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# Digital Maturity for Sustainable Livestock Process Management

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## Abstract

Digital transformation in livestock enterprises creates managerial value only when digital tools are embedded in business processes and translated into measurable sustainability effects. The paper develops a digital maturity and portfolio prioritization approach for sustainable livestock process management. The research uses a structurally balanced pilot sample of 20 Ukrainian livestock en-terprises, documentary evidence, expert-documentary scoring, KPI baseline comparison and multi-criteria normalization. The results show uneven maturity across strategy, process automation, data analytics, digital architecture and cyber-resilience. The highest priority is assigned to BI and data warehouse initiatives, followed by ERP-based feed logistics integration and operational control solutions.

## Keywords

Business process management, digital maturity, digital transformation, key performance indicators, livestock enterprises, sustainability.

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## Introduction

Digital transformation is changing the way agricultural and rural enterprises plan resources, control production cycles, collect operational data and communicate managerial decisions. In livestock en-terprises this change is especially sensitive because biological cycles, feed logistics, veterinary mea-sures, productivity accounting, biosecurity procedures and product traceability generate a conti-nuous flow of operational information. If this information remains fragmented across paper journals, spreadsheets and isolated applications, digital technologies do not become a source of susta-inable competitiveness; they only reproduce existing process weaknesses in another technical form.

The problem investigated in this paper concerns the managerial assessment of digital transformation in livestock business process management. The main difficulty is not only whether an enterprise has digital tools, but whether these tools change process controllability, data reliability, decision speed and sustainability-oriented outcomes. This problem is important because livestock enterprises ope-rate under biological, logistical, veterinary and market constraints; therefore, digital transformation that is not connected with process management may increase technical complexity without improving managerial results.

The scientific discussion on digital transformation has moved from technology adoption to organizational capability and value creation. Digital transformation is interpreted as an organizational change process produced by digital technologies and strategic responses (Vial, 2019). It affects business models, organizational structures and strategic adaptation (Verhoef et al., 2021). In the context of business process management, technologies such as IoT, analytics and automation requi-re a process-oriented integration logic rather than isolated technological implementation (Butt, 2020). Process maturity is also important because stable improvement depends on the transition from fragmented routines to managed and measured processes (Van Looy, 2014), while business processes in digital transformation require explicit measurement strategies (Debnath et al., 2022).

A separate research stream links digital maturity with sustainability. The potential of digital transformation can be assessed through structured maturity dimensions (Corejova and Chinoracky, 2021). At the same time, maturity models need explicit sustainable performance indicators to avoid a narrow technological interpretation of progress (Fortier et al., 2025). Empirical evidence from agrifood supply chains confirms that digital maturity is related to sustainable performance (Barbosa et al., 2025). For Ukraine, ICT-driven advancement is important for implementing sustainable development values (Lysenko and Makovoz, 2025), while digitalization, risk management and artifi-cial intelligence are increasingly relevant for improving agricultural business processes (Zelisko et al., 2024).

Despite these contributions, two gaps remain important. First, many studies assess digital transfor-mation at the level of technologies, general organizational readiness or supply-chain performance, while livestock enterprises require a process-level diagnostic instrument that connects maturity domains with feed logistics, veterinary control, productivity accounting and traceability. Second, maturity assessment often ends with a diagnostic score and does not show how managers should select a limited portfolio of digital initiatives under budget, time and risk constraints. This is problematic because digital initiatives in livestock enterprises must be staged and coordinated with production cycles, data quality, staff readiness and cyber-resilience.

The scientific problem of the paper is formulated as follows: how can digital maturity diagnostics be connected with KPI-based managerial effects, sustainability outcomes and an operational algorithm for prioritizing digital initiatives in livestock business process management. The working hypothesis is that digital maturity becomes operationally useful when maturity domains, process bottlenecks, KPI baselines, sustainability links and risk-adjusted portfolio logic are treated as one dia-gnostic and decision-support system.

The purpose of the paper is to conduct a diagnostic assessment of digital maturity in livestock business process management and to suggest a portfolio prioritization algorithm that connects matu-rity gaps, KPI effects, sustainability orientation, costs, implementation duration and risks. The object of the research is business process management in livestock enterprises. The subject of the research is the set of digital tools, data governance routines, maturity domains and managerial mechanisms that influence process controllability, transparency, resilience and sustainable performance.

