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Oksana Makovoz[1]

oksana.makovoz@tu-dresden.de

Technische Universität Dresden

Sergii Lysenko[2]

National Technical University Kharkiv Polytechnic Institute

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From Digital Records to Verifiable Business Claims: Evidence Governance in Agri-Food Value Chains

Oksana Makovoz[1],[2] and Sergii Lysenko[2]

[1] International Institute (IHI) Zittau Dresden University of Technology, Dresden, Germany

[2] National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine

Corresponding author: Oksana Makovoz, oksana.makovoz@tu-dresden.de

ORCID: Oksana Makovoz 0000-0001-8728-1500; Sergii Lysenko 0009-0004-3720-5285

Abstract

Digital transformation makes operational records abundant, yet the existence of digital records does not establish that a consequential business claim can be independently reconstructed. This study develops evidence verifiability capability (EVC) as a claim-specific organizational capability through which process governance and evidence controls convert digital records into defensible business evidence. The framework is examined through a two-stage documentary multi-case design covering 12 agri-food companies: five process-oriented cases from Ukraine and seven external analytical replications based on official corporate reporting. Across the corpus, a process KPI or operational result is directly observable in 12/12 cases, a digital/process mechanism and traceability/control evidence in 9/12 cases each, and responsibility/auditability evidence in 7/12 cases. Sensitivity analysis that includes partial evidence raises the latter figure to 11/12, demonstrating that broad governance disclosure is more common than claim-level reconstruction. Reproducible operational calculations further show why outcome change and digital attribution must remain separate: Astarta's milk production rose 35.5% between 2020 and 2025, Ovostar's H1 processing share rose 9.7 percentage points between 2023 and 2024, and KSG Agro's average daily gain rose 8.19%, yet only the last source explicitly identifies a non-digital cause – genetics – so digital attribution is rejected. The study contributes to a management-level mechanism linking evidence architecture to verification effort and to evidence-related information asymmetry and proposes an evidence-by-design approach for technology management, assurance and agri-food governance.

Keywords: business process management; digital governance; evidence verifiability; information asymmetry; process evidence; technology management

JEL classification: M10; M15; O33; Q56

1 Introduction

Digital transformation has changed how organizations execute, monitor and coordinate business processes. Enterprise systems, cloud platforms, connected devices, analytics and artificial intelligence generate operational records at previously unavailable speeds and levels of granularity. Yet a record is not automatically evidence. A timestamp does not demonstrate that an underlying event occurred as recorded; a dashboard does not show whether a metric can be reconstructed from source events; and tamper-resistant storage can preserve an incorrect input perfectly. The distinction matters whenever process data supports consequential managerial decisions, supplier qualification, assurance, sustainability reporting, automated controls, or cross-organizational coordination.

Digital-transformation research consistently treats technology as an organizational change problem rather than a simple adoption decision (Verhoef et al. 2021; Vial 2019). Business process management (BPM) adds that value depends on process ownership, measurement, routines and governance (Butt 2020; vom Brocke et al. 2014), while recent work emphasizes reciprocal relationships between digitalization and process-management capability (Huy and Phuc 2025; Iden et al. 2025). Makovoz and Lysenko (2025) similarly assess digital transformation through process-management and sustainability outcomes, and Makovoz and Lysenko (2026) connect digital maturity to sustainable livestock process management. These studies support a process-centred view, but they leave an evidentiary question unresolved: a process can be digitally mature while the records behind a specific KPI, decision or disclosure remain insufficient for independent reconstruction. Audit, process-mining and process-data-governance research comes closest to this problem. Appelbaum (2016) shows that digital audit evidence becomes less reliable when provenance and log histories are incomplete. Process-mining research demonstrates that event logs can strengthen audit-risk assessment and internal-control analysis (Chiu et al. 2026; Jans et al. 2013; Mugwira et al. 2026), while van der Aalst (2016) formalizes the use of event data to reconstruct actual process behavior. Goel et al. (2024) broaden this perspective by identifying governance requirements for process data, including mappings between real-world process concepts and recorded data, provenance, controls and organizational responsibilities. The unresolved issue appears one step earlier than the analytical method: what makes the recorded event sequence evidentially adequate for the business claim that is subsequently analysed?

A second literature stream addresses digital provenance, traceability and trust. Provenance models preserve origin and transformation history (Moreau et al. 2015; Pan et al. 2023), while blockchain and Internet-of-Things research addresses integrity, traceability and shared records (Casino et al. 2019; Rejeb et al. 2019; Saberi et al. 2019). Sustainability research moves closer to the claim problem: event-based analytics can test data authenticity (Chen et al. 2024), traceability can constrain greenwashing (Charfi et al. 2026), and outcome verifiability can condition stakeholder responses to sustainability performance (Oh 2026). Assurance research similarly shows that credibility depends on the quality and scope of evidence available to assurance providers (Christensen et al. 2021; Simnett et al. 2009; Zengin-Karaibrahimoglu et al. 2026). These contributions are complementary but usually treat provenance, traceability, assurance or outcome verifiability as distinct analytical objects. The gap addressed here is therefore one of integration and level of analysis. Existing research does not jointly specify the material event-to-claim chain as the unit of analysis, the set of evidence properties that must survive across that chain, and a conservative rule for weakening the claim when a critical link is missing. The problem is particularly evident in agri-food value chains, where physical events, sensor readings, enterprise records, supplier declarations, regulatory controls and sustainability disclosures may all contribute to one business assertion. In such settings, the question is not simply whether a company has digital systems or traceability technology, but whether the evidence supporting a material claim remains attributable, traceable, reconstructable and auditable from the originating event through the final statement.

The study addresses two research questions.

RQ1 asks: What organizational conditions make digital process records suitable as independently verifiable evidence for material business claims?

RQ2 asks: How consistently are those conditions observable across a bounded agri-food case corpus, and how do missing links change the maximum inference that the available evidence can support?

The study makes three contributions. First, it conceptualizes evidence verifiability capability (EVC) as a claim-specific, formative and non-compensatory organizational capability comprising attribution,

provenance, integrity, traceability, reconstructability and auditability. Second, it links the completeness of the evidence chain to verification effort and evidence-related information asymmetry, thereby connecting process-data governance to a management and economics mechanism rather than treating verifiability as a purely technical property. Third, it demonstrates the diagnostic value of the framework on a predefined 12-case documentary corpus with reproducible counts, sensitivity checks and operational calculations. The empirical contribution is deliberately bounded: the study does not estimate causal effects of digital performance from public documents; instead, it shows how the same operational number can support different claims depending on the completeness of its evidence chain.

