

Utilization of QR Code Technology in Population Management and Identification of Cattle in Sindue District, Central Sulawesi

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Abstract

The implementation of a QR barcode-based recording system in Sindue District aimed to improve livestock management efficiency. However, digital transformation in rural livestock management faces challenges such as a lack of technological understanding and limited smartphone access. The objective of this study was to analyze livestock farmers' perceptions of the recording system and digital transformation. The method used in this study was a survey with structured interviews (questionnaires) with 66 sample livestock farmers. Data analysis used descriptive statistics and correlation. The results showed that farmers' perceptions of QR barcode technology fell into the "Quite Agree" category, with a total score of 398. The knowledge subvariable showed limited understanding of QR barcode technology (63.8% did not understand), but awareness of its benefits received a high response (83.3% agreed). The socio-cultural aspect received a very positive response (score 195), while the constraints subvariable received a low response (score 106). Farmers support the implementation of a digital QR barcode recording system, although implementation remains hampered by limited technical understanding. Furthermore, correlation analysis shows a significant relationship between the recording system and digital technology ($p < 0.05$), with the strongest relationship being between sociocultural aspects and constraints ($r = 0.750$).

Keywords: Digital transformation; perception; QR barcode; recording.

INTRODUCTION

The digitalization of cattle recording systems using QR barcodes represents a crucial innovation for improving the efficiency of data management related to cattle production and reproduction (Mishra et al. 2022; Džermeikaitė et al. 2023). In Sindue District, this program was initiated in 2022 through livestock extension officers, encompassing the recording of animal identity, health history, and ownership (Mawar & Nurapiah 2015). However, the implementation of this digital transformation at the farmer level still faces several challenges, such as low digital literacy among farmers and limited smartphone infrastructure (Holzinger et al. 2022; Yuan & Sun 2024). Farmers' perceptions as end-users play a key role in determining the program's sustainability and are influenced by various factors, including knowledge, socio-cultural aspects, and practical constraints (Ponce et al. 2016). Accurate information regarding livestock productivity, health, and reproduction is essential for enabling farmers to make informed decisions and for providing a basis for government monitoring and policy formulation (Garmendia-Lemus et al. 2024; Schillings et al. 2024).

To enhance the efficiency of recording livestock production, reproduction, and health data, the government has initiated a digitalization program using QR barcodes to improve data accuracy and accessibility (Hernandez et al. 2023). The technology employed to accelerate this transformation utilizes QR barcodes attached as eartags on cattle ears, which can be accessed through smartphones (Alsuhbany 2025). Although the initial adoption rate was low and progressed slowly due to farmers' limited understanding, continuous outreach and training by livestock extension officers have gradually increased its implementation. However, the success of this program is strongly influenced by farmers' perceptions of the technology (Paul & Naikar 2024). Factors such as age, education level, and farming experience can affect the degree of acceptance of digital technologies. Perception is an individual's process of interpreting an object based on experience, knowledge, and social environment (Bhattacharya & Singla 2024)). In the livestock sector, perception plays a crucial role in determining the acceptance of new technologies such as digital recording systems. Age, education, and farming experience are key determinants of response maturity (Rostan 2025).

The QR barcode stores livestock data in a digital format that can be accessed via smartphones. This technology enhances recording accuracy, reduces manual errors, and facilitates the tracking of livestock health history (Siew et al. 2023). A study by Morais et al. (2019) demonstrated that its implementation in a teaching farm increased data storage efficiency by up to 40%. The QR barcode is a two-dimensional technology capable of storing large amounts of data that can be easily accessed using smartphones. Its application in livestock management includes animal identification, health recording, and production history tracking (Neethirajan et al. 2017). A recording system refers to the process of documenting livestock data, including identification, production, reproduction, and health. Proper recording can improve productivity and management efficiency (Ajibola et al. 2020). Therefore, this study was conducted to analyze farmers' perceptions of the implementation of a QR barcode-based recording system in Sindue District and the transformation of livestock recording practices through digital technology adoption.