The benefit of the research for science is the transformation of a general BPM-digital transformati-on-sustainability idea into a livestock-specific maturity and prioritization mechanism. The benefit for business is an operational sequence for choosing digital initiatives when financial and organizational resources are limited. The benefit for studies is a replicable case that demonstrates how digital transformation can be connected with measurable process effects and sustainable rural development.

## Literature survey

The literature survey is organized around five research streams: BPM and process maturity, digital transformation capability, digital maturity diagnostics, agri-food digitalization and sustainability, and multi-criteria decision-making. The review is not limited to listing previous studies. Its purpose is to identify where the existing literature remains insufficient for livestock enterprises: many studies explain the importance of digital transformation, but fewer studies show how to convert maturity diagnostics into process-level priorities, KPI effects and sustainability-oriented managerial decisi-ons.

BPM and process maturity literature provides the first foundation, but it is not sufficient on its own. Process maturity supports the transition from fragmented routines to managed and optimized processes (Van Looy, 2014). This logic is especially important for digital transformation because di-gital tools should be embedded into process redesign rather than simply attached to existing workflows (Butt, 2020). Business processes in digital transformation also require explicit measurement strategies that make it possible to evaluate the effects of transformation rather than only describe technological adoption (Debnath et al., 2022). However, this stream usually remains sector-neutral and does not explain how maturity should be interpreted for livestock-specific process chains such as feed logistics, veterinary control, productivity accounting and traceability.

Digital transformation literature clarifies why technology adoption alone cannot be treated as transformation. Digital transformation should be understood as organizational change triggered by digital technologies (Vial, 2019). Value creation depends on strategic adaptation, organizational structure and business model change (Verhoef et al., 2021). In addition, organizational performance is linked not only to digital technology itself, but also to digital capability and digital innovation, which mediate the transformation of technology into business value (Khin and Ho, 2019). These studies are conceptually strong, but they remain too broad for enterprise-level process diagnostics. They justify why digital transformation matters, but they do not provide a sufficient operational mechanism for ranking concrete initiatives under cost, time and risk constraints in rural livestock enterprises.

Digital maturity models offer diagnostic structure, but they often stop at scoring. Multi-attribute maturity assessment can be used to diagnose the digital maturity of SMEs (Kljajic Borstnar and Pucihar, 2021), while composite approaches help assess the potential of digital transformation (Corejova and Chinoracky, 2021). Organizational readiness is also important before AI-based transformation because digital transformation requires not only technology but also appropriate structures, competences and implementation conditions (Aldoseri et al., 2024). These resources help assess specific areas, but they do not provide a comprehensive answer to the management que-stion that arises after the assessment: which digital initiatives should be implemented first, and why? The weakness is especially relevant for livestock enterprises because limited budgets require a defensible portfolio logic rather than a general digitalization checklist.

Agri-food and sustainability-oriented studies bring the problem closer to the sector of this article, but a gap still remains. Fuzzy AHP can be used to structure criteria for digital transformation in agribusiness, which supports the idea that transformation priorities must be weighed (Martins et al., 2023). Digital maturity is also related to sustainable performance in agri-food supply chains (Barbosa et al., 2025). Digital technologies and risk management are relevant for agricultural supply cha-ins because they influence coordination, resilience and decision-making (Lumbantobing et al., 2025). The relationship between digital transformation and sustainability in agribusiness is increa-singly treated as a separate research agenda (Annosi et al., 2024). Digitalization, artificial intelligen-ce and risk considerations are also important for improving agricultural business processes (Zelisko et al., 2024). Nevertheless, these studies mainly address agribusiness, supply chains or general ag-ricultural processes, whereas livestock enterprises need a more specific link between maturity do-mains, operational bottlenecks, KPI changes and sustainability effects.

The MCDM literature is useful because digital transformation decisions are multi-criteria by nature. AHP provides a methodological basis for deriving criteria weights (Saaty, 1980), while TOPSIS, VIKOR and related methods support the comparison of alternatives with conflicting criteria (Opricovic and Tzeng, 2004; Zavadskas et al., 2014). However, MCDM models are often applied after alternatives have already been formulated. The missing element is the bridge between maturity dia-gnosis and the construction of alternatives: the enterprise must first identify which bottlenecks are strategically important, then translate them into initiatives, and only then rank them.