2 Theoretical foundation and evidence-governance framework

2.1 From digital process records to defensible evidence

BPM treats a business process as a managed system of activities, decisions, roles, information flows and controls rather than a sequence of automated tasks. Under digital transformation, the managerial meaning of a record depends on how process boundaries, decision rights, measures and exceptions are organized. Process maturity can therefore strengthen evidentiary conditions by making event boundaries and responsibilities explicit, but maturity does not guarantee that the derivation of a particular claim can be reconstructed. An organization may have stable workflows and sophisticated dashboards while retaining only aggregated outputs, incomplete correction histories or weak actor attribution. This distinction is consistent with the difference between operational capability and strategic renewal. EVC is not proposed as a dynamic capability in the sense of reconfiguring the resource base; it is closer to an operational capability that repeatedly produces evidence of sufficient quality for verification (Helfat and Winter 2011). Process maturity provides an enabling substrate only where it clarifies who owns the evidence-producing event, which transformations are allowed, how exceptions are handled and which records are retained (Van Looy 2014).

Audit and process-mining research specifies several requirements of such evidence. Event logs become analytically valuable when case identifiers, activities, timestamps and relevant attributes preserve the actual path of process execution (Jans et al. 2013; van der Aalst 2016). Recent auditing studies show that process-mining evidence can extend internal-control, and risk analysis, but also that audit usefulness depends on data relevance, materiality and judgment rather than on event volume alone (Chiu et al. 2026; Mugwira et al. 2026). IoT-oriented BPM research similarly shows that automated sensing must be interpreted within process context (Janiesch et al. 2020). The present study therefore moves upstream from analysis of an event log to the governance conditions under which event data can function as defensible evidence.

Provenance, identity, integrity, traceability and auditability contribute different parts of the evidence chain. Provenance preserves origin and transformation history (Moreau et al. 2015; Pan et al. 2023); provenance-aware compliance work shows how lineage can support auditability in connected systems (Pasquier et al. 2018). Identity and role controls bind actions to accountable actors or systems. Integrity controls make unauthorized modification detectable. Traceability links objects and events across stages. Data governance adds authority, standards and decision rights over the information lifecycle (Abraham et al. 2019). Recent work on data trusts similarly emphasizes roles, access rules and controlled stewardship as governance conditions for responsible data use (Aldenhoff et al. 2026). The evidence-verifiability-enforceability perspective in sustainable value chains likewise shows that the value of trusted records depends on whether claims can be verified and acted upon across organizational boundaries

(Nikolakis et al. 2018). Reproducible transformation logic is equally important when fragmented operational data are converted into decision information (Sousa et al. 2026). None of these mechanisms is sufficient by itself. A blockchain can protect an incorrect sensor reading; a traceability identifier can link records without explaining how a KPI was calculated; a transparent report can disclose a number whose transformation lineage is unavailable; and an auditable system can reveal that evidence is incomplete. This non-equivalence is important for management because technology investments are often justified through broad claims such as greater trust or transparency. The evidentiary question is narrower: what would an independent reviewer need to reconstruct this particular claim?

2.2 Evidence verifiability capability and its boundaries

EVC is defined as an organization's repeatable, claim-specific capability to preserve enough evidence about a material business-process claim that an independent reviewer can attribute the relevant events, follow their provenance, detect unauthorized change, link the relevant records, reconstruct the derivation and inspect the governing controls and exceptions. The six properties are constitutive rather than reflective indicators. They create the capability instead of expressing a single latent maturity trait, which makes a formative specification appropriate (Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003; Petter et al. 2007). The construct is also non-compensatory at claim level. Necessary-condition reasoning distinguishes a prerequisite from a factor that merely raises an average score (Dul 2016). If the selected claim requires actor attribution and no responsible actor or system can be linked to the event, strong integrity or traceability elsewhere cannot repair that missing link. Likewise, a perfectly preserved log does not establish a causal digital-performance effect if a competing non-digital mechanism explains the observed outcome. EVC therefore operates as a profile with claim-specific gates rather than as a maturity index whose dimensions are averaged. EVC is narrower than transparency, data quality, traceability, auditability and downstream outcome verifiability. Transparency concerns visibility; data quality concerns fitness, accuracy and contextual usefulness (Wang and Strong 1996); traceability concerns linkage across objects or stages; and auditability concerns inspectability. Outcome verifiability concerns whether stakeholders can corroborate an outcome after it has been produced (Oh 2026). EVC focuses on the upstream process configuration that makes corroboration possible: the retained relationship between event, responsible actor, source record, transformations, controls and final claim. In that sense, EVC complements rather than replaces these adjacent constructs. The distinction also clarifies the relationship with sustainability assurance. Assurance can improve credibility, but the quality and scope of sustainability assurance vary across providers and institutional settings (Christensen et al. 2021; Zengin-Karaibrahimoglu et al. 2026). Continuous and technology-enabled assurance architectures can increase the availability of evidence (Dai and Vasarhelyi 2017), yet they still depend on the quality and reconstructability of the underlying process evidence. EVC therefore concerns the evidence architecture that exists before an auditor, buyer or regulator begins an assurance task.

2.3 Verification effort and evidence-related information asymmetry

The economic mechanism proposed by the framework is verification effort. When a manager, buyer, auditor or regulator cannot observe how a claim was produced, the party must search for additional records, reconcile inconsistent versions, request explanations, repeat calculations or accept greater uncertainty. This is a specific manifestation of information asymmetry: one party knows more about the generation of the claim than the party asked to rely on it (Akerlof 1970). EVC reduces this burden not by making the outcome favorable, but by making the basis of the outcome inspectable. In signaling terms, an assertion is more credible when another actor can independently corroborate the signal and challenge its supporting evidence (Spence 1973). The managerial implication is important: evidence architecture

can reduce transaction and verification effort even when performance itself is unchanged. Conversely, extensive digitalization can coexist with high verification costs if the event-to-claim path remains fragmented. Figure 1 summarizes this mechanism. The framework starts with a material business claim and traces backward to process governance and evidence controls. EVC is generated through six constitutive properties; independent reconstruction is the immediate verification mechanism; and assurance readiness, decision credibility and accountability are downstream management outcomes. Source-data validity, interoperability, system continuity and claim materiality act as boundary conditions because a well-preserved record can still be wrong, inaccessible or irrelevant to the claim being assessed.

