staff, with findings pointing to significant weaknesses in management knowledge and practices, particularly among contractors. Subcontractors were noted as key contributors to poor project

scheduling, which often led to major financial losses. The current research focused on risk analysis through integrated multi-dimensional assessment criteria, while reinforcing risk control by aligning monitoring mechanisms with the implementation of water and sanitation projects.

Within the Kenyan context, Njuguna (2019) explored the effect of risk management techniques on project outcomes in Nairobi City County. Employing a descriptive research design and surveying 135 participants—including project managers, supervisors, risk managers, construction firms, and finance officers the study established that risk management practices positively influence project performance. Specifically, strategies such as risk transfer, reduction, and control were strongly associated with improved outcomes, while even risk retention was found to enhance performance in certain cases. The study bridged existing gaps by enhancing risk recognition through the involvement of diverse stakeholders, advancing risk evaluation by connecting targeted strategies with measurable implementation outcomes, and reinforcing risk oversight through the assessment of transfer, reduction, and retention mechanisms, all of which were aligned to strengthen the effective implementation of water and sanitation projects. Otieno and Mutiso (2021) extended the discussion, focusing on the role of project risk management strategies on project performance. Their descriptive study reviewed 116 agricultural projects and concluded that key risk management indicators significantly enhanced project success. Findings emphasized that practices such as risk identification, analysis, and control directly contributed to better agricultural project outcomes. The current study shifted this focus to the context of water and sanitation projects, where the emphasis was on project implementation as the key outcome variable.

IV. Methodology

The study adopted an explanatory research design to establish how project risk management shapes the implementation of water and sanitation projects in Nyanza region, Kenya. This design was considered appropriate as it allows testing of relationships and cause–effect patterns among study variables. The target population comprised 35 respondents drawn from seven ongoing projects, each involving five key participants: a project manager, a consultant, an implementation team member, an accountant, and a community representative. Since the number was small, the study applied a census approach, ensuring that all individuals directly involved in project decision-making and oversight were included. This provided comprehensive coverage and minimized sampling bias. Data collection relied on structured questionnaires with closed-ended questions, chosen for their ability to gather standardized responses efficiently while maintaining anonymity and objectivity. The collected data was processed through both descriptive and inferential statistical techniques. Descriptive analysis summarized trends and distributions, while inferential analysis tested hypotheses on the relationship between risk management practices and project implementation outcomes. The results were organized and presented in tables. The following linear regression model was applied:

$Y=\beta_0 + \beta_1 X_1 + \varepsilon$

Y - Implementation of Water and Sanitation Projects

β_0 - Constant

β_1 - Beta Coefficient

X_1 - Project Risk Management

ε - Error of Margin

V. Results

This section outlines the data presentation, discussion, and interpretation of the descriptive and inferential findings.

5.1 Descriptive Statistics

The study sought to establish the influence of project risk management on implementation of water and sanitation projects. The descriptive findings are presented in Tables 1 and 2:

Table 1: Influence of Project Risk Management on Implementation of Water and Sanitation Projects

	SD	D	N	A	SA	Mean	Std. Dev.
	Percentage (%)						
The project team ensures identification of all project risks that may cause delays	0	5.7	5.7	28.6	60	4.43	0.85
We advocate for the use of alternative plan in case of any event that may cause project delay	0	0	0	51.4	46.6	4.49	0.507
Projects teams inspect ongoing projects to ensure projects are not delayed	0	5.7	5.7	20	68.6	4.51	0.853

We encourage use of a detailed work plan to ensure no event leads to delays in project	2.9	0	5.7	25.7	65.7	4.51	0.853
Project risk manager responds to risks appropriately as defined in the risk management plan	2.9	2.9	0	25.7	68.6	4.54	0.886
The risk management team separates actual risk events from sources of risks	2.9	0	14.3	11.4	71.4	4.49	0.951
We do detailed risk analysis to anticipate and mitigate any shortcoming in the future	0	2.9	0	20	77.1	4.71	0.622

The descriptive analysis established that 28.6% agreed and 60% strongly agreed, totaling 88.6% (Mean=4.43, SD=0.85) that the project team ensures identification of all project risks that may cause delays. This shows that most teams are proactive in identifying possible risks, which is critical in mitigating factors that could derail project timelines, though a minority still perceive gaps in this area. It emerged that 51.4% agreed while 46.6% strongly agreed, making a combined 98% (Mean=4.49, SD=0.507), that they advocate for the use of alternative plan in case of any event that may cause project delay. Such a near-unanimous stance underscores the value placed on contingency measures, reflecting a culture of preparedness against unforeseen challenges. The survey showed that 20% agreed and 68.6% strongly agreed, totaling 88.6% (Mean=4.51, SD=0.853), that projects teams inspect ongoing projects to ensure projects are not delayed. This suggests that inspection is widely embraced as an accountability mechanism to safeguard timelines, though some respondents appear to question its consistency.