The literature survey, therefore, reveals a clear research gap. Existing studies either focus on broad digital transformation theory, general maturity scoring, agribusiness digitalization, sustainability performance or MCDM ranking. The decision-making framework for digital transformation in livestock farming remains underdeveloped; it should combine: areas of maturity -> process bottle-necks -> impact on key performance indicators (KPIs) -> interpretation from a sustainability per-spective -> prioritised digital initiatives. This gap explains the importance of the present study. It transforms digital maturity from a descriptive score into a decision-support system for sustainable livestock business process management.

According to the results of the literature survey presented in Table 1, it is clear that contemporary

| Research stream | Key contribution to the paper | Critical limitation addressed in this paper |
|---|---|---|
| BPM and process maturity | Explains ownership, standardization, measurement and continuous improvement | Insufficient adaptation to livestock process chains and operational bottlenecks |
| Digital transformation capability | Shows that technology creates value through organizational and strategic change | Too broad for enterprise-level ranking of concrete initiatives |
| Digital maturity diagnostics | Provides domain-based scoring and readiness assessment | Often stops at diagnosis and does not guide initiative selection |
| Agri-food digitalization and sustainability | Links digitalization with sustainability, risk and supply-chain performance | Weak process-level explanation for livestock BPM and KPI effects |
| MCDM | Supports weighted comparison of alternatives with conflicting criteria | Needs to be connected with maturity gaps before alternatives are ranked |

Source: Compiled by the authors

Table 1: Literature streams and their role in the proposed approach.

theories are positioned not merely as an indicator of new technology adoption, but as a mechanism to support DT decision-making. It connects process maturity with digital transformation priorities and sustainability-oriented outcomes in a way that is comprehensible to managers of livestock enterprises.

## Materials and methods

The research period covers February 2025 - April 2026. The unit of observation was the enterprise-level digital maturity profile rather than an individual employee. This distinction is important becau-se the paper does not present a representative sociological survey of employees; it presents a pilot expert-documentary diagnostic assessment of enterprise-level process management and digitalizati-on evidence.

The empirical basis includes 20 livestock-related enterprises and organizations. The sample was purposive and structurally balanced: 10 entities represented the state sector and 10 represented pri-vate business structures. The selection logic combined the availability of sufficient information, regional diversity and relevance to livestock-related process management. The balanced structure allows comparison between state-sector and private-sector profiles, but the sample should not be interpreted as statistically representative of all Ukrainian livestock enterprises.

The evidence base was grouped into four blocks. The first block covered process context: process maps, roles, regulations, AS-IS and TO-BE descriptions and internal documents. The second block covered digital tools and architecture: ERP, CRM, BI dashboards, digital journals, cloud services, data integration and system interoperability. The third block covered KPI performance: reporting timeliness, data quality, transparency, automation and coordination indicators. The fourth block covered managerial effects and risks: decision speed, process visibility, quality of control, cyber-resilience and continuity risks.

The expert-documentary assessment used a five-domain maturity model: D1 - strategy and digital change governance; D2 - processes and automation; D3 - data, analytics and transparency; D4 - digital architecture and integration; D5 - cybersecurity, compliance and resilience. Each domain was assessed on a 0-4 scale, where 0 means absence of a formal routine, 1 means episodic use, 2 means partial formalization, 3 means systematic use and 4 means integration, measurement and regular managerial review.

The calculation procedure included three steps (formulas 1-10).

First, the score of each indicator was normalized:

$$r_{ij} = \frac{x_{ij}}{4}, \quad x_{ij} \in [0;4], \quad r_{ij} \in [0;1], \tag{1}$$

where $x_{ij}$ is the expert-documentary score of indicator *i* in domain *j*.

Second, the domain score was calculated as follows:

$$S_j = \sum_{i=1}^{n_j} w_{ij} r_{ij}, \quad \sum_{i=1}^{n_j} w_{ij} = 1, \tag{2}$$

where $w_{ij}$ is the weight of indicator *i* within domain *j*.

Third, the integral digital maturity index was calculated as follows:

$$I = \sum_{j=1}^{m} W_j S_j, \quad \sum_{j=1}^{m} W_j = 1, \tag{3}$$

where *I* is the integral digital maturity index, *m* is the number of maturity domains, and $W_j$ is the weight of domain *j*.