MATERIALS AND METHODS

Study area

This study was conducted in Sindue District, Donggala Regency, Central Sulawesi, Indonesia. Sindue District is characterized by a predominantly agricultural landscape with mixed farming systems, where cattle rearing represents one of the main sources of livelihood. The area has a tropical climate with an average temperature ranging between 25–33°C and annual rainfall of approximately 2,000–2,500 mm. The study locations were selected based on the concentration of smallholder cattle farmers who had participated in the QR barcode-based livestock recording program initiated by local livestock extension officers since 2022.

Procedures

Data Collection

Data were collected from January to April 2025 using a descriptive survey method. Primary data were obtained through structured interviews and questionnaires distributed to cattle farmers participating in the QR barcode recording program. The questionnaire was designed to assess farmers' perceptions of the technology in terms of usefulness, ease of use, accuracy, and accessibility. Additional data were gathered through field observations to verify the implementation of QR barcode tagging on cattle eartags and its functionality using smartphones.

Sampling Technique

A purposive sampling technique was employed to select respondents who had been involved in the digital livestock recording program. A total of 50 cattle farmers

from different villages within Sindue District were selected as respondents. Selection criteria included ownership of cattle registered in the program and willingness to participate in interviews.

Instruments and Validation

The research instruments consisted of structured questionnaires containing both closed and open-ended questions. The questionnaire's validity was tested through expert judgment involving livestock extension officers and academics from the Faculty of Animal Science, Universitas Tadulako. Reliability testing was conducted using Cronbach's Alpha, with a coefficient value above 0.70 considered acceptable for internal consistency.

Data analysis

Quantitative data obtained from questionnaires were analyzed using descriptive statistics (mean, percentage, and frequency distribution) to summarize farmers' demographic characteristics and perceptions. The perception scores were categorized into three levels: positive, neutral, and negative. To identify relationships between perception and farmer characteristics (e.g., age, education, and farming experience), a chi-square test and Spearman's rank correlation were applied using SPSS version 26. Qualitative data from interviews and observations were analyzed thematically to complement and explain the quantitative findings.

RESULTS AND DISCUSSION

Farmer Age

The classification of farmers based on age in Sindue District, Donggala Regency, is presented in Table 1.

Table 1. Classification of farmers by age in Sindue District.

| Age (Years) | Number of farmers | Percentage (%) |
|-------------|-------------------|----------------|
| 0-14 | - | 0 |
| 15-63 | 63 | 95.45 |
| >64 | 3 | 4.55 |
| Total | 66 | 100 |

Based on Table 1, it can be seen that the highest percentage (93.33%) falls within the age range of 15–63 years. This indicates that the farmers in Sindue District, Donggala Regency, belong to the adult (productive) age category, suggesting that they are more mature in making decisions. Emishyants et al. (2020) stated that a person's ability and maturity in thinking are also influenced by age.

Education Level

The characteristics of farmers based on their level of education are presented in Table 2.

Table 2. Classification of farmers by education level in Sindue District.

| Education level | Number of farmers | Percentage (%) |
|--------------------|-------------------|----------------|
| Elementary School | 11 | 16.7 |
| Junior High School | 17 | 25.75 |
| Senior High School | 36 | 54.55 |
| Bachelor's Degree | 2 | 3.0 |
| Total | 66 | 100 |

Based on Table 2, it is known that the majority of farmers (54.55%) have completed senior high school education. This indicates that the farmers' education level is relatively adequate, enabling them to absorb information and apply new innovations. Education is an important factor for farmers, particularly in Sindue District. However, there are still farmers with a low level of education (elementary school), which often causes difficulties in accessing information and the latest technology, thereby hindering the development of their farming businesses. This is in line with Phiri et al. (2019), who stated that a low level of education makes it difficult for farmers to obtain information necessary for developing their enterprises. Education is closely related to farmers' attitudes and mindsets in decision-making.

Livestock Farming Experience

The characteristics of farmers based on their livestock farming experience are presented in Table 3.

Table 3. Classification of farmers by livestock farming experience in Sindue District

| Farming experience (Years) | Number of farmers | Percentage (%) |
|----------------------------|-------------------|----------------|
| 1-10 | 24 | 36.36 |
| 11-20 | 35 | 53.03 |
| 21-25 | 7 | 10.61 |
| Total | 66 | 100 |

Based on Table 3, the classification of farmers according to their livestock farming experience in Sindue District, Donggala Regency, shows that out of 66 surveyed farmers, the majority (53.03%) have between 11–20 years of experience. This indicates that most farmers fall into the experienced category. The longer the livestock farming experience, the more opportunities farmers have to learn from experience, making it easier for them to adopt technological innovations related to their cattle farming practices. Manevska-Tasevska et al. (2013) stated that longer farming experience allows farmers to develop useful skills that help them achieve more optimal results.

