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Enhancing Managerial Efficiency Through a Digital Fingerprint Attendance and Monitoring Dashboard: A Community Empowerment Initiative in the TEFA Integrated Agriculture Unit

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ABSTRACT
Background: Digital transformation in community-based vocational units remains uneven, particularly in agricultural practice settings where daily operations depend heavily on manual labor. Inefficiencies in attendance monitoring and the absence of real-time managerial data often hinder decision-making and limit empowerment opportunities for casual workers. These challenges motivated the implementation of a digital fingerprint attendance system supported by an integrated monitoring dashboard in the TEFA Integrated Agriculture Unit.
Aims: The study aims to evaluate how the introduction of a digital attendance and monitoring system influences managerial efficiency while strengthening the foundation for community empowerment among daily workers engaged in agricultural activities.
Methods: A mixed-method approach was adopted, integrating observational data, pre- and post-implementation attendance records, and structured interviews with supervisors and casual workers. Quantitative data captured punctuality trends, consistency of attendance, and time-based operational efficiency, while qualitative insights were used to interpret changes in worker engagement and perceptions of digital tools.
Results: Findings indicate a substantial improvement in attendance accuracy, reduced reporting delays, and enhanced managerial oversight through real-time dashboard visualization. Supervisors reported greater clarity in workforce allocation, while workers experienced increased transparency regarding working hours. Although empowerment outcomes were not uniform across individuals, most participants acknowledged that the system encouraged discipline and fairness in workload recognition.
Conclusion: The introduction of a digital fingerprint attendance system demonstrates meaningful progress toward strengthening managerial efficiency in community-based vocational units. More importantly, the intervention provides an early but significant foundation for community empowerment by fostering transparency, reinforcing equitable work practices, and promoting technological readiness among casual workers. The study suggests that digital tools, when integrated with ongoing capacity-building efforts, can evolve into broader empowerment mechanisms that improve not only administrative efficiency but also workers' sense of participation, agency, and long-term inclusion in agricultural digitalization initiatives. Future replication in similar rural contexts is promising, provided that training, responsiveness to local needs, and sustained community engagement remain central.

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INTRODUCTION

Digital transformation has increasingly shaped how institutions manage services and empower communities, yet agricultural vocational units in rural contexts often lag behind in adopting such innovations. These units depend heavily on manual labor routines and informal attendance practices, creating inefficiencies that directly affect workflow reliability and worker accountability. Without integrated digital systems, managerial decisions frequently rely on fragmented or inaccurate information, slowing down operational responses and limiting opportunities for community participation. Collaborative governance research emphasizes that transparent information flow is essential for enabling effective coordination among local actors, as shown by (Dai & Azhar, 2024; Picavet et al., 2023; Yahia et al., 2021). This insight underscores the urgency of developing digital mechanisms that enhance administrative clarity and reduce procedural inconsistencies. Agricultural vocational units, which simultaneously function as learning environments and community-based service platforms, have strong

potential to benefit from such innovations. Therefore, examining how digital attendance systems can improve both managerial efficiency and community engagement is highly relevant and timely.

Daily labor operations in agricultural teaching factories often operate within structures that lack systematic technological support, causing attendance documentation to be error-prone and difficult to verify. These limitations reduce managerial efficiency by creating gaps between actual workforce activities and recorded administrative data. In addition, communities that participate in these programs gain fewer chances to develop digital literacy or engage with technology-enhanced workflows. Studies on farmer capacity building highlight that structured learning environments supported by organized information systems play a vital role in improving decision-making and productivity, as indicated by (Baldin et al., 2021; Cui et al., 2022; Kim et al., 2023). This demonstrates that integrating digital tools into daily operations can strengthen both managerial processes and the empowerment capacity of workers. When such systems are absent, agricultural vocational ecosystems risk stagnating in outdated routines, limiting their ability to adapt to technological advancements. Addressing these constraints is crucial to ensure that empowerment programs are supported by concrete, operationally significant innovations.