In the pilot version, equal domain weights were used:

$$W_j = \frac{1}{m}. \tag{4}$$

Since the model includes five domains, the equal weight of each domain is:

$$W_j = \frac{1}{5} = 0.20. \tag{5}$$

If it is necessary to present the integral maturity index on the original 0–4 scale, the normalized index can be transformed as follows:

$$I_{0-4} = 4I. \tag{6}$$

The prioritization of digital initiatives used six criteria: expected maturity gain, KPI effect, transparency and controllability, implementation duration, cost and risk. Benefit criteria were normalized so that a larger value increased the utility of an initiative.

$$N_b(z_k) = \frac{z_k - \min(z)}{\max(z) - \min(z)}. \tag{7}$$

Cost, duration and risk criteria were normalized in the opposite direction:

$$N_c(z_k) = \frac{\max(z) - z_k}{\max(z) - \min(z)}. \tag{8}$$

The general utility of initiative k was expressed as follows:

$$U_k = \alpha N_b(\Delta I_k) + \beta N_b(\Delta KPI_k) + \\ + \gamma N_b(T_k) + \rho N_c(L_k) + \\ + \delta N_c(C_k) + \varepsilon N_c(R_k), \quad (9)$$

where $U_k$ is the total utility score of initiative $k$;

$\Delta I_k$ is the expected maturity gain;

$\Delta KPI_k$ is the expected KPI effect;

$T_k$ is the transparency and controllability score;

$L_k$ is implementation duration;

$C_k$ is implementation cost;

$R_k$ is risk level;

$N_b$ is benefit normalization;

$N_c$ is cost normalization.

The weights of the prioritization criteria satisfy the following condition:

$$\alpha + \beta + \gamma + \rho + \delta + \varepsilon = 1. \quad (10)$$

The higher the value of $U_k$, the higher the priority of the corresponding digital initiative.

Sustainability was operationalized through proxy indicators linked with process management. Economic sustainability was represented by reporting timeliness, cost control, losses and resource-use efficiency. Environmental sustainability was represented by feed losses, energy use, traceability, microclimate control and waste-related process discipline. Social sustainability was represented by labor safety, staff digital competence, reduction of routine manual work, veterinary compliance and the reliability of responsibilities in process execution. This proxy design is appropriate for a pilot maturity assessment, while a larger field study should collect direct environmental and social mea-surements.

Data in Table 2 clarify the methodological boundary of the paper. The results should be treated as a pilot diagnostic application that demonstrates the logic of assessment and prioritization. The next stage of research should increase the number of enterprises, collect direct system logs and validate the weight system with a larger expert panel.

## Results and discussion

The starting point of the results is a process-oriented interpretation of digital transformation. A digital tool is not assessed by its technical novelty alone. It is assessed by the degree to which it im-proves process execution, data availability, managerial visibility, decision speed and sustainability-related outcomes. For livestock enterprises, the core process chain can be generalized as planning, supply and feed logistics, livestock operations, veterinary and biosecurity control, productivity ac-counting, sales and logistics. Each process generates data and creates decision points; therefore, digital maturity should be measured where process execution and managerial control meet. The diagnostic model consists of five connected domains. D1 captures whether digital transformation is governed as a managed change portfolio. D2 captures whether core livestock processes are described, standardized and automated. D3 captures whether data are reliable, timely

| Element | Specification in the paper | Reasoning |
|---|---|---|
| Research period | February 2026 -April 2026 | Defines the temporal boundary for collecting, harmonizing and verifying the empirical evidence |
| Observation unit | Enterprise-level digital maturity profile | The study assesses process management systems and enterprise-level evidence, not personal attitudes |
| Sample | 20 livestock-related enterprise profiles: 10 state sector and 10 private-sector | A structurally balanced pilot sample enables group comparison |
| Data sources | Documents, regulations, reporting forms, digital records, expert-documentary scoring | Combines observable evidence with diagnostic judgement |
| Assessment method | 0-4 maturity scale across five domains | Provides an interpretable maturity profile for enterprises with limited digital data |
| Decision method | Multi-criteria utility function with benefit and cost-risk normalization | Transforms diagnostic gaps into a ranked portfolio of digital initiatives |
| Sustainability logic | Economic, environmental and social proxy indicators connected with BPM effects | Links digital maturity with sustainable rural business outcomes |

Source: Compiled by the authors

Table 2: Research design and methodological decisions.

and available for managerial analytics. D4 captures whether digital systems are integrated rather than isolated. D5 captures whether digital infrastructure is protected through access control, backup, incident procedures and cyber-resilience. These domains correspond to the full managerial cycle from strategic intent to operational continuity.