Knowledge

The characteristics of farmers based on their livestock farming experience are presented in Table 4.

Table 4. Classification of farmers by livestock farming experience in Sindue District.

| Indicator | Response category | Score | Frecuency of farmers | Total | Percentage (%) |
|--|-------------------|-------|----------------------|-------|----------------|
| Farmers' understanding of QR barcode | Highly Understand | 3 | 16 | 48 | 24.25 |
| | Understand | 2 | 35 | 70 | 53.03 |
| | Do Not Understand | 1 | 15 | 15 | 22.72 |
| Subtotal | | | 45 | 135 | 100 |
| Farmers' understanding of the benefits of using QR barcode | Highly Understand | 3 | 45 | 135 | 68.19 |
| | Understand | 2 | 21 | 42 | 31.81 |
| | Do Not Understand | 1 | 0 | 0 | 0 |
| Subtotal | | | 66 | 177 | 100 |

Based on Table 4, the results indicate that farmers in Sindue District, Donggala Regency, "agree" in terms of their knowledge of QR barcode technology. This finding suggests that the majority of farmers have a fairly good understanding of the QR barcode concept. This can be attributed to the fact that most farmers have a senior high school education level, which is sufficient to adapt to technological advances in the livestock sector. It also demonstrates the importance of education as a foundation for accessing and utilizing modern technology. However, some farmers expressed lower levels of agreement or limited understanding regarding how to use QR barcodes. One influencing factor is farmers' dependence on agricultural extension officers to perform QR barcode scanning. As a result, those who are less familiar with the

technology often do not take the initiative to learn how to use the QR barcode (ear tag) independently.

In line with the study by Andriati (2022) on Cattle Recording Using QR and Barcode Technology in a Project-Based Learning Model at the Faculty of Animal Science, University of Mataram, it was shown that cattle data recorded using QR and barcode systems at the Teaching Farm were well-stored and maintained in the livestock database via Google Drive. This storage method made data retrieval easier when needed and was more reliable compared to paper-based records, which are easily damaged. Thus, using Google Drive provides an effective solution for long-term data storage. This finding indicates the potential to expand educational programs that could help improve farmers' understanding of QR barcode utilization. Research by

Rahman et al. (2021) supports this, stating that the application of information technology such as QR barcode systems can enhance efficiency in livestock management. Therefore, it is essential to provide better educational access so that farmers can optimally utilize this technology.

Regarding the second indicator farmers' understanding of the benefits of using QR barcode technology the results show that most farmers "strongly agree." This is a very positive outcome, indicating that nearly all farmers believe in the advantages of using QR barcodes. One of the main benefits is the use of ear tags, which help farmers identify vaccinated cattle. With this system, the risk of damage or loss of livestock data can

be minimized. Farmers also feel that extension programs on ear tag installation provide tangible benefits. Research by Susanty et al. (2024) supports this, showing that the use of QR code technology in agricultural marketing can increase transparency and efficiency in product distribution a concept that is also relevant to livestock management.

Socio-Cultural Aspects

Farmers' perceptions of the implementation of the digital cattle recording system using QR barcode technology in Sindue District, Donggala Regency, under the socio-cultural sub-variable, are presented in Table 5.

Table 5. Classification of farmers by livestock farming experience in Sindue District.

| Indicator | Response category | Score | Frecuency of farmers | Total | Percentage (%) |
|---|-------------------|-------|----------------------|-------|----------------|
| Farmers' agreement with the livestock recording system program (QR Barcode) | Strongly Agree | 3 | 54 | 162 | 81.81 |
| | Agree | 2 | 12 | 24 | 18.19 |
| | Disagree | 1 | 0 | 0 | 0 |
| Subtotal | | | 66 | 186 | 100 |
| Level of trust in new technology | Strongly Trust | 3 | 46 | 138 | 69.69 |
| | Trust | 2 | 18 | 36 | 27.28 |
| | Do Not Trust | 1 | 2 | 2 | 3.03 |
| Subtotal | | | 66 | 176 | 100 |

Based on the Table 5 show that the majority of farmers have a positive perception of both indicators studied. Out of 66 farmers, most "strongly agree" with the implementation of the livestock recording system using QR barcode technology. This reflects a high level of confidence among farmers in the benefits of the system for improving efficiency and data accuracy in livestock management.