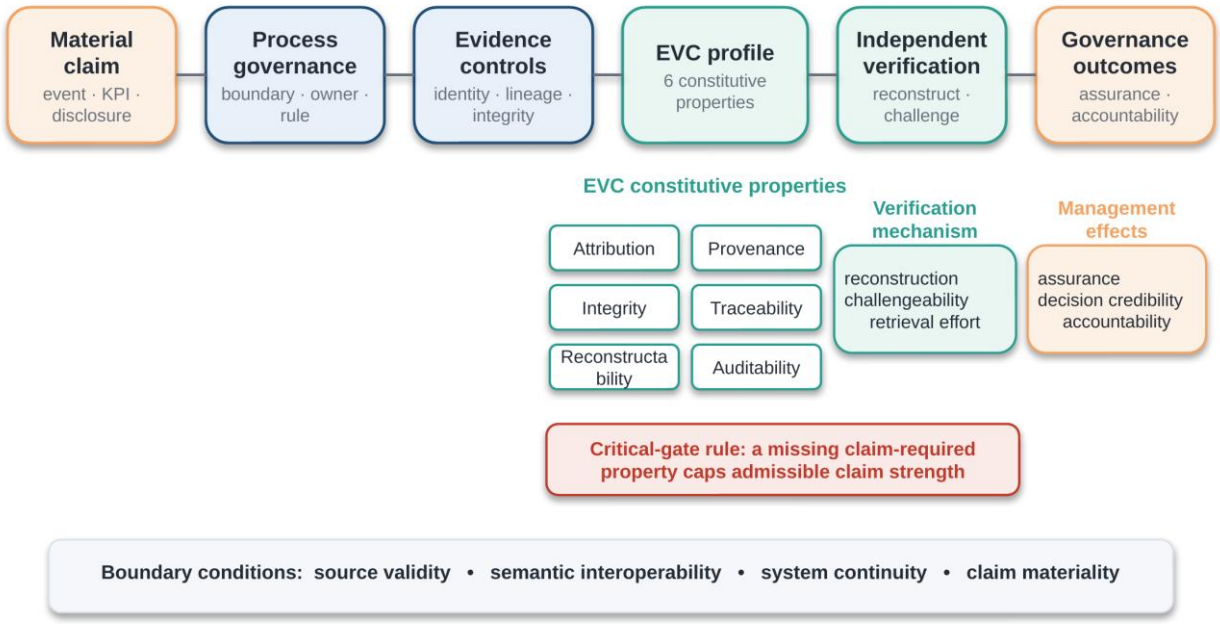


Fig. 1 Claim-specific evidence-governance framework

Source: authors' conceptual synthesis based on Abraham et al. (2019), Appelbaum (2016), Moreau et al. (2015), Oh (2026), Pan et al. (2023) and Pasquier et al. (2018).

3 Methodology

3.1 Research design and rationale for the 12-case corpus

The study combines conceptual development with documentary multi-case analysis. The conceptual component follows a theory-synthesis logic in which neighboring constructs are compared, a residual organizational problem is isolated, and a mechanism is specified (Jaakkola 2020; MacInnis 2011; Webster and Watson 2002). It is not presented as a systematic literature review and does not claim exhaustive coverage of all literature on digital trust, provenance or assurance. The literature is used to delimit the construct and derive the evidence-governance mechanism. The empirical component follows documentary analysis and analytical-replication logic rather than statistical sampling (Bowen 2009; Eisenhardt 1989; Eisenhardt and Graebner 2007). The unit of analysis is a material business claim attached to a bounded process-evidence chain, not the firm as a whole. A chain begins with an event or observation, passes through responsible actors or systems and material transformations, and ends in a

decision, KPI, disclosure or assurance claim. This unit is necessary because a single organization may support one claim with detailed evidence and another only with aggregated disclosure.

The number of cases was not chosen through a statistical power target. Twelve cases are the final cases retained from the bounded source registry after applying the same documentary eligibility rules. The Ukrainian core was required to satisfy five conditions: direct relevance to livestock or an immediately related agri-food process; an accessible first-party or official source; a documented digital or organizational change or a process KPI; enough information to reconstruct at least one link between a process mechanism and a result; and an identifiable period and source provenance. The external replication group additionally required official annual or sustainability reporting and process evidence concerning digital systems, traceability, controls or responsibility. Applying these rules produced five Ukrainian core cases and seven external analytical replications. The purpose of the external group is not to create a statistical control group or a country comparison; it is to test whether the same evidence fields remain meaningful across different reporting environments. The retained Ukrainian core comprises Astarta Holding, documented through annual, sustainability and operating sources and the AgriChain implementation description (Astarta Holding PLC 2021, 2023, 2025, 2026; AgriChain 2025); Moloko Vitchyzny (Moloko Vitchyzny LLC n.d.-a, n.d.-b); Ovostar Union/YASENSVIT (Ovostar Union Public Company Limited 2024a, 2024b; SV Altera 2019); KSG Agro (KSG Agro n.d.); and MHP (MHP SE 2025). The external analytical-replication group comprises Arla Foods (Arla Foods amba 2025), Danish Crown (Danish Crown 2024), Royal Agrifirm (Royal Agrifirm Group 2025), ForFarmers (ForFarmers NV 2025), Fonterra (Fonterra Co-operative Group 2024), JBS (JBS SA 2025) and Adecoagro (Adecoagro SA 2025). This explicit registry is important because the study does not infer from a hidden or expandable convenience sample: all Stage-1 percentages are calculated on this fixed twelve-case corpus, while the four deep cases are selected only after the common screen.

Four cases are selected for deeper analysis only after the common screen. Astarta represents a mechanism-rich digital livestock context with incomplete public claim reconstruction; YASENSVIT represents a tightly bound SCADA control process; MHP represents broad governance and traceability disclosure at a more aggregated level; and KSG Agro represents a negative attribution control in which a favorable KPI has a documented non-digital explanation. This maximum-variation selection enables testing whether the framework discriminates among different cases rather than merely confirming positive digitalization narratives. Table 1 consolidates the corpus produced by these eligibility rules. It separates the five-case Ukrainian core from the seven-case external analytical-replication group, reports the source-class mix in each group, and identifies where the four deep cases are incorporated into the design. The table links the case-selection rationale above to the two-stage analysis that follows.

Table 1 Corpus composition, source profile and analytical role

Corpus group	n	Source-class composition	Role	Deep cases (n)
Ukraine core	5	A=1; B=2; A+B=1; A+C=1	Process-specific digital/organizational evidence and operational KPIs	4
External analytical replication	7	A=7	Official annual/sustainability reporting; field transferability across agri-food contexts	0

Corpus group	n	Source-class composition	Role	Deep cases (n)
Total	12	A=8; B=2; mixed=2	Analytical replication and maximum-variation contrast	4

Source: authors' case registry based on the corporate and implementation sources cited in the manuscript and Supplementary Information 1. A = formal corporate report/data pack; B = first-party corporate source; C = technology-provider implementation source.

The corpus composition is important for interpretation. All seven external replications rely on Class A reporting, whereas the Ukrainian core intentionally retains more heterogeneous sources in order to preserve process specificity. The external group therefore tests whether the documentary fields travel across formal reporting contexts; it is not used as a statistically comparable control group. Figure 2 summarizes the analytical sequence used after the corpus has been defined. Common Stage-1 coding is applied to all 12 cases, and only then are four maximum-variation cases selected for claim-level EVC analysis. The right-hand panel reports the documentary source composition used to interpret later differences in observability.

