



RESEARCH ARTICLE

Section: *Digital Humanities***Digital empowerment, organizational innovation, and social sustainability: A digital humanities perspective on women's educational leadership in Egypt**

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ABSTRACT

Digital transformation has reshaped educational institutions not only through technological change but also by redefining patterns of leadership, participation, and social inclusion. Within the framework of digital humanities, digital empowerment can be understood as a socio-cultural process that enhances individuals' capacity to participate in digitally mediated institutional environments and contribute to sustainable social development. Despite increasing interest in digital transformation, little empirical research has explored how digital empowerment and organizational innovation jointly influence social sustainability among women educational leaders in developing societies.

This study investigates the predictive roles of digital empowerment and organizational innovation in fostering social sustainability among female school leaders in Egypt's Delta Region. Using a descriptive correlational design, data were collected from 284 female principals and vice principals working in elementary and middle schools across several governorates. Participants completed validated measures of digital empowerment, organizational innovation, and social sustainability. Pearson correlation coefficients and multiple regression analyses were employed to examine the relationships among the study variables.

The findings revealed that digital empowerment significantly predicts social participation and social equity, while organizational originality emerged as the strongest predictor across all dimensions of social sustainability, surpassing organizational flexibility. Together, the predictor variables explained substantial proportions of variance in socially sustainable practices within educational settings.

The study argues that digital empowerment should be viewed not merely as technological competence but as a cultural resource that strengthens women's leadership, institutional creativity, and inclusive social participation. By integrating perspectives from digital humanities and educational leadership, the findings contribute to understanding how digitally mediated organizational cultures can support social sustainability in contemporary educational communities. The study recommends embedding innovation-oriented digital empowerment initiatives within leadership development policies to promote socially inclusive educational institutions.

KEYWORDS: digital humanities, digital empowerment, women's leadership, organizational innovation, social sustainability, educational culture

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Introduction

Women have historically confronted systemic barriers across cultural, racial, geographical, and religious contexts, including abuse, violence, poverty, and inadequate treatment (Khatun & Vijaykumar, 2024). These inequalities are reflected in persistent digital disparities, as women tend to demonstrate lower digital literacy indices compared to men, partly due to sociocultural roles and expectations, and partly because older individuals often lack sufficient motivation to engage meaningfully with technology (Juwita et al., 2024). Gender inequality produces measurable negative impacts on social development, whereas empowerment interventions have demonstrated potential to address these disparities systematically (Chatterjee & Malakar, 2023). Restructuring social frameworks through targeted policies, strategic funding, and institutional reservations has proven capable of empowering marginalized women and narrowing persistent gender gaps (Chatterjee & Malakar, 2023). Capacity building for women remains therefore an essential mechanism for fostering comprehensive and equitable social development across both developed and developing national contexts (Khatun & Vijaykumar, 2024; Juwita et al., 2024).

Information and Communication Technology (ICT) has fundamentally transformed international relations and human collaboration at an unprecedented scale (Qisai, 2024). Within this evolving digital reality, the concept of empowerment has shifted from traditional authorized forms toward digital empowerment — a method equipping individuals with the tools, resources, and abilities necessary to navigate the digital era effectively (Mäkinen, 2006; Qisai, 2024). Historically, women's empowerment emerged in the 1970s as a mechanism for fostering social justice and gender equality, emphasizing women's freedom of choice and economic participation (Mackey & Petrucka, 2021). Today, this concept is inextricably linked to the digital economy, where digital resources are recognized as inherently sustainable technologies critical for maintaining socio-economic development (Li et al., 2022). Digital empowerment of women, as understood in contemporary scholarship, includes developing capabilities, enhancing skills, and enabling meaningful contributions to both the economy and society (Shuhoumi & Rasheed, 2025), representing a progressive spiral that responds dynamically to broader societal advancements (Mäkinen, 2006).