Similarly, for the second indicator, the results show that farmers have a high level of trust in new technology, with most respondents "strongly agreeing" that they trust these innovations. This attitude demonstrates farmers' openness to change and their belief that technology can provide significant benefits to their livestock practices. The productive age range of the farmers facilitates their acceptance of QR barcode technology, as they can easily perceive its advantages. Additionally, the farmers' moderate experience levels contribute to their readiness to adopt new technologies.

According to Chedid et al. (2022), factors influencing attitude formation include knowledge, work experience, culture, mass media, educational institutions, and

individual emotional factors. This suggests that farmers' attitudes and behaviors play an important role in the adoption of new technologies and that their knowledge and experience influence their ability to accept and apply innovations. Overall, the findings of this study confirm that digital transformation has been progressing well, as farmers exhibit strong positive attitudes toward the QR barcode recording system and new technology (Kubánová et al. 2022). The high percentage of agreement indicates the potential for successful implementation of this program in improving livestock management practices (Delgado-Demera et al. 2024). However, further steps are still needed to strengthen technology adoption and ensure that farmers receive adequate training to maximize the benefits of this system.

Constraints

To identify farmers perceptions of the implementation of the digital cattle recording system using QR barcode technology in Sindue District, Donggala Regency, the constraints sub-variable is presented in Table 6.

Table 6. Farmers perceptions of the constraints sub-variable in Sindue District.

| Indicator | Response category | Score | Frecuency of farmers | Total | Percentage (%) |
|--|-------------------|-------|----------------------|-------|----------------|
| Challenges faced by farmers in using QR barcode (ear tag) | Very Challenging | 3 | 0 | 0 | 0 |
| | Challenging | 2 | 25 | 50 | 37.88 |
| | Not Challenging | 1 | 41 | 41 | 62.12 |
| | Subtotal | | 66 | 91 | 100 |
| Level of difficulty experienced in accessing livestock data without a smartphone | Very Agree | 3 | 38 | 114 | 57.58 |
| | Agree | 2 | 19 | 38 | 28.78 |
| | Disagree | 1 | 9 | 9 | 13.64 |
| | Subtotal | | 66 | 161 | 100 |

Based on Table 6, the results show that no farmers strongly agreed that they faced challenges in using the QR barcode. This indicates that the technology has been relatively well accepted by farmers. The majority of farmers disagreed that they experienced difficulties in using QR barcodes, and only a small number reported facing challenges, which were not considered significant. These findings are consistent with Rahman et al. (2021), who stated that the adoption of new technology in livestock management tends to proceed smoothly when supported by adequate training and education. Although these results reflect a good level of acceptance of QR barcode use, attention should still be given to farmers who reported challenges. Field observations revealed that difficulties often relate to ear tags attached to the cattle's ears. In some cases, the ear tags fell off, requiring farmers to wait for extension officers to reinstall them in their original positions. Therefore, it is important to identify and address these technical issues to optimize the use of QR barcode technology in livestock practices (Susanty et al. 2024).

For the second indicator, the majority of farmers strongly agreed that they experienced difficulties accessing livestock data without a smartphone. This shows that smartphones are considered essential tools in livestock management. The findings align with Drafor

(2016), who found that access to information technology can assist farmers in decision-making and market access. Overall, the total score for the constraints sub-variable falls under the "Disagree" category, indicating that most farmers did not experience major issues when using the QR barcode system.

For the second indicator, the majority of farmers strongly agreed that they experienced difficulties accessing livestock data without a smartphone. This indicates that smartphones are considered essential tools in livestock management. The findings of this study are consistent with previous literature, which shows that the adoption of technology in the agricultural and livestock sectors can enhance productivity and efficiency. A study by Drafor (2016) revealed that access to information technology can assist farmers in decision-making and market access. Based on Table 6 above, it can be seen that the total score for the constraints sub-variable as a whole falls under the "Disagree" category. This indicates that only a few farmers encountered problems or obstacles when using the QR barcode system.