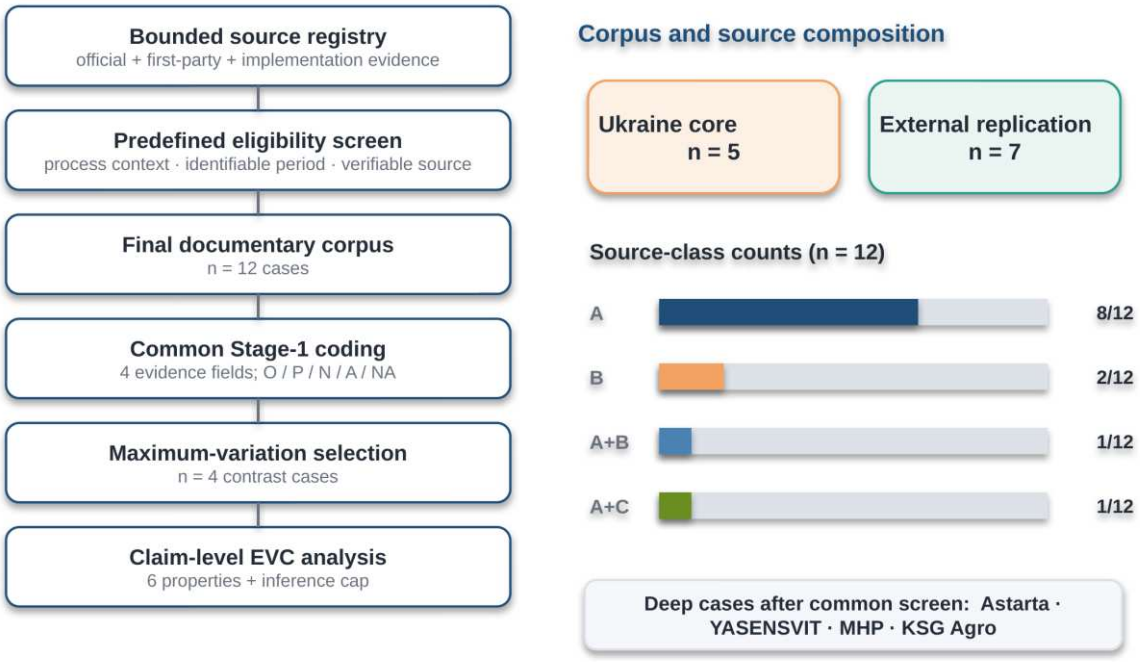


Fig. 2 Documentary multi-case research design and case selection

Source: authors' research design. The full 12-case register and inclusion details are provided in Supplementary Information 1.

This sequence separates screening from interpretation. The deep cases cannot define the common coding rules because they are chosen only after the 12-case screen, and source class is recorded before inference. These two safeguards reduce the risk that a missing public link is confused with weaker documentary granularity.

3.2 Source hierarchy, coding procedure and quantitative calculations

Sources were classified before interpretation. Class A comprises official annual, sustainability or operational reports and formal corporate data packs and is used for disclosed KPIs, formal controls and governance statements. Class B comprises first-party corporate webpages, product descriptions and company-hosted interviews; these sources can establish implementation context or management explanations but are not treated as independent confirmation of performance effects. Class C comprises implementation-provider case descriptions; they can establish technical architecture and intended functionality but are used conservatively because successful-project narratives may be selective. Stage 1 applies the same four documentary fields to all 12 cases: an identifiable digital or process mechanism; traceability/control evidence; a process KPI or operational result; and responsibility/auditability evidence. Each field is coded as observed (O), partial (P), not established (N), alternative cause (A) or not applicable (NA). The conservative rule is that missing documentary evidence is never completed by assumption, and N is not interpreted as proof that the organization lacks the corresponding internal capability.

The main coverage statistic for field j is $\text{Coverage}_j = O_j/N \times 100$, where O_j is the number of cases coded observed and $N = 12$. A sensitivity calculation also reports $(O_j + P_j)/N \times 100$ to show how conclusions change when partial evidence is treated as sufficient for broad observability. Because the cases are purposively selected and heterogeneous, the percentages are descriptive and are not subjected to inferential significance testing.

Operational calculations are reproduced only where public sources provide comparable values. Relative change is calculated as $\Delta\% = (x_t - x_0)/x_0 \times 100$. For multi-year Astarta indicators, compound annual growth is reported as $\text{CAGR} = (x_t/x_0)^{(1/T)} - 1$, with T measured in years. Ovostar's processing share is calculated as processed eggs divided by eggs produced. These arithmetic results describe observed dynamics; they are not interpreted as causal digital effects unless the evidence chain supports attribution. Stage 2 applies the six EVC properties to the four contrast cases and identifies the strongest evidence available, the first missing or competing link and the maximum inference supported by the record. No composite EVC score is calculated because the framework is deliberately non-compensatory. Detailed coding rules, case records, calculations and source-verification tables are provided in Supplementary Information 1.

4 Results

4.1 Case-level and corpus-level evidence patterns

The first result concerns the distribution of evidence across the full corpus. Before aggregating the four evidence fields, the case-level screen is reported to show how the overall percentages are constructed and to make clear that the 12 cases contribute different documentary configurations. Table 2 reports, for each case, the number of fields coded directly observed, the number coded partial and any alternative-cause or not-established states. This table also makes the logic of the maximum-variation deep-case selection visible rather than treating the corpus as a homogeneous sample.

Table 2 Case-level Stage-1 evidence profile across the 12-case corpus

Case	Group	Source class	Observed fields	Partial fields	Other states	Analytical role
Astarta	Ukraine	A+B	3/4	1	–	Deep: mechanism-rich / incomplete reconstruction
Moloko Vitchyzny	Ukraine	B	2/4	2	–	Bundled digital + physical modernization
Ovostar / YASENSVIT	Ukraine	A+C	3/4	1	–	Deep: bounded digital control + aggregate outcome
KSG Agro	Ukraine	B	1/4	0	A=1; N=1; NA=1	Deep: negative attribution control
MHP	Ukraine	A	4/4	0	–	Deep: disclosure-rich / aggregated evidence
Arla Foods	External	A	4/4	0	–	Analytical replication
Danish Crown	External	A	3/4	1	–	Analytical replication
Royal Agrifirm	External	A	2/4	2	–	Analytical replication
ForFarmers	External	A	4/4	0	–	Analytical replication
Fonterra	External	A	4/4	0	–	Analytical replication
JBS	External	A	3/4	1	–	Analytical replication
Adecoagro	External	A	4/4	0	–	Analytical replication

Source: authors' documentary coding. Four Stage-1 fields are mechanism, traceability/control, process KPI and responsibility/auditability. O = observed; P = partial; A = alternative cause; N = not established; NA = not applicable. The full field-by-field matrix is in Supplementary Information 1.

The case-level pattern shows why a simple average would be misleading. Five cases contain all four fields directly, while several others contain broad process or governance information that is only partial at the selected claim level. KSG Agro is intentionally retained despite low digital-evidence coverage because the explicit alternative cause is analytically valuable: the framework must be able to reject

digital attribution rather than reward the mere presence of a positive KPI. The four deep cases are therefore selected for contrast, not because they are the "best" or most digital cases. Table 3 aggregates the case-level states in Table 2 by evidence field. It reports strict observability for the full corpus and for the two analytical groups, and it adds a relaxed O+P bound so that evidence granularity can be distinguished from complete non-observation.