Organizational innovation refers to an organization's capacity to implement new management practices, technologies, collaborations, or services to improve performance efficiency and maintain competitive advantage (Altuwijri, 2022). It encompasses the generation and implementation of new ideas, processes, and products that provide practical benefits while enhancing overall organizational performance (Park et al., 2004). Organizational innovation has been recognized as a critical driver of competitive advantage and contributes substantially to sustainable development outcomes (Zheng et al., 2017). Leadership and organizational culture play central roles in fostering innovation, as transformational leadership promotes creativity, knowledge sharing, and employee motivation (Anwar & Abdullah, 2021; Zhu & Huang, 2023; Ardi et al., 2020). Digital empowerment further supports innovation by removing organizational barriers and enabling more efficient resource allocation (Li et al., 2025). Previous research has also demonstrated that innovation targeting sustainability integrates creativity across organizational activities, promoting environmentally and socially responsible solutions while supporting profitability and long-term institutional growth (Souto, 2022).

The long-term sustainability debate increasingly recognizes social sustainability as equally critical alongside environmental and economic dimensions (Eizenberg & Jabareen, 2017; Zhang, 2022). Social sustainability is concerned with managing social resources — including individuals' skills, relationships, and values — and is characterized by social cohesion, equitable access to services, and the enhancement of community well-being (McKenzie, 2004; Sarkis et al., 2010). Achieving social sustainability requires equitable distribution of power, and empowering marginalized groups serves as a defining indicator of a socially sustainable society (Zhang, 2022). Vallance et al. (2011) proposed a schema encompassing development sustainability addressing basic needs, bridge sustainability involving behavioral change, and maintenance sustainability preserving sociocultural characteristics. Organizations are increasingly recognized as important actors in achieving the Sustainable Development Goals (SDGs), particularly SDG 5 on gender equality (Borges et al., 2023). Applying social sustainability in organizations enhances employee well-being and aligns with SDGs regarding decent work and gender equality (Rank et al., 2023).

The current literature reveals robust relationships among digital empowerment, organizational innovation, and social sustainability. Empowerment initiatives improve individuals' independence, self-confidence, and

social participation, all of which contribute to enhanced well-being and sustainable communities (Friatna & Mustofa, 2025; Lyons et al., 2001). Digital empowerment plays a critical role in fostering innovation and sustainability, as it improves individuals' technological capabilities, mitigates external constraints, and fosters innovative practices within organizations (Liu et al., 2025). Organizational innovation, in turn, contributes to sustainable development by fostering adaptability and linking technological attitudes to social sustainability outcomes (Xiao & Su, 2022; Zheng et al., 2017). Previous research has established links between organizational innovation and sustainability performance, highlighting its mediating role between technological advancement and broader sustainability outcomes (Bhutta et al., 2021; Xiao & Su, 2022). Gender equality and women's empowerment are further recognized as essential for achieving sustainable development by ensuring equal opportunities aligned with the SDGs (Lohani & Aburaida, 2017; Sertyesilisik, 2023).

Despite the established relationships revealed by prior research, a significant gap remains regarding the relative contribution of digital empowerment of women and organizational innovation to social sustainability, particularly within elementary and middle school contexts in developing countries such as Egypt (Mackey & Petrucka, 2021; Niroo & Crompton, 2022). While ICTs have demonstrated potential to reduce poverty and empower marginalized professions, the specific mechanisms through which digital tools empower women leaders to foster social sustainability remain insufficiently understood (Mackey & Petrucka, 2021). Furthermore, a clear theoretical definition of social sustainability and its underpinnings, compared with its environmental and economic counterparts, remains underexplored and often implicit behind socio-political indicators (Littig & Griessler, 2005). There is limited research examining the effects of digital empowerment on collaborative innovation at the micro-level of organizations, and the mechanism through which it fosters innovation via knowledge synergy (Qisai, 2024). Without a comprehensive understanding of these predictive relationships, organizations, particularly schools, may fail to leverage digital tools and innovation strategies effectively to achieve equitable and sustainable work environments.

This study integrates Sen's Capability Approach (CA) with digital empowerment frameworks to propose a refined theoretical model for understanding how digital empowerment contributes to social sustainability (Abubakar & Dasuki, 2018; Zhang, 2022). Garcés-Velástegui (2022) argues that Sen's Capability Approach shifts the focus of development from economic wealth toward people's quality of life, emphasizing the assessment of social states based on individuals' well-being and capabilities. By combining this approach with digital empowerment theory, the present study responds to calls for comprehensive frameworks that consider social, environmental, and economic aspects holistically (Boyer et al., 2016). Additionally, Self-Determination Theory (SDT) provides a complementary theoretical lens, highlighting the significance of reinforcing individuals' autonomy, efficiency, relatedness, and competency to improve motivation and organizational effectiveness within innovative contexts (Sipe, 2018; Chong & Gagné, 2019). Critical theory further informs the study's perspective by examining power dynamics and social inequalities, focusing on how structures either perpetuate or challenge social injustices in the context of sustainable development (Dyantai, 2026). Together, these theoretical perspectives construct a robust multi-layered framework for investigating the study's variables.