Analysis indicated that 25.7% agreed and 65.7% strongly agreed, summing up to 91.4% (Mean=4.51, SD=0.853), that they encourage use of a detailed work plan to ensure no event leads to delays in project. This reflects strong reliance on structured planning as an effective strategy for anticipating and addressing potential disruptions. It was noted that 25.7% agreed and 68.6% strongly agreed, giving a total of 94.3% (Mean=4.54, SD=0.886), that the project risk manager responds to risks appropriately as defined in the risk management plan. This demonstrates confidence in the leadership role of risk managers, indicating that their interventions are largely viewed as timely and aligned to established guidelines. The descriptive analysis revealed that 11.4% agreed and 71.4% strongly agreed, representing 82.8% (Mean=4.49, SD=0.951), that the risk management team separates actual risk events from sources of risks. This points to a considerable ability to differentiate between root causes and actual events, although the lower consensus compared to other areas signals some variations in effectiveness. 20% agreed and 77.1% strongly agreed, totaling 97.1% (Mean=4.71, SD=0.622), that they do detailed risk analysis to anticipate and mitigate any shortcoming in the future. The overwhelming level of agreement highlights the central role of forward-looking risk assessment in preventing delays and ensuring project success.

The study findings resonate with Njuguna (2019), who established that risk management practices significantly improve project performance. Just as Njuguna highlighted that controlling, transferring, or retaining risks positively affects outcomes, the current results demonstrate that proactive identification, detailed analysis, and contingency planning are critical in preventing delays and safeguarding project objectives. The strong agreement on structured planning, inspections, and timely responses by risk managers reflects a culture of preparedness and forward-looking oversight, resonating with the importance of systematic risk mitigation emphasized in the prior study.

Table 2: Implementation of Water and Sanitation Projects

	SD	D	N	A	SA	Mean	Std. Dev
	Percentage (%)						
Our Water and Sanitation project activities start and are complete on time as scheduled	0	0	5.7	20	74.3	4.69	0.583
Water and Sanitation projects are usually completed based on cost and budget provisions	2.9	0	14.3	11.4	71.4	4.49	0.951
All project activities and outcomes meet the intended quality standards	0	5.7	2.9	20	71.4	4.57	0.815
All projects' activities are undertaken and completed based on the set technical requirements	0	8.6	8.6	8.6	74.3	4.49	0.981
Water and Sanitation projects are completed to the satisfaction of community members	0	5.7	17.1	2.9	74.3	4.46	0.98
Water and Sanitation projects are usually evaluated based on the preset objectives	0	5.7	2.9	20	71.4	4.57	0.815

The descriptive assessment revealed that 20% agreed and 74.3% strongly agreed, bringing the total to 94.3% (Mean=4.69, SD=0.583) that our Water and Sanitation project activities start and are complete on time as scheduled. Such a high level of concurrence underscores efficiency in planning and adherence to timelines, signaling that time management practices within these projects are highly dependable. It was further revealed that 11.4% agreed and 71.4% strongly agreed, summing up to 82.8% (Mean=4.49, SD=0.951) that Water and Sanitation projects are usually completed based on cost and budget provisions. This shows that financial discipline is generally observed, ensuring that expenditure is carefully aligned with allocated resources despite a small proportion of divergent views. Findings indicated that 20% agreed and 71.4% strongly agreed, totaling 91.4% (Mean=4.57, SD=0.815) that all project activities and outcomes meet the intended quality standards. This points to consistent achievement of expected benchmarks, reflecting a strong emphasis on quality assurance and adherence to performance standards.