Recent findings on digital platform governance show that technological systems create more transparent and coordinated environments for managing stakeholder interactions, as noted by (L. Chen et al., 2022; Y. Chen et al., 2021; Doshi & Schmidt, 2024). For community-based agricultural units that must balance production, teaching, and service roles, digital attendance and monitoring dashboards offer a practical means to enhance managerial clarity while also promoting equitable labor practices. Empowerment research further demonstrates that structured technological interventions can strengthen agency among community members, even when initial digital literacy levels are low, as highlighted by (Dushkova & Ivlieva, 2024; Sharma et al., 2022; Soares et al., 2024). These insights collectively reinforce the importance of digital attendance systems not only as administrative tools but also as mechanisms that support empowerment and fairness. The relevance of this research lies in its aim to investigate these interconnected outcomes within a rural agricultural vocational setting, where modernization efforts remain critically needed.

The rationale for this study emerges from the recognition that digital attendance systems can address managerial inefficiencies while simultaneously supporting empowerment processes in agricultural community settings. Unlike many technological interventions that focus solely on productivity, this study acknowledges the dual role of digital tools in shaping transparency and participation within rural institutions. Agricultural vocational units are not merely production spaces but are also designed to develop skills, foster community engagement, and strengthen collective capacity. Introducing a fingerprint attendance and monitoring dashboard becomes a strategic approach for improving both administrative consistency and empowerment readiness. By evaluating this digital system, the study aims to generate insights into how technological integration can transform local work cultures, enhance fairness, and prepare communities for future digital innovations. This rationale positions the study as a meaningful contribution to discussions on digital transformation in rural service and community environments.

Prior research suggests that community-oriented governance systems benefit greatly from technological structures that promote accountability, transparency, and collaboration. Chen et al., (2025) demonstrate that governance becomes more effective when stakeholders share clear and reliable information, reinforcing the idea that digital attendance systems can enhance organizational coherence. Singh & Singh, (2023) show that capacity building in agricultural environments requires systematic knowledge support, highlighting that digital systems can facilitate such learning and operational improvement. These studies illustrate that digital innovations play a central role in supporting both managerial and community empowerment outcomes. They provide a conceptual foundation for examining how similar systems might function in agricultural vocational units, where digital adoption remains limited.

Similarly, research on digital platform leadership highlights the importance of organized digital environments for expanding participation and improving boundary coordination, as seen in Leong et al., (2019). Empowerment-focused interventions, such as those discussed by Maza et al., (2016), further show that structured digital tools can enhance confidence, participation, and managerial understanding among community members. Together, these findings suggest that digital attendance and monitoring dashboards hold potential as drivers of both administrative efficiency and empowerment. However, limited research has examined these dynamics in rural agricultural vocational settings, where operational and community contexts differ significantly from urban or institutional environments. This gap supports the need for more empirical studies targeting community-based agricultural ecosystems.

Although previous studies offer valuable insights into governance, capacity building, and digital platform integration, they rarely examine how simple administrative technologies—such as fingerprint attendance systems—can influence empowerment outcomes within rural agricultural vocational units. Much of the existing work focuses on empowerment programs or technological adoption separately, leaving the intersection between managerial efficiency and empowerment underexplored. Additionally, few studies address how transparency, fairness, and engagement among daily workers evolve when administrative systems become digitalized. These gaps underline the importance of evaluating digital attendance tools in community-based agricultural settings where modernization efforts are ongoing but often uneven.

This study aims to evaluate the impact of implementing a digital fingerprint attendance and monitoring dashboard on managerial efficiency and empowerment outcomes in an agricultural vocational unit. It investigates whether digital tools can enhance the accuracy of attendance records, improve transparency in workforce monitoring, and support more participatory interactions between workers and supervisors. The study also examines whether exposure to such technologies fosters readiness for digital adoption and strengthens empowerment indicators among casual workers. The underlying hypothesis posits that digital attendance systems contribute positively to both managerial and community empowerment dimensions, particularly when supported by consistent organizational practices and active community involvement.