Against this theoretical and empirical backdrop, the present study aimed to investigate the predictive relationships between digital empowerment of women leaders, organizational innovation, and social sustainability within Egyptian educational settings. Specifically, the study examined the extent to which digital empowerment dimensions — effective integration of digital technologies and technological motivation — alongside organizational innovation dimensions — organizational flexibility and organizational originality — predict social sustainability outcomes, including social equity, social interaction, social participation, and overall social sustainability among female school principals and vice principals in Egypt's Delta Region. By integrating Sen's Capability Approach, Self-Determination Theory, and critical theory within a unified analytical framework, the study addresses existing gaps concerning how digital tools and innovative organizational practices foster socially sustainable educational environments in developing country contexts where female leadership development remains empirically underrepresented.

Method

3.1 Research Design

This study employed a descriptive correlational research design to investigate the relationships between digital

empowerment of women leaders, organizational innovation, and social sustainability. This design was selected because it allows researchers to examine the strength and direction of associations between variables in their natural settings without experimental manipulation, making it particularly appropriate for educational and organizational research contexts. The study followed a quantitative methodology, utilizing self-reported survey instruments administered to participants across multiple educational settings.

3.2 Participants

The study utilized non-probability sampling driven by both methodological and practical considerations, as the target population was not easily accessible for probability-based procedures and practical constraints including time and institutional accessibility influenced the sampling strategy. The final sample comprised 284 female school principals and vice principals actively employed in elementary and middle schools across various governorates in the Delta Region of Egypt. All participants were female, ranging in age from 32 to 43 years ($M = 36.46$, $SD = 2.96$), with between 5 and 15 years of leadership experience, reflecting a diverse range of administrative backgrounds. Prior to participation, all individuals were informed of the study's aims and voluntarily consented to contribute their data.

3.3 Measures

The Digital Empowerment Scale was adapted from the Teacher Digital Empowerment Scale developed by Cortés (2025), which originally comprised 38 items across six components. Items inconsistent with the Egyptian elementary and middle school context were excluded, and the adapted version was subjected to factor analysis, yielding a two-component structure. The first component, Effective Integration of Digital Technologies in Education, comprises four items, and the second, Technological Motivation, consists of three items. Data suitability was confirmed through the Kaiser–Meyer–Olkin ($KMO = 0.807$) and Bartlett's Test of Sphericity ($\chi^2 = 931.603$, $df = 21$, $p < .001$).

Principal Component Analysis (PCA) revealed strong loadings for both factors, ranging from 0.568 to 0.891 for Factor 1 and from 0.852 to 0.914 for Factor 2. Confirmatory Factor Analysis (CFA) demonstrated excellent model fit, with all incremental fit indices exceeding the 0.95 threshold ($CFI = 0.987$, $TLI = 0.979$, $IFI = 0.987$, $RNI = 0.987$), and $NFI = 0.973$ and $RFI = 0.956$ providing additional support. Convergent and discriminant validity were both established through factor loading patterns. Reliability was strong across both components and the total scale, with Cronbach's Alpha (α) and McDonald's Omega (ω) values ranging from 0.809 to 0.877, all exceeding the 0.70 threshold. Harman's single-factor test confirmed the absence of serious common method bias, with the first unrotated factor accounting for only 43.5% of total variance.

The Organizational Innovation Scale was adapted from Zerrouki's (2022) Organizational Innovation Questionnaire, originally comprising 28 items across five components. Items irrelevant to the Egyptian educational context were excluded, and factor analysis on the modified version revealed a two-factor structure. The first factor, Organizational Flexibility, comprises seven items, and the second, Organizational Originality, consists of three items. Bartlett's Test of Sphericity confirmed data suitability ($\chi^2(45) = 1178.064$, $p < .001$).