The results further showed that 8.6% agreed and 74.3% strongly agreed, combining to 82.9% (Mean=4.49, SD=0.981) that all projects' activities are undertaken and completed based on the set technical requirements. It suggests a deliberate focus on technical compliance, with the majority of respondents recognizing that activities are executed in line with prescribed specifications. Analysis revealed that 2.9% agreed and 74.3% strongly agreed, amounting to 77.2% (Mean=4.46, SD=0.980) that Water and Sanitation projects are completed to the satisfaction of community members. This reflects the community-centered orientation of the projects, where most beneficiaries appreciate the outputs, even though a notable minority expressed reservations. Additionally, 20% agreed and 71.4% strongly agreed, making up 91.4% (Mean=4.57, SD=0.815) that Water and Sanitation projects are usually evaluated based on the preset objectives. This highlights a structured approach to evaluation, ensuring that assessment processes are goal-oriented and directly linked to the original project intentions. Overall, the findings revealed that the implementation of water and sanitation projects is influenced by project risk management practices.

5.2 Inferential Statistics

Inferential analysis was conducted to establish the relationship between project risk management and implementation of water and sanitation projects. It incorporated the correlation and regression analysis techniques.

5.2.1 Correlation Analysis

Correlation analysis was conducted to determine the strength and direction of the relationship between project risk management and implementation of water and sanitation projects. Results are presented in Table 3:

Table 3: Correlation between Project Risk Management and Implementation of Water and Sanitation Projects

		Implementation of water and sanitation projects
Project Risk Management	Pearson Correlation	.415*

	Sig. (2-tailed)	.013
	N	35

The results in Table 3 show a positive and statistically significant relationship between project risk management and the implementation of water and sanitation projects (r = 0.415*; p = .013). This implies that improvements in risk management practices are associated with better implementation outcomes. Based on the results, risk identification ensures that potential threats and opportunities are recognized early, allowing managers to anticipate challenges that could hinder project execution. Risk analysis then evaluates the likelihood and potential effect of these risks, enabling decision-makers to prioritize the most critical issues and allocate resources effectively. Finally, risk control focuses on applying measures such as mitigation, transfer, or acceptance strategies, which stabilize project activities and safeguard against disruptions which enhance implementation of water and sanitation projects.

5.2.2 Regression Analysis

Regression analysis was undertaken to predict the implementation of water and sanitation projects from the changes in project risk management. Findings are shown in Tables 4, 5, and 6:

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.415[a]	.172	.147	.26832

The regression model in Table 4 shows a coefficient of determination of R Square = 0.172, indicating that project risk management explained 17.2% of the variation in the implementation of water and sanitation projects. This means that project risk management influenced the implementation of water and sanitation projects.

Table 5: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.664	4	3.776	17.911	.013[b]
	Residual	2.593	30	.124		
	Total	13.257	34			

a. Dependent Variable: Implementation of Water and Sanitation Projects

b. Predictors: (Constant), Project Risk Management

The findings indicate that the Analysis of Variance (ANOVA) shows a significant F-test value (F = 17.911; p = 0.013) at the 95% confidence level. This confirms that the overall regression model is valid and statistically significant in explaining the relationship between project risk management and the implementation of water and sanitation projects.

Table 6: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.877	.751		2.499	.000
	Project Risk Management	0.986	.259	.415	3.807	.000

a. Dependent Variable: Implementation of Water and Sanitation Projects

Based on the results in Table 6, the model was expressed as $Y = 1.877 + 0.986X_1 + \varepsilon$. This indicates that a one-unit increase in project risk management results in a corresponding increase of 0.986 units in the implementation of water and sanitation projects. The results confirm that variations in project risk management reliably predicted changes in the implementation of water and sanitation projects. The t-value was significant (t = 3.807; p = 0.000 < 0.05) at the 95% confidence level, indicating a significant relationship between project risk management and the implementation of water and sanitation projects. Consequently, project risk management was found to positively influence the implementation of water and sanitation projects.

VI. Conclusion

The study concludes that effective risk management is essential for maintaining uninterrupted project operations. Systematic identification of potential risks, coupled with contingency planning and detailed risk analysis, ensures that

projects remain resilient against unforeseen challenges. Structured inspections and adherence to comprehensive work plans prevent delays and maintain orderly execution of project activities. Clear differentiation between risk sources and actual events enables timely interventions that safeguard project schedules. Embedding risk management within operational routines strengthens preparedness, allowing project teams to anticipate and mitigate disruptions, ensuring consistent activity flow. Neglecting risk considerations can lead to disorderly operations and delays, underlining the importance of proactive risk management for smooth and sustained implementation.

Recommendation

The study recommends that that water works development agencies implement comprehensive risk management frameworks to proactively identify, assess, and mitigate potential threats to project implementation. Agencies should develop and regularly update contingency plans, while fostering a culture of risk awareness and accountability among project teams to enhance resilience against unforeseen challenges.

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