The diagnostic results show that the private-sector group had a higher baseline maturity than the state-sector group. This difference can be explained by stronger investment flexibility, faster managerial decisions and a higher probability of using ERP, CRM, BI or integrated accounting tools. At the same time, both groups improved after digital changes, which confirms that maturity diagnostics can support operational prioritization rather than only describe the current state.

The information in Table 3 indicates three patterns. First, all domains improved in both groups. Second, private enterprises remained more digitally mature both before and after the changes. Third, the strongest state-sector improvement related to data and analytics, while the strongest private-sector improvement was connected with processes and automation. This means that digital transformation should be managed as a differentiated domain portfolio rather than as a single technology program.

Subsequent to the analysis of the data in Table 4, the managerial effect is visible not only in technological readiness but also in the quality of management. The state-sector group gained 16-18 per-centage points across indicators, whereas the private-sector group gained 15-17 percentage points. This means that even when initial maturity is different, a process-oriented digitalization programme can improve reporting, data quality, transparency and routine coordination.

The diagnostic profile indicates that the main bottlenecks are not limited to lack of equipment or software. In many livestock enterprises the key restrictions are delayed data collection, duplicate manual entry, weak connection between operational records and managerial dashboards, unclear ownership of data and insufficient cyber-resilience of operational systems. Such restrictions reduce the managerial value of digital tools because managers receive information too late or cannot trust its completeness. For this reason, the proposed solution is not a single technology implementation. It is a set of transformation scenarios that can be combined into a staged roadmap. The scenarios translate maturity gaps into manageable initiatives and prevent the common situation in which an enterprise invests in a complex ERP or IoT solution before basic data and process rules are ready.

Data in Table 5 reveal that sustainability is not an additional slogan placed after digital transformation. It is embedded into the process effects of each scenario. The first scenario improves compliance and reduces errors; the second supports resource and feed-loss control; the third creates the basis for energy and productivity optimization;

| Domain | State before | State after | Change | Private before | Private after | Change |
|---|---|---|---|---|---|---|
| D1 Strategy and governance | 1.83 | 2.31 | +0.48 | 2.19 | 2.80 | +0.61 |
| D2 Processes and automation | 1.87 | 2.37 | +0.50 | 2.31 | 3.01 | +0.70 |
| D3 Data and analytics | 1.79 | 2.37 | +0.58 | 2.08 | 2.65 | +0.57 |
| D4 Architecture and integration | 1.75 | 2.20 | +0.45 | 2.18 | 2.80 | +0.62 |
| D5 Cybersecurity and resilience | 1.77 | 2.31 | +0.54 | 2.07 | 2.67 | +0.60 |
| Average | 1.80 | 2.31 | +0.51 | 2.17 | 2.79 | +0.62 |

Source: Compiled by the authors

Table 3: Average digital maturity scores by domains in the pilot sample, 0-4 scale.

| Indicator | Meaning | State before | State after | Change | Private before | Private after | Change |
|---|---|---|---|---|---|---|---|
| E1 | Timeliness of reporting and decision support | 45 | 62 | +17 | 59 | 75 | +16 |
| E2 | Data quality and error control | 49 | 66 | +17 | 53 | 70 | +17 |
| E3 | Process transparency and KPI coverage | 47 | 63 | +16 | 57 | 73 | +16 |
| E4 | Automation and coordination of routine actions | 48 | 66 | +18 | 58 | 73 | +15 |

Source: Compiled by the authors

Table 4: Managerial effects of digitalization in the pilot sample, percentage points.

| Scenario | Main content | Domains | Managerial effect | Sustainability effect |
|---|---|---|---|---|
| S1 Quick effects | Digital checkpoints, electronic journals, checklists, basic data standardization | D1-D3 | Early transparency, fewer manual errors, clearer responsibility | Less waste from data errors, better compliance and staff discipline |
| S2 Integration and controllability | ERP/accounting integration, reference data, warehouse batches, feed logistics control | D2-D4 | Less duplication, shorter cycles, better traceability | Lower feed losses, better resource planning and financial sustainability |
| S3 Analytics and optimization | BI dashboards, forecasting, microclimate monitoring, resource optimization | D3-D4 | Faster decisions, better planning and resource use | Energy efficiency, productivity control and early warning of operational deviations |
| S4 Cyber-resilience and compliance | Access control, backup, audit, incident management and recovery procedures | D5 | Lower downtime and lower risk of data loss | Continuity of rural business infrastructure and protection of sensitive operational data |

Source: Compiled by the authors

Table 5: Digital transformation scenarios and sustainability-oriented process effects.

and the fourth protects the continuity of digital in-frastructure. Therefore, the sustainability dimension is operationalized through measurable process consequences rather than only through general environmental declarations.