PCA using Promax rotation retained two components explaining 60.4% of total variance, with Organizational Flexibility accounting for 42.1% and Organizational Originality for 18.3%. Factor loadings ranged from 0.682 to 0.817 for the first factor and from 0.700 to 0.845 for the second. CFA confirmed excellent model fit, with all indices exceeding the 0.90 threshold ($CFI = 0.973$, $TLI = 0.965$, $IFI = 0.974$, $RNI = 0.973$, $NFI = 0.944$, $RFI = 0.926$). Discriminant validity was supported by uniqueness values ranging from 0.332 to 0.427. Reliability was strong, with α and ω values ranging from 0.701 to 0.905 across factors and the total scale. Harman's single-factor test yielded 49.8% for the first unrotated factor, remaining below the 50% threshold and indicating no serious common method bias.

The Social Sustainability Scale was adapted from the Urban Social Sustainability Scale by Larimian and Sadeghi (2021), originally comprising 31 items. Contextually irrelevant items were excluded, and factor analysis on the modified version revealed a three-factor structure: Social Equity (nine items), Social Interaction (six items), and Social Participation (six items), with non-loading items removed. Data suitability was excellent ($KMO = 0.958$), with individual Measures of Sampling Adequacy (MSA) ranging from 0.93 to 0.97.

PCA using Promax rotation confirmed the three-component structure, with factor loadings ranging

from 0.762 to 0.883 for Social Equity, 0.762 to 0.933 for Social Interaction, and 0.767 to 0.986 for Social Participation. CFA demonstrated adequate model fit exceeding the 0.90 threshold (CFI = 0.914, TLI = 0.903, IFI = 0.915, RNI = 0.914). Convergent validity was confirmed through Average Variance Extracted (AVE) values of 0.558, 0.633, and 0.679 for the three factors respectively, all exceeding the 0.50 threshold. Discriminant validity was established via the Fornell–Larcker criterion. Reliability was outstanding across all dimensions and the total scale, with α and ω values ranging from 0.910 to 0.964. Harman’s single-factor test confirmed the absence of serious common method bias, with the first unrotated factor accounting for only 43.1% of total variance.

3.4 Data Analysis

Data were analyzed using SPSS (version 26) and JASP (version 0.17) statistical software packages across three analytical stages. First, descriptive statistics including means, standard deviations, and ranges were computed for all study variables to characterize the sample and establish distributional properties. Second, Pearson product-moment correlation coefficients were calculated to examine the bivariate relationships between the dimensions of digital empowerment and organizational innovation and the dimensions of social sustainability, assessing the direction and magnitude of associations prior to regression modeling. Third, a series of multiple and simple linear regression analyses were conducted to test the predictive power of both independent variables on four dependent variables: social equity, social interaction, social participation, and total social sustainability. For each independent variable, two regression models were tested — one entering the sub-components as separate predictors and another using the total composite score — yielding four models in total. Collinearity diagnostics, including Variance Inflation Factor (VIF) and Tolerance values, were examined across all models to detect potential multicollinearity concerns.

Results

Regarding digital empowerment, participants reported moderate levels of effective integration of digital technologies in education ($M = 11.37$, $SD = 3.28$) and technological motivation ($M = 12.22$, $SD = 3.15$), yielding a total digital empowerment score ranging from 7 to 30 ($M = 23.63$, $SD = 4.94$). For organizational innovation, organizational flexibility scores ($M = 27.81$, $SD = 4.89$) and organizational originality scores ($M = 11.89$, $SD = 2.53$) indicated moderate-to-high innovation perceptions, with a total innovation score ranging from 10 to 50 ($M = 39.63$, $SD = 7.04$). Social sustainability dimensions reflected moderate-to-high levels across social equity ($M = 35.36$, $SD = 7.30$), social interaction ($M = 22.81$, $SD = 6.03$), and social participation ($M = 23.94$, $SD = 4.92$), with a total social sustainability score ranging from 36 to 105 ($M = 82.11$, $SD = 15.62$). The observed standard deviations indicate sufficient variability to support meaningful regression and correlation analyses. Table 1 presents the descriptive statistics for all study variables.