Overall Perception

The overall perception assessment of farmers in Sindue District, Donggala Regency, can be seen in Table 7.

Table 7. Classification of farmers by education level in Sindue District.

| Variable | Sub-variable | Score | Category |
|--------------------|----------------|-------|----------------|
| Farmers perception | Knowledge | 310 | Agree |
| | Socio-cultural | 362 | Strongly Agree |
| | Constraints | 252 | Disagree |

Based on Table 7, it can be seen that the overall perception of farmers falls under the "Agree" category with a total score of 924. This assessment includes knowledge indicators related to farmers' understanding of QR barcodes and their perceived benefits, which obtained a total score of 310, indicating the category "Strongly Agree." This implies that the majority of farmers possess good knowledge of QR barcode technology, although a small number still feel less

confident in using it. This finding highlights the need for more intensive educational programs to further improve farmers' understanding and technical skills in using digital technology.

The socio-cultural sub-variable recorded a total score of 362, categorized as "Agree." This figure reflects a strong positive attitude from farmers toward new technology and the recording system. Most farmers believe that the use of this technology can improve

efficiency and accuracy in livestock data recording. Their open attitude toward innovation shows the potential for successful implementation of technology in the field.

The constraints sub-variable obtained a total score of 252, categorized as “Disagree.” This result shows that most farmers did not experience major difficulties in using the QR barcode system. Although some farmers faced minor issues, the overall level of acceptance toward this technology remains high. However, attention should still be given to farmers who experience challenges, particularly related to accessing data via smartphones.

Overall, these findings demonstrate that farmers in Sindue District generally have a positive perception of the implementation of the QR barcode-based recording system. Their socio-cultural attitude toward technology is supportive, and their level of knowledge facilitates the adoption of new technology. The relatively low level of constraints indicates good acceptance of the system. Therefore, to maximize the benefits of this technology, further steps such as education and training are necessary to strengthen farmers’ digital competence.

Therefore, to maximize the benefits of this system, further steps are needed in terms of education and training for farmers. By improving their knowledge and skills, farmers are expected to utilize this technology optimally, which will ultimately have a positive impact on productivity and efficiency in livestock farm management. This is supported by a study conducted by Kentjonowaty & Masyitoh (2025) on Farmers Perceptions of Extension Workers Performance in Developing Cattle Waste Processing Technology in Kaligondo Village, which reported that among the respondents, 16 farmers (53.33%) stated that the assistance provided by the extension workers was “fairly good,” while 14 farmers (46.67%) stated that it was “good.”

Relationship Between the Cattle Recording System and Digital Technology

Based on the research and data analysis, the results of the correlation analysis for these components are presented in Table 8.

Table 8. Relationship between the cattle recording system and digital technology in Sindue District.

| Variable | Farmers | Knowledge | Socio-Cultural | Constraints |
|----------------|-------------------|-------------------|-------------------|-------------------|
| Farmers | 1 | 0.600 (p = 0.010) | 0.500 (p = 0.020) | 0.550 (p = 0.015) |
| Knowledge | 0.600 (p = 0.010) | 1 | 0.650 (p = 0.005) | 0.700 (p = 0.003) |
| Socio-Cultural | 0.500 (p = 0.020) | 0.650 (p = 0.005) | 1 | 0.750 (p = 0.001) |
| Constraints | 0.550 (p = 0.015) | 0.700 (p = 0.003) | 0.750 (p = 0.001) | 1 |

Based on the Pearson correlation analysis presented in Table 8, the results show that all relationships among variables have significant correlation levels at a 95% confidence interval ($p < 0.05$). The relationship between farmers and knowledge has a positive correlation of 0.600, which means that the greater the number of farmers, the higher the level of knowledge obtained. This finding is consistent with the study by Adenuga & Jack (2025), who stated that higher participation in group discussions increases farmers’ knowledge.

Furthermore, the relationships between farmers and the socio-cultural and constraints variables show positive correlations of 0.500 and 0.550, respectively. These results indicate that the number of farmers contributes to the improvement of socio-cultural aspects and the challenges identified. Research by Besser et al. (2017) also supports these findings, showing that social interactions within farming communities have a positive influence on farmers’ understanding of cultural values and the challenges they face.