Table 3 Documentary evidence observability by field and corpus group

Evidence field	All 12: strict O	Ukraine core: strict O	External replication: strict O	All 12: O + P
Digital/process mechanism	9/12 (75.0%)	4/5 (80.0%)	5/7 (71.4%)	11/12 (91.7%)
Traceability / control	9/12 (75.0%)	3/5 (60.0%)	6/7 (85.7%)	11/12 (91.7%)
Process KPI / operational result	12/12 (100.0%)	5/5 (100.0%)	7/7 (100.0%)	12/12 (100.0%)
Responsibility / auditability	7/12 (58.3%)	1/5 (20.0%)	6/7 (85.7%)	11/12 (91.7%)

Source: authors' documentary coding. O = observed; P = partial. The complete case-by-case matrix is reported in Supplementary Information 1.

Three patterns are visible. First, operational outcomes are the easiest evidence to find: every case contains at least one process KPI or operational result. Second, a documented digital/process mechanism and traceability/control evidence are each directly observable in 75.0% of cases. Third, direct responsibility/auditability evidence falls to 58.3%, producing a 41.7 percentage-point gap relative to KPI visibility. This gap is central to the study: organizations can disclose what happened more often than they expose the responsibility, version history and evidence path required to reconstruct why a consequential claim should be accepted. The sensitivity column also matters. When partial evidence is counted with observed evidence, responsibility/auditability coverage rises from 58.3% to 91.7%. The finding therefore does not imply that governance information is absent from most cases. Instead, it distinguishes broad governance context from direct claim-level evidence. A report may describe responsibilities and assurance processes while still omitting the actor-level event history or transformation rules needed to reconstruct a selected metric. Figure 3 visualizes the same corpus-level result in two views. Panel A compares strict and relaxed observability for all 12 cases, while Panel B shows the strict rates separately for the Ukrainian core and the external replication group.

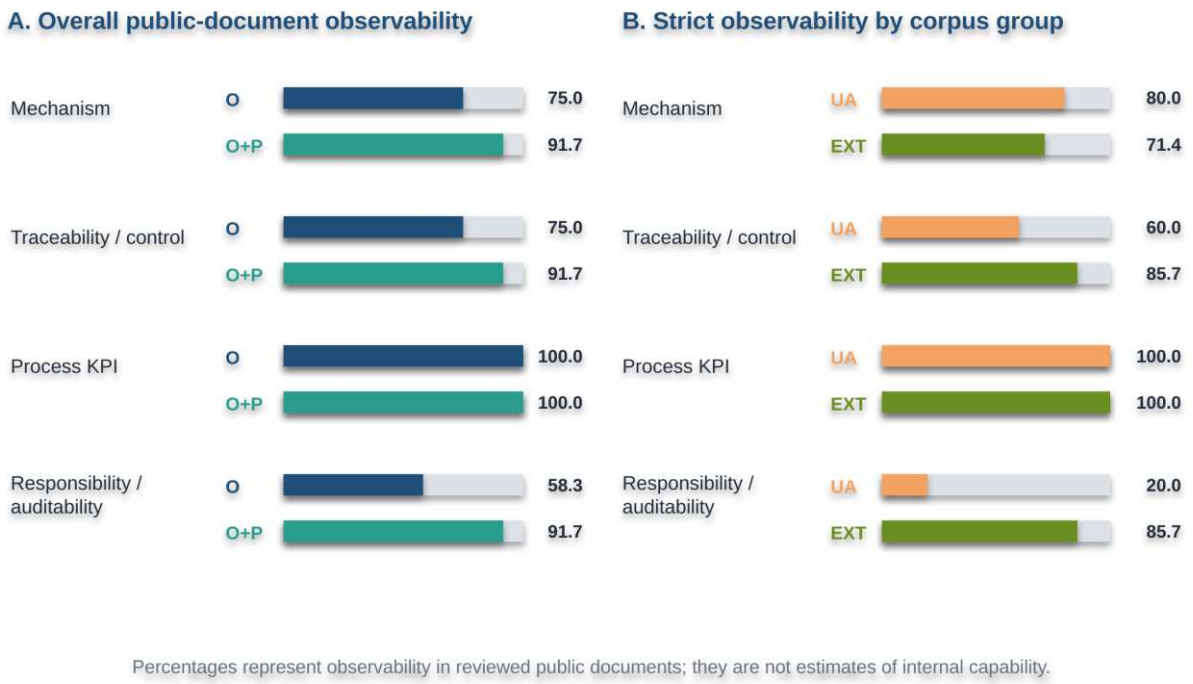


Fig. 3 Documentary evidence observability across the 12-case corpus

Source: authors' calculations from the documentary coding matrix in Supplementary Information 1. Percentages describe public-document observability, not internal organizational capability.

The visualization makes the central asymmetry visible: process KPIs are documented in every case, whereas direct claim-level responsibility and auditability evidence are much less consistently observable. The large strict-to-relaxed increase for responsibility/auditability indicates that governance context is often disclosed, but not always linked tightly enough to reconstruct a particular business claim.

4.2 Robustness of the corpus-level coverage result

Because "partial" evidence is a judgment about granularity rather than complete absence, the aggregate result is recalculated under a relaxed rule that counts O and P together. The strict result is retained as the primary estimate because the research question concerns claim-level reconstructability; the relaxed result is a sensitivity bound showing how much coverage would rise if broad contextual evidence were accepted as sufficient (see Table 4).

Table 4 Sensitivity of evidence coverage to the treatment of partial evidence

Evidence field	Strict: O only	Relaxed: O + P	Change
Digital/process mechanism	9/12 (75.0%)	11/12 (91.7%)	+16.7 pp
Traceability / control	9/12 (75.0%)	11/12 (91.7%)	+16.7 pp
Process KPI / operational result	12/12 (100.0%)	12/12 (100.0%)	0.0 pp
Responsibility / auditability	7/12 (58.3%)	11/12 (91.7%)	+33.4 pp

Source: authors' sensitivity calculation from the Stage-1 coding matrix. Percentage-point changes may differ by 0.1 because of rounding.

The sensitivity result reinforces, rather than overturns, the main interpretation. Operational KPIs remain universally observable under both rules. The largest change occurs for responsibility/auditability, where the rate increases from 58.3% to 91.7%. This indicates that governance context is usually disclosed somewhere, but often at a level that does not bind responsibility and audit history directly to the selected claim. The strict-relaxed gap is therefore itself a substantive result: it measures the loss of evidentiary specificity caused by aggregation.

4.3 Reproducible operational calculations

The second result examines how much can be learned from the numbers themselves before any digital attribution is attempted. Table 5 reproduces the operational calculations used in the case discussion. It deliberately presents the arithmetic result and the admissible inference in separate columns.