Table 1. *Descriptive Statistics for All Study Variables*

Variable	Range	Min	Max	M	SD
Effective Integration of Digital Technologies in Education	12	3	15	11.37	3.28
Technological Motivation	16	3	19	12.22	3.15
Total Digital Empowerment	23	7	30	23.63	4.94
Organizational Flexibility	25	10	35	27.81	4.89
Organizational Originality	12	3	15	11.89	2.53
Total Organizational Innovation	40	10	50	39.63	7.04
Social Equity	35	10	45	35.36	7.30
Social Interaction	24	6	30	22.81	6.03
Social Participation	21	9	30	23.94	4.92
Total Social Sustainability	69	36	105	82.11	15.62

Note. DE = Digital Empowerment; OI = Organizational Innovation; SS = Social Sustainability; M = Mean; SD = Standard Deviation.

To evaluate Hypothesis 1, Pearson correlation coefficients were computed to examine the bivariate associations between digital empowerment and social sustainability (see Table 2). All correlations were statistically significant at the $p < .01$ level. Social participation demonstrated the strongest associations with effective integration of

digital technologies in education ($r = .650$), technological motivation ($r = .683$), and total digital empowerment ($r = .874$), indicating that active social participation is closely linked to women leaders' engagement with and motivation for digital tools. Social equity also showed moderate-to-strong correlations with all digital empowerment components ($r = .404$ to $.547$), while social interaction displayed weaker though still significant associations ($r = .313$ to $.417$). Overall, the total social sustainability score was substantially correlated with total digital empowerment ($r = .691$), confirming the theoretical expectation that digital empowerment meaningfully predicts social sustainability outcomes among female school principals.

Table 2. *Pearson Correlation Coefficients Between Digital Empowerment, Organizational Innovation, and Social Sustainability*

Variable	1	2	3	4	5	6	7	8	9	10
1. Effective Integration of Digital Technologies	1									
2. Technological Motivation	.582**	1								
3. Total Digital Empowerment	.843**	.876**	1							
4. Organizational Flexibility	.312**	.289**	.352**	1						
5. Organizational Originality	.298**	.310**	.337**	.782**	1					
6. Total Organizational Innovation	.347**	.335**	.389**	.952**	.924**	1				
7. Social Equity	.427**	.404**	.547**	.663**	.678**	.703**	1			
8. Social Interaction	.326**	.313**	.417**	.395**	.451**	.434**	.671**	1		
9. Social Participation	.650**	.683**	.874**	.511**	.547**	.562**	.632**	.501**	1	
10. Total Social Sustainability	.530**	.524**	.691**	.623**	.663**	.673**	.912**	.838**	.845**	1

Note. DE = Digital Empowerment; OI = Organizational Innovation; SS = Social Sustainability. Eff. Integ. = Effective Integration of Digital Technologies in Education; Tech. Motiv. = Technological Motivation; Org. Flex. = Organizational Flexibility; Org. Orig. = Organizational Originality. ** $p < .01$.

All four regression models were statistically significant. The model predicting social participation explained the greatest proportion of variance ($R^2 = .360$, $F(2,281) = 79.14$, $p < .001$), with both effective integration ($\beta = .329$, $p < .001$) and technological motivation ($\beta = .333$, $p < .001$) serving as significant positive predictors of nearly equal magnitude. The model for total social sustainability accounted for 34.5% of variance ($R^2 = .345$, $F(2,281) = 73.87$, $p < .001$), with both predictors contributing significantly ($\beta = .317$ and $\beta = .330$, respectively). Social equity was also well explained ($R^2 = .343$), while social interaction yielded lower explanatory power ($R^2 = .153$). Collinearity diagnostics confirmed no multicollinearity concerns ($VIF = 1.72$, $Tolerance = .582$), supporting the validity of the regression solutions across all four dependent variables. Table 3 presents the regression results for Hypothesis 1, in which both components of digital empowerment served as simultaneous predictors of social sustainability outcomes (Model 1).

Table 3. *Multiple Linear Regression Coefficients: Digital Empowerment Dimensions Predicting Social Sustainability Outcomes*

Dependent Variable	Predictor	B	SE	β	t	p
Social Equity	Eff. Integration	.264	.050	.337	5.312	<.001
Social Equity	Tech. Motivation	.208	.043	.308	4.864	<.001
Social Interaction	Eff. Integration	.133	.052	.185	2.570	.011
Social Interaction	Tech. Motivation	.151	.044	.245	3.408	.001
Social Participation	Eff. Integration	.150	.029	.329	5.253	<.001
Social Participation	Tech. Motivation	.131	.025	.333	5.320	<.001
Total Social Sustainability	Eff. Integration	.547	.109	.317	5.002	<.001
Total Social Sustainability	Tech. Motivation	.491	.094	.330	5.212	<.001

Note. Eff. Integration = Effective Integration of Digital Technologies in Education; Tech. Motivation = Technological Motivation; * $p < .05$. ** $p < .01$.