METHOD

Research Design

This study employed a mixed-methods research design to capture both the managerial effects and empowerment outcomes resulting from the implementation of a digital fingerprint attendance system. The quantitative component focused on measuring attendance accuracy, punctuality patterns, and changes in reporting efficiency before and after digitalization. The qualitative component explored workers' perceptions, supervisors' experiences, and the contextual factors influencing digital adoption in the agricultural vocational environment. This design was selected because mixed-methods approaches enable deeper understanding of both measurable outcomes and subjective interpretations, which aligns with perspectives highlighted by (Dolan et al., 2023; Pregoner, 2024). regarding the need for integrated governance insights. The integration of quantitative and qualitative strands allowed the study to triangulate findings and strengthen its internal validity. The digital attendance intervention served as the central treatment variable, while managerial efficiency and empowerment indicators were conceptualized as dependent variables. The design ensured that operational changes were assessed alongside community responses, making the framework suitable for studying empowerment processes described by (Ajith et al., 2022; Dushkova & Ivlieva, 2024). This mixed-methods structure therefore provided a comprehensive foundation for evaluating the dual function of digital tools within community-based agricultural settings.

Participants

Participants in this study consisted of supervisors and daily workers assigned to operational units within the Integrated Agriculture TEFA environment. The sampling included individuals directly involved in daily attendance processes to ensure that data reflected real interactions with the digital system. Workers represented various shifts and functional roles, allowing the study to capture diverse operational experiences and perceptions of digitalization. Supervisors were included because they were

responsible for monitoring attendance and allocating tasks, which gave them unique insights into managerial efficiency. This composition aligns with the community-based empowerment framework emphasized by Klinsky & Sagar, (2022); Turin et al., (2021), who highlighted the role of inclusive participation in capacity-building activities. Participants were selected using purposive sampling to ensure relevance to the research questions and the digital intervention being evaluated. Participation was voluntary, and confidentiality was maintained throughout the study to protect individuals' identities and responses. This participant structure allowed the analysis to reflect both managerial and community dimensions critical to understanding digital transformation in rural vocational contexts.

Instrument

The primary instrument used in the quantitative phase was the digital fingerprint attendance device accompanied by an integrated monitoring dashboard that captured real-time attendance records. These tools generated timestamped datasets that were used to evaluate punctuality, presence, and reporting accuracy over the study period. The dashboard also provided visual summaries that enabled supervisors to interpret attendance trends more efficiently. For the qualitative component, semi-structured interview guides were used to explore workers' reactions, perceived benefits, and challenges in adapting to digital systems. The structure of these questions was informed by earlier empowerment frameworks identified by Wright, (2022); Narasimhan et al., (2024), ensuring alignment with established community engagement principles. Field observations were also conducted to understand how the system functioned within daily operational routines. Documentation reviews of pre-digital attendance records provided baseline comparisons essential for assessing improvement. This combination of digital instrumentation and human-centered data collection made the instrument set comprehensive and appropriate for evaluating both managerial and empowerment outcomes.

Data Analysis Plan

Quantitative data obtained from the fingerprint system were analyzed using descriptive statistics to examine changes in attendance accuracy, punctuality trends, and reporting intervals. Pre- and post-implementation data were compared to determine whether digitalization improved managerial efficiency in measurable ways. Graphical analysis from dashboard exports was also incorporated to visualize shifts in behavior and reporting patterns. Qualitative data from interviews were analyzed using thematic analysis to identify emerging patterns related to empowerment, transparency, and digital readiness. Thematic clustering followed an inductive approach that allowed findings to emerge naturally from participant narratives, consistent with interpretive principles discussed by (Burr et al., 2022; Wiltshire & Ronkainen, 2021). Integrating quantitative and qualitative findings strengthened the study's credibility through triangulation. The combined analysis provided insights into how digital attendance systems reshape both managerial practices and community engagement. This analytical structure ensured alignment with the study's objective of evaluating digital tools as catalysts for efficiency and empowerment in agricultural vocational settings.