Table 5 Reproducible operational calculations and admissible inference

Case	Metric	Baseline	Comparison	Calculation	Result	Admissible inference
Astarta	Average herd	22k (2020)	29k (2025)	(29−22)/22×100	+31.8%; CAGR 5.7%	Long-run segment growth; not a causal digital estimate
Astarta	Daily milk yield	21.4 kg/day (2020)	27.5 kg/day (2025)	(27.5−21.4)/21.4×100	+28.5%; CAGR 5.1%	Productivity improvement observed; digital contribution not isolated
Astarta	Milk production	93 kt (2020)	126 kt (2025)	(126−93)/93×100	+35.5%; CAGR 6.3%	Output growth coexists with digital practices and herd expansion
Ovostar	Eggs produced, H1	732m (2023)	706m (2024)	(706−732)/732×100	−3.6%	Aggregate production declined
Ovostar	Eggs processed, H1	213m (2023)	274m (2024)	(274−213)/213×100	+28.6%	Processing volume increased
Ovostar	Processing share, H1	29.1%	38.8%	38.8−29.1	+9.7 pp	Product-flow structure changed; digital cause not established
YASENSVIT	SCADA control scope	20 poultry houses	20 poultry houses	documented process scope	hourly plan/actual control	Control architecture established; response effect not measurable publicly

Case	Metric	Baseline	Comparison	Calculation	Result	Admissible inference
KSG Agro	Average daily gain	476 g/day	515 g/day	(515−476)/476×100	+8.19%	Digital attribution rejected; genetics is documented cause

Source: authors' calculations based on Astarta Holding PLC (2021, 2025, 2026), Ovostar Union Public Company Limited (2024a, 2024b), SV Altera (2019) and KSG Agro (n.d.). Calculations reproduce disclosed values and do not by themselves establish a digital causal effect.

Astarta provides the longest documented time horizon. Between 2020 and 2025, average herd size increased from 22 to 29 thousand head, average daily milk yield from 21.4 to 27.5 kg, and milk production from 93 to 126 kt. These correspond to cumulative increases of 31.8%, 28.5% and 35.5%, with approximate annual compound growth of 5.7%, 5.1% and 6.3%, respectively. Figure 4 normalizes the three series to 2020 = 100 so that changes measured in different units can be compared on the same scale.

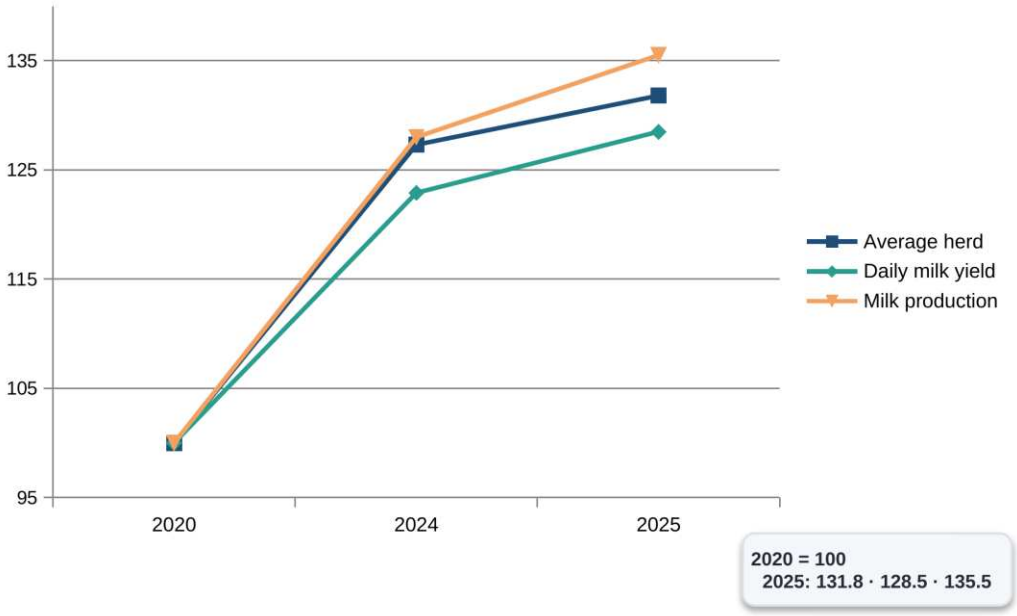


Fig. 4 Astarta livestock indicators normalized to 2020 = 100

Source: authors' calculations from Astarta Holding PLC (2021, 2025, 2026). The figure describes observed livestock-segment dynamics and is not a causal estimate of ProFeed or AgriChain Cattle.

The Astarta trend is consistent with a period in which digital livestock-management practices are documented, including ProFeed and AgriChain Cattle (AgriChain 2025). However, output growth is also mechanically affected by herd expansion, and the public sources do not provide the event-level task history, counterfactual comparison or complete transformation lineage required to isolate the digital contribution. The correct conclusion is therefore stronger than a mere description but weaker than causality: digital management and improving livestock outcomes coexist within the period, while the magnitude of the digital contribution remains unreconstructed.

Ovostar and YASENSVIT illustrate a different configuration. Ovostar's H1 egg production fell by 3.6% between 2023 and 2024, yet the number of eggs processed increased by 28.6%, lifting the processing share from 29.1% to 38.8%. The change indicates a substantial shift in product flow, but the aggregate operational reports do not identify a corresponding digital mechanism. By contrast, the YASENSVIT implementation case documents a bounded SCADA mechanism: hourly plan-versus-actual water control across 20 poultry houses. The technical process is clear, but public material does not expose alarm acknowledgement, response timestamps or a primary event log from which response effectiveness could be calculated.

KSG Agro provides the negative attribution control. Average daily gain rises from 476 to 515 g/day, an 8.19% improvement, but the same source identifies Canadian genetics as the explanation. A technology-centred narrative could still point to digital systems elsewhere in the organization; the evidence-governance rule does not allow that contextual fact to override the documented mechanism for the selected KPI. Figure 5 presents these three contrasts together because they demonstrate three distinct inference boundaries: an operational shift with no documented digital mechanism, a digital control mechanism with insufficient outcome evidence, and a positive KPI with a documented non-digital cause.