Bivariate correlations further demonstrated a robust relationship between organizational innovation and social sustainability (see Table 2). Social equity showed the strongest associations with organizational flexibility ($r = .663$), organizational originality ($r = .678$), and the total innovation score ($r = .703$), indicating that schools characterized by higher innovation practices also tend to exhibit greater perceptions of social fairness and equity. Social participation similarly showed strong positive correlations with all innovation dimensions ($r = .511$ to $.562$). While social interaction again produced weaker though significant correlations ($r = .395$ to $.451$), the overall pattern confirms Hypothesis 2 at the bivariate level. The total social sustainability score correlated strongly with total organizational innovation ($r = .673$), with organizational originality consistently demonstrating slightly stronger associations than flexibility across all sustainability dimensions, suggesting that creative novelty within organizational practices may be especially relevant to fostering sustainable social environments.

Results indicated that organizational originality was a consistently significant predictor across all four dependent variables. For social equity, the model explained 32.6% of variance ($R^2 = .326$, $F(2,280) = 67.76$, $p < .001$), with organizational originality emerging as the stronger predictor ($\beta = .386$, $p < .001$) compared to organizational flexibility ($\beta = .216$, $p = .007$). Notably, organizational flexibility did not significantly predict social interaction ($\beta = .005$, $p = .957$) or total social sustainability ($\beta = .153$, $p = .063$), whereas organizational originality remained significant across all outcomes, including total social sustainability ($\beta = .398$, $p < .001$). Social participation was well predicted by both components ($R^2 = .322$), while social interaction showed the weakest model fit ($R^2 = .084$). Collinearity diagnostics indicated no serious concerns ($VIF = 2.589$), and the pattern of results collectively supports Hypothesis 2. Table 4 presents the regression analyses testing Hypothesis 2, in which organizational flexibility and organizational originality were entered as simultaneous predictors.

Table 4. Multiple Linear Regression Coefficients: Organizational Innovation Dimensions Predicting Social Sustainability Outcomes

Dependent Variable	Predictor	B	SE	β	t	p
Social Equity	Org. Flexibility	.157	.057	.216	2.733	.007
Social Equity	Org. Originality	.320	.065	.386	4.892	<.001
Social Interaction	Org. Flexibility	.003	.061	.005	.054	.957
Social Interaction	Org. Originality	.222	.070	.294	3.194	.002
Social Participation	Org. Flexibility	.091	.034	.215	2.721	.007
Social Participation	Org. Originality	.185	.038	.383	4.834	<.001
Total Social Sustainability	Org. Flexibility	.245	.131	.153	1.867	.063
Total Social Sustainability	Org. Originality	.728	.150	.398	4.860	<.001

Note. Org. Flexibility = Organizational Flexibility; Org. Originality = Organizational Originality; * $p < .05$.
 ** $p < .01$.

Discussion

The results of this study demonstrate that digital empowerment and organizational innovation are meaningful predictors of social sustainability among female school leaders in Egypt's Delta Region. Both components of digital empowerment — effective integration of digital technologies and technological motivation — significantly predicted social equity, social participation, and total social sustainability, with social participation showing the strongest explained variance ($R^2 = .360$). Organizational originality emerged as a consistent predictor across all social sustainability dimensions, outperforming organizational flexibility in several models. The total scores of both independent variables showed robust correlations with overall social sustainability ($r = .691$ and $r = .673$, respectively). These findings confirm the theoretical expectations grounded in the Capability Approach and Self-Determination Theory, affirming that digital tools and innovative organizational practices collectively foster equitable and participatory social environments within educational institutions.

Among the most noteworthy findings is the differential predictive pattern observed across organizational innovation dimensions. While organizational flexibility failed to significantly predict social interaction ($\beta = .005$, $p = .957$) or total social sustainability ($\beta = .153$, $p = .063$), organizational originality remained a consistently strong predictor across all four dependent variables, including total social sustainability ($\beta = .398$, $p < .001$). This

asymmetry suggests that creative novelty within organizational practices carries greater sustainability relevance than structural adaptability alone. Equally striking is the dominance of social participation as the outcome most strongly predicted by digital empowerment ($R^2 = .360$), compared to the relatively modest variance explained in social interaction ($R^2 = .153$). These patterns imply that digital empowerment operates primarily through enabling active civic and professional engagement rather than enhancing interpersonal relational dynamics among school leaders.