RESULTS AND DISCUSSION

Results

The implementation of the digital fingerprint attendance system produced clear improvements in the accuracy and consistency of daily attendance reporting within the TEFA Integrated Agriculture Unit. Comparison between pre-digital and post-digital data showed that attendance discrepancies decreased substantially, and reporting delays that previously occurred during manual documentation were almost entirely eliminated. The monitoring dashboard provided supervisors with real-time information, enabling faster decisions regarding task allocation and labor distribution. Workers demonstrated a noticeable shift in punctuality, especially during the first month of system adoption, where daily check-ins became more consistent than the baseline period. Observations also indicated that workers adapted quickly to the digital interface after initial demonstrations, showing increased comfort with using fingerprint devices. Data visualization exported from the dashboard revealed smoother attendance curves across days, indicating more stable workforce availability. Supervisors reported that digital attendance data required significantly less verification effort compared to manual logbooks. Overall, the introduction of the system created a more transparent operational environment that supported both managerial efficiency and worker engagement.

Table 1. Comparison of Attendance Indicators Before and After Digitalization

Attendance Indicator	Manual System (Baseline)	Digital System (After Implementation)
Average Daily Punctuality (%)	67%	89%
Missing or Duplicate Entries	14 cases/month	1 case/month
Reporting Delay (minutes)	25 minutes average	3 minutes average
Supervisor Verification Time	High	Very Low
Worker Check-in Consistency	Moderate	High

The table shows clear operational improvements following the transition to the digital fingerprint system. Notably, punctuality increased by more than twenty percent, and missing or duplicated entries dropped substantially. The reduction in reporting delays indicates that the digital tool improved overall workflow speed. These shifts affirm the effectiveness of the digital attendance system in strengthening managerial oversight and workforce reliability.

Discussion

The findings of this study demonstrate that digital attendance systems can significantly enhance managerial efficiency within community-based agricultural vocational units. Improved data accuracy and reduced verification time indicate that digitalization introduced greater clarity in daily labor monitoring, aligning with the emphasis on boundary-work coordination discussed by Chen et al. (2025). The consistent attendance patterns observed after implementation show that workers responded positively to structured digital routines, supporting the idea that technological systems can shape behavioral norms. This phenomenon resonates with the capacity-building perspective of Singh and Singh (2023), who highlight that well-structured tools can strengthen local operational competencies. Additionally, the system's transparency contributed to a sense of fairness among workers, reflecting empowerment principles highlighted by Maza et al. (2016). The increased ease of managerial interpretation through dashboard visualization also aligns with insights by Leong et al. (2019) regarding the role of digital platforms in enabling coordinated organizational action. Together, these findings affirm that digital attendance systems serve not merely as technical instruments but as catalysts that transform daily management in rural agricultural environments. Such outcomes are significant for community empowerment, particularly in settings where digital readiness is gradually being developed.

A second key insight from the results lies in the relationship between digital transparency and the empowerment experiences of daily workers. Workers' improved punctuality and reduced inconsistencies suggest that the system fostered a greater sense of accountability, which aligns with the broader empowerment logic articulated by Maza et al. (2016). The rapid adaptation of workers to the fingerprint device demonstrates that digital tools can foster technological readiness even among individuals with limited prior exposure. This observation connects with the principles of knowledge transfer emphasized by Singh and Singh (2023), showing that simple structured interventions can facilitate learning and adaptation. Additionally, the system encouraged equal treatment across worker groups because attendance recognition depended entirely on biometric verification, enhancing fairness and reducing subjective biases. This aligns with the transparency dimensions highlighted by Chen et al. (2025) in governance settings where shared information supports trust-building. The dashboard's role in creating predictable and easily interpretable patterns also reflects the significance of coordinated digital boundaries described by Leong et al. (2019). Collectively, these factors indicate that digital attendance systems can simultaneously strengthen administrative accountability and support community empowerment trajectories. The dual effect reinforces the importance of integrating digital tools into community-based agricultural programs to enhance both operational and social outcomes.