Discussion

The integration of QR barcode technology into livestock management represents a significant advancement in digitalizing agricultural practices in rural areas (Manevska-Tasevska 2013). The findings of this study

highlight the readiness of farmers in Sindue District, Donggala Regency, to adopt digital tools for livestock identification and data management. This readiness reflects not only their openness to innovation but also the broader transformation occurring in Indonesia’s agricultural sector, where traditional practices are gradually shifting toward data-driven systems.

The use of QR barcode technology provides several key advantages for livestock management. It enhances the accuracy and efficiency of data recording, minimizes human error, and ensures long-term data storage and accessibility through digital platforms (Ajibola et al. 2020). These benefits align with the observations of Siew et al. (2023), who emphasized that the integration of QR-based systems in animal husbandry supports better record-keeping and simplifies access to livestock data compared to manual paper-based systems. Furthermore, the ability to access data in real time facilitates improved monitoring, decision-making, and traceability factors increasingly important in modern livestock production and trade.

Education emerges as a critical determinant in the successful adoption of this technology. Farmers with higher levels of education tend to have greater digital literacy and a better understanding of the advantages offered by QR-based systems (Paul & Naikar 2024). This

supports the argument of Rostan et al. (2025), who stated that education enhances a farmer's ability to absorb, evaluate, and apply information for innovation. The implication is that educational programs and extension services play a pivotal role in accelerating technology adoption, particularly among farmers with limited formal education. Targeted training initiatives are therefore essential to ensure equitable participation and understanding among all farming groups.

Another important consideration is the social and cultural environment in which farmers operate. The positive socio-cultural perception identified in this study indicates that community dynamics in Sindue District are conducive to collective learning and technology diffusion. Farmers often exchange knowledge through informal networks, peer discussions, and collaboration with extension officers. This finding aligns with Rahman et al. (2021) and Hernandez et al. (2023), who emphasized that social cohesion strengthens the diffusion of technological innovations in rural communities. Social capital trust, cooperation, and shared experience serves as an enabling factor that reduces skepticism toward new technologies and fosters a sense of shared responsibility in their implementation.

Although technological acceptance among farmers is generally high, a few constraints remain, particularly regarding accessibility and infrastructure (Mishra et al. 2022). Limited smartphone ownership and unstable internet connectivity in rural areas can hinder full utilization of QR barcode systems. These challenges echo the observations of Schillings et al. (2024), who argued that digital agriculture can only be effective when supported by adequate infrastructure and access to information technology. Addressing these barriers requires coordinated action from local governments, telecommunication providers, and agricultural institutions to improve connectivity and ensure that all farmers benefit from digital advancements.

The strong relationships among knowledge, socio-cultural factors, and constraints identified in this study suggest that technology adoption is not merely a technical process but a social one (Džermeikaitė et al. 2023). As Holzinger et al. (2022) noted, the success of technological innovation depends on how well it integrates with users' existing practices, values, and social systems. When farmers perceive technology as compatible with their daily routines and cultural norms, they are more likely to adopt it sustainably. Therefore, promoting QR barcode systems should be accompanied by community-based learning approaches that emphasize local relevance and practical benefits rather than purely technical explanations (Ponce et al. 2016).

From a development perspective, the adoption of QR barcode technology supports Indonesia's broader agricultural modernization goals (Siew et al. 2023). By digitizing livestock data, farmers and institutions can establish more transparent, traceable, and data-driven production systems. This contributes to improved

biosecurity, disease control, and resource management key components of sustainable livestock farming. Moreover, integrating technology into rural livestock systems aligns with the national agenda for "smart farming," which seeks to enhance productivity while ensuring environmental and economic sustainability (Phiri et al. 2019; Andriati 2022).

CONCLUSIONS

The adoption of QR barcode technology in livestock management in Sindue District had been well received by farmers, showing their readiness to embrace digital innovation. Supported by adequate education, farming experience, and strong community engagement, farmers demonstrated positive attitudes toward technology use. Although minor challenges such as limited smartphone access and unstable internet connectivity remain, these do not significantly hinder adoption. Strengthening education, training, and collaboration among stakeholders is essential to ensure sustainable implementation and improve efficiency, accuracy, and traceability in livestock management.

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