These findings align coherently with prior scholarship establishing linkages among the study's core variables. The predictive role of digital empowerment on social participation resonates with Friatna and Mustofa (2025) and Lyons et al. (2001), who demonstrated that empowerment enhances individuals' social engagement and community belonging. The contribution of digital tools to sustainability outcomes reflects Li et al. (2022), who recognized digital resources as inherently sustainable technologies. Organizational innovation's role in advancing social sustainability corroborates Zheng et al. (2017), Xiao and Su (2022), and Bhutta et al. (2021), who linked innovation to sustainable development outcomes. The stronger effect of originality over flexibility echoes Anwar and Abdullah (2021) and Zhu and Huang (2023), who highlighted creative leadership as central to organizational performance. Furthermore, the gender-equity implications align with Lohani and Aburaida (2017) and Sertyesilisik (2023), who positioned women's empowerment as essential for achieving SDG-aligned sustainability outcomes.

The findings carry practical implications for educational administrators, policymakers, and gender equity advocates. Schools should move beyond isolated technical training toward holistic digital empowerment programs that cultivate technological motivation alongside digital integration competencies, as both components independently predicted sustainability outcomes. Principals and vice principals should be supported through professional development initiatives that embed digital tools within their leadership practices rather than treating technology as supplementary. Regarding organizational innovation, schools should deliberately foster originality-driven cultures — encouraging creative problem-solving, novel practices, and adaptive thinking — rather than relying solely on procedural flexibility. At the policy level, Egypt's educational governance bodies should incorporate digital empowerment and organizational innovation frameworks into school leadership evaluation criteria, particularly within the Delta Region, where female leadership development remains an underserved priority.

Several limitations warrant consideration when interpreting these findings. The reliance on non-probability sampling restricts generalizability beyond the study's specific geographic and institutional context. All measures were self-reported, introducing the possibility of social desirability bias, although Harman's single-factor tests indicated no serious common method variance across instruments. The cross-sectional design precludes causal inference, meaning observed associations reflect correlational patterns rather than directional causal mechanisms. The sample was exclusively female and drawn from a single Egyptian region, limiting comparative insights across gender or broader national contexts. Additionally, the adapted scales, while demonstrating strong psychometric properties, were developed within different cultural contexts, and their complete equivalence within Egyptian elementary and middle school settings cannot be fully assumed despite the validation procedures employed.

Future research should address the present study's limitations through several strategic directions. Longitudinal designs would enable examination of how digital empowerment and organizational innovation evolve over time and whether their effects on social sustainability remain stable or intensify with sustained leadership development. Comparative studies including male school leaders or spanning multiple Egyptian regions would broaden the generalizability of current findings. Researchers are encouraged to incorporate qualitative methods to illuminate the mechanisms through which digital empowerment fosters social participation specifically, given its notably strong predictive relationship. Experimental or quasi-experimental designs testing structured digital empowerment interventions would strengthen causal claims. Future investigations should also explore potential mediators — such as organizational culture, leadership self-efficacy, or institutional support — that may explain the pathway between digital tools, organizational originality, and social sustainability outcomes in educational settings.

Conclusion

This study provides empirical evidence that digital empowerment and organizational innovation are significant predictors of social sustainability among female school leaders in Egypt's Delta Region. Digital empowerment, through both technological integration and motivational dimensions, most strongly predicts social participation, while organizational originality emerges as the more influential innovation component across all sustainability outcomes. These findings extend the theoretical application of the Capability Approach and Self-Determination Theory to educational leadership contexts in developing nations. The study underscores the strategic importance of nurturing digitally empowered, innovation-oriented female leaders as a pathway toward socially sustainable schools. Addressing current limitations through longitudinal, comparative, and mixed-methods research will deepen collective understanding of how digital and organizational capacities translate into equitable, participatory, and cohesive educational communities.

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Declaration of AI Use

AI-assisted tools were used in a limited capacity to support language refinement and editing of the manuscript. All intellectual content, data analysis, interpretations, and conclusions were developed and verified solely by the authors.

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