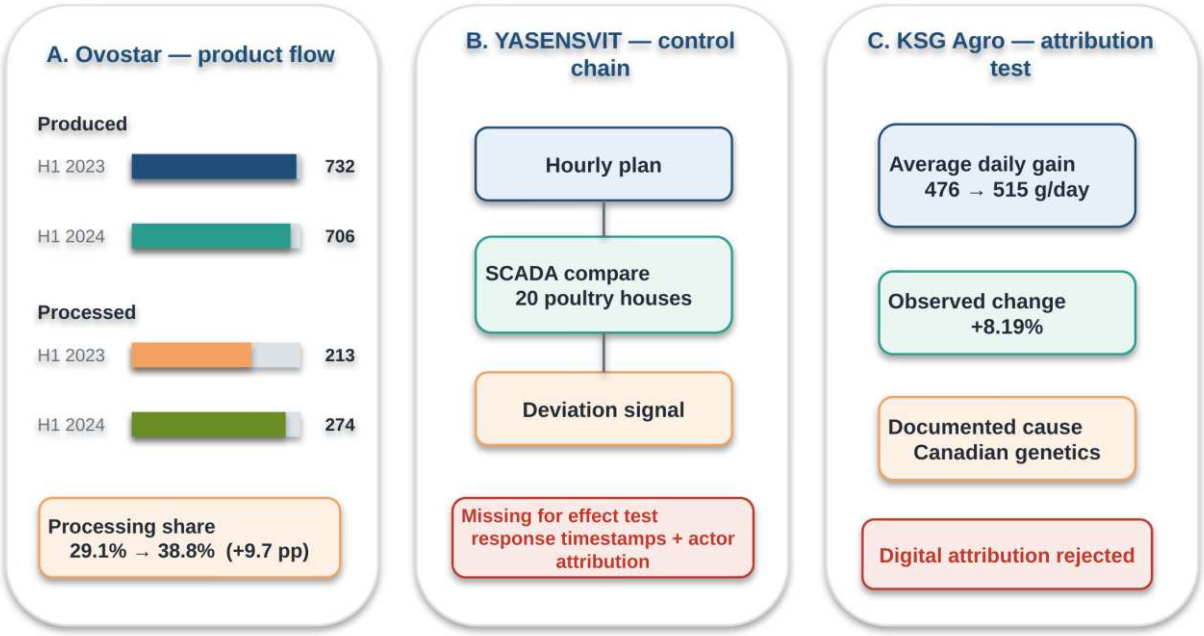


Fig. 5 Operational changes and admissible inference in three contrast cases

Source: authors' calculations and synthesis based on Ovostar Union Public Company Limited (2024a, 2024b), SV Altera (2019) and KSG Agro (n.d.).

The three panels show why observed change, digital mechanism and causal attribution must remain separate analytical questions. Ovostar shows a substantial change in product-flow structure without a documented digital cause at the reporting level; YASENSVIT shows a bounded digital-control mechanism without public response-time evidence; and KSG Agro shows a positive KPI for which the source itself documents a non-digital cause. These contrasts lead directly to the claim-level inference limits examined in Table 6.

4.4 Claim-level evidence and inference limits

The four deep cases can now be compared as claim-level evidence configurations rather than as maturity scores. Table 6 reports the material claim, strongest evidence, first missing or competing link and maximum inference supported by the documentary record. MHP is included in this comparison even though no single before/after KPI is calculated because its value lies in the opposite configuration: broad governance and traceability disclosure with limited reconstruction of one selected event-to-claim path.

Table 6 Claim-level evidence configuration and inference limits in the contrast cases

Case	Material claim	Strongest supported evidence	First missing / competing link	Maximum admissible inference
Astarta	Livestock improvement is a digital effect	Digital livestock systems + reproducible multi-year outcome series	Actor-level task history; correction history; transformation lineage	Digital mechanism and positive trend supported; causal contribution not independently reconstructable
YASENSVIT	SCADA improves water-control response	Hourly plan/actual architecture for 20 poultry houses	Alarm acknowledgement; response timestamps; actor attribution	Control architecture supported; response-effect claim not publicly auditable
MHP	Disclosed governance metrics are claim-level verifiable	Formal controls, traceability, audit context and quantitative indicators	Single event-to-claim lineage; versioned transformation rules	High disclosure and governance visibility; claim-level reconstructability not established
KSG Agro	Productivity improvement is a digital effect	515 vs 476 g/day + explicit causal explanation	Competing mechanism: genetics	Observed KPI retained; digital attribution rejected

Source: authors' claim-level analysis. Case-specific source records and coding decisions are reported in Supplementary Information 1.

The deep-case analysis confirms the non-compensatory logic of EVC. In Astarta, traceability of the digital mechanism and reproducible segment outcomes do not compensate for missing actor-level and transformation evidence when the claim is causal. In YASENSVIT, the existence of a bounded control architecture does not compensate for missing response-time evidence when the claim concerns control effectiveness. MHP shows that broad disclosure and governance context do not automatically create event-to-claim reconstructability. KSG Agro shows the strongest boundary: a positive KPI is preserved as an observation even when digital attribution is rejected. The framework therefore changes the wording and strength of the claim rather than forcing every case into a positive or negative digitalization score.

5 Discussion

5.1 Theoretical contribution

The findings clarify the theoretical role of EVC relative to BPM and digital-transformation research. Prior work correctly emphasizes process ownership, maturity, routines and measurement as conditions

for digital value creation (Butt 2020; Iden et al. 2025; vom Brocke et al. 2014). The present study adds an evidentiary layer: process governance matters not only because it coordinates work but because it determines whether the records generated by that work can support a defensible claim. This shifts the analytical question from whether a process is digital or mature to whether a selected assertion about the process can be reconstructed from accountable events and transformations. The multi-case design also clarifies why the final corpus size is analytically meaningful without being statistically representative. The 12 cases do not estimate a population parameter; they expose variation in source class, process specificity, governance disclosure and causal ambiguity. The seven external replications test whether the documentary fields travel across more formal reporting contexts, while the five Ukrainian core cases preserve more process-specific heterogeneity. What matters for the theory is not convergence on one average score but whether the framework behaves coherently across these different evidence configurations. The negative and incomplete cases are therefore as informative as the evidence-rich cases.

The study also narrows the contribution of provenance, process mining and technology-centred traceability. Provenance and event logs clearly increase verification potential (Appelbaum 2016; Chiu et al. 2026; Jans et al. 2013; Moreau et al. 2015; Mugwira et al. 2026), and distributed technologies can strengthen integrity and cross-actor traceability (Casino et al. 2019; Rejeb et al. 2019; Saberi et al. 2019). The case analysis shows why these mechanisms are enabling conditions rather than sufficient evidence. A protected history can retain a wrong source observation; a complete event log can be aggregated into a KPI whose transformation rule is undocumented; and a traceable process can still support only a descriptive claim if a causal alternative remains uncontrolled. The relationship with outcome verifiability is upstream rather than competing. Oh (2026) explains why verifiability of sustainability outcomes affects stakeholder responses. EVC explains how an organization constructs the process evidence that makes such corroboration possible before the outcome reaches the stakeholder. This distinction is important because the public cases show that outcome visibility can be high while direct responsibility and audit evidence remain lower. The 41.7 percentage-point gap between KPI visibility and strict responsibility/auditability evidence quantifies that upstream bottleneck in the present corpus. Finally, the framework connects evidence architecture to information economics. The relevant managerial cost is not simply data collection but the search, reconciliation and challenge effort required when the origin and derivation of a claim are unclear. Akerlof's (1970) information-asymmetry mechanism and Spence's (1973) signaling logic therefore apply at the level of process evidence: evidence that can be independently reconstructed is less costly to verify and more difficult to support through assertion alone. This does not imply that EVC eliminates trust problems; it specifies one organizational mechanism through which verifiable evidence can reduce a particular form of uncertainty.

5.2 Managerial implications: evidence by design

For managers, the central implication is to design evidence from the claim backward. The starting point should be the decision, KPI, supplier assertion or disclosure that must withstand challenge, not the technology that is available. The evidence design then specifies the originating event, accountable actor or system, source record, transformation rules, correction history, retention requirement and verification path. Technology selection follows this evidentiary design: digital identity is useful when attribution is weak; provenance and versioning matter when calculation chains are opaque; interoperability matters when evidence crosses organizational boundaries; and source validation remains essential when sensing or manual entry can be wrong.