The prioritization algorithm proposed in the paper connects maturity gaps with KPI effects, transparency, cost, duration and risk. It intentionally remains more transparent than a full AHP-TOPSIS procedure because the first managerial need of livestock enterprises is a reproducible ranking that can be discussed with managers, accountants, veterinarians and IT coordinators. AHP can be used at the next stage to justify weights, while TOPSIS or VIKOR can be used for robustness testing.

Subsequent to the analysis of the data in Table 6, the first implementation priority should be a data warehouse and BI dashboard layer. This initiative has the highest utility because it affects the most critical bottleneck: the absence of reliable and timely managerial data. The ERP contour for feed logistics ranks second because it connects planning, procurement and warehouse accounting. Mobi-le veterinary control and IoT monitoring are important operational initiatives, but their effect be-comes stronger after the data and integration foundation is prepared. The cyber-resilience initiative has a lower direct KPI effect in the table, but it should be treated as a mandatory control embedded into each implementation wave.

Sustainability is a central dimension of the proposed approach, not a secondary effect. In livestock process management, sustainability cannot be reduced to environmental reporting alone. It should be interpreted as the ability of an enterprise to maintain economic viability, reduce resource losses, protect animal and product traceability, support labor safety, increase transparency and preserve the continuity of rural business infrastructure.

Economic sustainability is linked with the ability to plan resources, reduce avoidable losses and make timely decisions. When reporting is delayed or feed movements are not traceable, managers cannot react to deviations in time. Digital maturity in D2, D3 and D4 improves economic sustaina-bility because process automation, data quality and integration reduce duplicate operations and increase the reliability of planning. In the pilot results, the improvement of reporting timeliness and data quality by 16-18 percentage points in the state-sector group and 15-17 percentage points in the private-sector group demonstrates this managerial effect.

Environmental sustainability is linked with feed logistics, energy use, microclimate control, waste reduction and traceability of production. The approach does not claim that environmental outcomes were directly measured in the pilot stage. Instead, it identifies digital process proxies that prepare the basis for direct environmental measurement. For example, ERP-based feed logistics can reduce unexplained feed losses; IoT microclimate monitoring can support more efficient energy use; and BI dashboards can make deviations visible before they become systemic resource losses.

Social sustainability is linked with staff competence, reduction of routine manual work, labor safety, veterinary compliance and accountability of process roles. Digital transformation changes not only the technical system but also the way people work. Therefore, D1 and D2 are

| Initiative | Process link | Scenario | Key scores | Utility / rank |
|---|---|---|---|---|
| Data warehouse and BI dashboards | Productivity accounting and management reporting | S2 | Maturity gain 0.12; KPI effect 0.20; transparency 0.85; risk 0.30 | 0.69 / 1 |
| ERP contour for feed logistics and warehouse batches | Feed planning, procurement, warehouse and write-off | S2 | Maturity gain 0.10; KPI effect 0.15; transparency 0.75; risk 0.35 | 0.34 / 2 |
| Mobile module for veterinary incidents and biosecurity protocols | Veterinary control, vaccination and quarantine measures | S1 | Maturity gain 0.06; KPI effect 0.10; transparency 0.65; risk 0.25 | 0.09 / 3 |
| IoT microclimate monitoring with automated alerts | Animal keeping conditions and operational alerts | S3 | Maturity gain 0.08; KPI effect 0.12; transparency 0.60; risk 0.40 | 0.08 / 4 |
| OT/IoT cyber-resilience: network segmentation and IAM | IT infrastructure and operational systems protection | S4 | Maturity gain 0.09; KPI effect 0.08; transparency 0.70; risk 0.45 | 0.08 / 5 |

Source: Compiled by the authors

Table 6: Pilot prioritization matrix for digital initiatives.