Implications

The findings from this study offer important implications for digital transformation strategies within rural vocational agricultural environments. The demonstrated improvement in managerial

efficiency highlights that even simple digital tools can significantly reshape operational workflows when implemented consistently. Digital attendance systems also present an accessible entry point for broader digitalization, serving as a foundational experience that builds technological readiness among community members. The enhanced transparency generated by the system suggests that digital tools can strengthen trust between supervisors and workers, reinforcing participatory governance structures. Furthermore, the positive behavioral shifts observed among workers indicate that digital platforms can encourage accountability and engagement without requiring complex interventions. These gains support the broader argument that digital systems can help agricultural teaching factories evolve into more structured and equitable community environments. The findings further imply that future community empowerment programs should intentionally integrate technological components to maximize their long-term sustainability. These implications underscore the strategic importance of aligning digital tools with the social and operational realities of rural agricultural institutions.

Limitations

Despite its important contributions, this study has several limitations that should be acknowledged to contextualize its findings. First, the research was conducted within a single agricultural vocational unit, which limits the generalizability of the results to other regions or institutional settings. The sample size, although appropriate for qualitative depth, may not fully capture all behavioral variations among workers across different contexts. Additionally, the study primarily relied on pre- and post-implementation comparisons without including long-term follow-up data that could reveal sustained or evolving impacts. The study also did not incorporate advanced inferential statistical tests, which might offer deeper insights into causal relationships. Workers' self-reported perceptions in interviews may contain biases that cannot be fully controlled despite confidentiality measures. Variations in digital literacy among participants could also influence the rate of adaptation in ways not fully explored by this study. Lastly, external factors such as seasonal workload changes or management style variations were not strictly controlled, potentially influencing attendance trends.

Suggestions

Future research should consider expanding the sample to include multiple agricultural vocational units to strengthen the comparative power and generalizability of the findings. Longitudinal studies that examine digital attendance use over extended periods would help identify sustained behavioral or empowerment effects. Integrating more advanced digital platforms, such as mobile notifications or integrated payroll automation, may further enhance operational efficiency and should be considered in subsequent investigations. Researchers may also explore how digital attendance systems intersect with gender dynamics, age differences, or levels of digital literacy to reveal more nuanced empowerment patterns. Operational studies that compare fingerprint systems with alternative digital tools, such as QR-based attendance, could provide additional insights regarding technological suitability. Collaboration with local government agencies may support broader implementation and scaling of digitalization programs. Finally, community training programs designed to accompany digital interventions should be evaluated to assess their contribution to empowerment and sustainability.

CONCLUSION

This study demonstrates that the integration of a digital fingerprint attendance system and monitoring dashboard significantly improves managerial efficiency within a community-based agricultural vocational unit. The enhanced punctuality, reduced reporting delays, and greater accuracy in attendance records indicate that digital tools can resolve longstanding challenges associated with manual documentation. Beyond administrative gains, the digital system also created conditions that support early forms of empowerment by promoting transparency, strengthening fairness, and encouraging greater accountability among daily workers. These findings align with the broader goals of community empowerment, where technological interventions contribute not only to operational improvements but

also to the development of skills and confidence within local communities. The willingness of workers to adapt to new digital routines reflects the potential for rural vocational environments to transition toward more modernized and inclusive service models. The system further supports participatory management because supervisors can make decisions using real-time data that is both reliable and easily interpreted. Such improvements show that simple technological tools can act as catalysts for broader organizational change in rural settings. Overall, the study underscores that digital attendance systems can function as effective instruments for advancing both service quality and community empowerment, making them highly relevant for institutional development programs within agricultural teaching factories.

AUTHOR CONTRIBUTIONS STATEMENT

Rosaliana Putri Anggraeni led the development of the research framework, coordinated the data collection process, and prepared the initial draft of the manuscript. She was responsible for designing the methodological approach, conducting field observations, and ensuring that the study aligned with the objectives of community empowerment and managerial improvement. Mukhsin contributed to data analysis, interpretation of findings, and critical revision of the manuscript for intellectual rigor and clarity. He supervised the integration of quantitative and qualitative results, refined the theoretical alignment with existing literature, and strengthened the argumentation throughout the discussion section. Both authors collaboratively reviewed the final manuscript, approved its submission, and agreed to be accountable for all aspects of the work.

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