| Maturity domain | Economic sustainability | Environmental sustainability | Social and resilience sustainability |
|---|---|---|---|
| D1 Strategy and governance | Investment prioritization, roadmap discipline, KPI ownership | Strategic attention to resource-saving goals | Change governance, training and responsibility |
| D2 Processes and automation | Lower process time, fewer manual errors, better cost control | Reduced losses from process deviations | Less routine manual work and clearer execution rules |
| D3 Data and analytics | Timely reporting and better management decisions | Evidence for resource-use and waste indicators | Transparency and accountability of operational decisions |
| D4 Architecture and integration | Less duplicated input, better planning across systems | Traceability of feed, batches and operational flows | Stable information flow between units and managers |
| D5 Cybersecurity and resilience | Lower risk of downtime and financial disruption | Continuity of monitoring and control systems | Protection of sensitive data and operational continuity |

Source: Compiled by the authors

Table 7: Sustainability interpretation of maturity domains and process indicators.

important be-cause strategy, governance, training and process ownership determines whether employees understand digital procedures and whether managers use data responsibly. Cyber-resilience in D5 also has a social dimension because data loss or system downtime can disrupt work, veterinary control and reporting obligations.

The sustainability contribution of the paper is the proposal to evaluate digital transformation through a maturity-to-effect chain: maturity domain -> process bottleneck -> digital initiative -> KPI effect -> sustainability proxy. This chain prevents abstract sustainability statements and forces each digital initiative to show how it affects economic, environmental or social performance. In future empirical work, this proxy structure should be expanded with direct measurements such as feed loss percentage, energy consumption per production unit, veterinary incident frequency, number of manual reporting hours, staff digital training coverage and downtime caused by digital incidents. The information in Table 7 (above) shows how the sustainability component can be assessed without turning the review into a general ESG report. Each maturity domain has a specific sustainability interpretation. This structure also explains why cyber-resilience is included in the maturity model: in modern rural infrastructure, sustainability depends not only on environmental indicators but also on reliable and secure digital operations.

## Conclusion

The paper confirms that digital maturity in livestock enterprises should be assessed through business process management rather than through technology adoption alone. A five-domain dia-gnostic model was formed: strategy and governance, processes and automation, data and analytics, digital architecture and integration, and cybersecurity and resilience. These domains cover the full management cycle from strategic coordination to operational data use and continuity of digital infrastructure.

The pilot sample of 20 Ukrainian livestock enterprises shows positive but uneven maturity dyna-mics. The average state-sector maturity increased from 1.80 to 2.31 points on the 0-4 scale, or by 0.51 points. The average private-sector maturity increased from 2.17 to 2.79 points, or by 0.62 points. The strongest state-sector improvement was observed in data and analytics, while the stron-gest private-sector improvement was observed in processes and automation. This means that state enterprises need stronger data governance and integration support, whereas private enterprises can move faster toward advanced process automation.

The managerial effects also improved. In the state-sector group, the increase across reporting timeliness, data quality, transparency and automation indicators ranged from 16 to 18 percentage points. In the private-sector group, the increase ranged from 15 to 17 percentage points. These results show that digitalization is most valuable when it reduces delays in reporting, improves the quality of primary records and increases the visibility of process execution.

The prioritization algorithm connects maturity gaps with KPI effects, sustainability proxies, costs, duration and risks. In the pilot ranking, the highest-priority initiative is the creation of a data ware-house and BI dashboards with utility 0.69. ERP-based feed logistics integration ranks second with utility 0.34. Mobile veterinary control, IoT microclimate monitoring and OT/IoT cyber-resilience should be implemented as staged or cross-cutting initiatives because their effectiveness depends on the quality of the data and integration foundation.

The sustainability contribution of the paper is the connection between digital maturity domains and economic, environmental and social process effects. Economic sustainability is supported through cost control, reporting timeliness and resource planning. Environmental sustainability is supported through feed-loss control, traceability, energy-related monitoring and reduction of operational devi-ations. Social and resilience sustainability is supported through staff competence, reduction of rou-tine manual work, veterinary compliance and secure continuity of digital operations.

For livestock enterprise management, the recommended roadmap is to start with data inventory, KPI ownership and BI dashboards; then integrate feed logistics and warehouse accounting; then pilot mobile veterinary and IoT tools; and finally formalize cyber-resilience as a permanent control mechanism. For science, the proposed model can be used for further empirical testing of the relati-onship between digital maturity, BPM quality and sustainability outcomes in rural business. For studies, the model provides a clear case for teaching how digital transformation can relate to mea-surable process effects and managerial decision-making.

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