The case calculations illustrate why this approach changes investment priorities. For Astarta, another performance dashboard would add little evidentiary value unless actor-level task and transformation

histories are retained for the claim being assessed. For YASENSVIT, the next evidentiary step is to preserve alarm acknowledgments and response timestamps so that a documented control architecture can be evaluated as a response process. For MHP, claim-level source mapping would connect broad governance disclosure to the operational records behind a selected metric. These are targeted evidence-governance investments rather than generic digitalization investments.

A second practical implication is the preservation of negative evidence. KSG Agro demonstrates why governance systems should retain documented alternative causes rather than treat every improving KPI as confirmation of a digital initiative. In project evaluation, this means maintaining a change register that records parallel operational, biological, organizational and market changes alongside the digital intervention. Such evidence is valuable because a credible evaluation system must be able to reject an attractive explanation when the documentary chain does not support it.

5.3 Agri-food and regulatory implications

The agri-food context makes evidence governance particularly salient because claims often connect physical events to digital records across several organizations. Food traceability requirements under Regulation (EC) No 178/2002 and official controls under Regulation (EU) 2017/625 establish sector-specific accountability foundations, but they do not prescribe a single digital architecture (European Parliament and Council 2002, 2017). Likewise, the Ecodesign for Sustainable Products Regulation, Regulation (EU) 2024/1781, establishes the Digital Product Passport for relevant products while excluding food and feed from its scope. Treating DPP as a general legal basis for food traceability would therefore be incorrect.

Other EU digital instruments create adjacent accountability contexts rather than one unified TrustTech mandate. NIS2, Directive (EU) 2022/2555, addresses cybersecurity and resilience; Regulation (EU) 2024/1183 establishes the European Digital Identity Framework; Regulation (EU) 2024/1689 establishes risk-based AI obligations; and corporate sustainability reporting is governed through Directive (EU) 2022/2464 as amended, including Directive (EU) 2026/470, with ESRS specified through delegated regulations (European Commission 2023, 2026; European Parliament and Council 2022a, 2022b, 2024a, 2024b, 2024c, 2026). The relevance of these instruments to EVC lies in the accountability conditions they create – identity, security, reporting and auditability – not in a claim that they mandate one evidence technology.

This interpretation also extends earlier work on ICT-enabled implementation of EU sustainability values in Ukraine (Lysenko and Makovoz 2025). Digital infrastructure can support responsible governance only where material claims remain reconstructable from process evidence. For exporters and agri-food firms operating under multiple reporting regimes, the strategic requirement is therefore interoperability of evidence definitions and identifiers, not merely interoperability of software interfaces.

6 Limitations and future research

The study has five principal limitations. First, the conceptual synthesis is purposive rather than systematic. Its function is theory building and construct delimitation, not estimation of the prevalence of positions in literature. Supplementary Information 1 reports the source-to-construct mapping used in conceptual synthesis.

Second, the case evidence is documentary and public. Official reports are stronger than promotional material for formal disclosures, but even audited or regulated documents can aggregate away event-level evidence. Internal logs may contain stronger attribution, provenance and audit evidence than public

materials reveal. Consequently, 'not established' in this study means not established from the reviewed public record, not absent inside the organization.

Third, the 12-case corpus is purposive and bounded. It is suitable for analytical replication and diagnostic contrast but not for statistical generalization. The sharp subgroup difference in responsibility/auditability evidence is especially sensitive to source composition because the external replication group relies heavily on formal annual and sustainability reporting. Future studies should construct matched cross-country samples using comparable document classes before interpreting such differences institutionally.

Fourth, coding followed predefined rules and a sensitivity analysis but was not independently duplicated by a second coder; no inter-rater statistic is therefore reported. Future replication should test coding agreement and refine operational definitions of partial versus direct claim-level evidence.

Fifth, the study does not estimate the causal effect of EVC on verification cost, assurance hours or decision quality. A next research program should use privileged internal event logs to operationalize authenticated-event coverage, lineage completeness, protected-log coverage, trace completeness, reconstruction success and audit retrieval time. These measures can then be related to actual verification effort while controlling for claim complexity and organizational context.

7 Conclusion

This study addresses a practical and theoretical problem created by digital transformation: organizations generate more process data than ever before, yet consequential business claims often remain difficult to verify. The answer to RQ1 is that digital records become defensible evidence only when process governance and evidence controls preserve a complete enough event-to-claim chain for the selected assertion. EVC captures that organizational capability through attribution, provenance, integrity, traceability, reconstructability and auditability. The properties are formative and non-compensatory because the evidentiary requirement depends on the claim: a missing claim-critical link cannot be repaired by strength elsewhere.

The answer to RQ2 is empirical and diagnostic. Across the 12-case corpus, process outcomes are the most visible evidence: 12/12 cases expose a KPI or operational result. Direct evidence of a mechanism and traceability/control appears in 9/12 cases, while direct responsibility/auditability evidence appears in 7/12. Treating partial evidence as sufficient increases most fields to 11/12, which shows that broad governance information is common, but claim-level reconstruction is less consistently available. The difference is important because the strength of a business claim depends not on the amount of surrounding documentation but on whether the specific chain can be reproduced.

The operational calculations make the inference boundary concrete. Astarta's 2020–2025 livestock indicators show substantial growth – 31.8% in average herd, 28.5% in daily milk yield and 35.5% in milk production – but the public record does not isolate the digital contribution from scale and other concurrent changes. Ovostar's H1 processing share rises by 9.7 percentage points, but the aggregate source does not establish a digital mechanism for the shift. YASENSVIT documents a bounded SCADA control architecture across 20 poultry houses, yet the absence of response timestamps prevents evaluation of response effectiveness. KSG Agro shows the opposite boundary: a positive 8.19% productivity difference is retained as an operational observation while digital attribution is rejected because genetics is the documented mechanism.

The broader contribution is to shift evidence governance from a technology-list problem to a claim-design problem. For management research, this links process governance and data controls to verification effort and information asymmetry. For practice, it suggests an evidence-by-design workflow: define the material claim, identify the originating event and accountable actor, preserve source and transformation history, retain corrections and exceptions, and only then select the technical controls needed to protect the chain. For agri-food and sustainability governance, the implication is equally direct: disclosure, traceability and secure records are valuable, but they become defensible evidence only when the underlying claim remains independently reconstructable.

Statements and Declarations

Data availability

The study uses publicly available corporate reports, operational updates and implementation materials cited in the reference list. Supplementary Information 1 contains the case-selection criteria, source hierarchy, full 12-case coding matrix, reproducible calculations, deep-case evidence records and regulatory-source verification.

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Author contributions

Sergii Lysenko led the conceptual development, source collection, documentary case analysis, framework operationalization and manuscript drafting. Oksana Makovoz contributed conceptual refinement, supervision, interpretation and critical revision of the manuscript. Both authors reviewed and approved the final manuscript and accept responsibility for its content.

Competing interests

The authors declare that they have no relevant financial or non-financial interests to disclose.

Ethics approval

Not applicable. The study uses publicly available documentary sources and does not involve human participants or animals as research subjects.

Consent to participate and consent for publication

Not applicable.

Declaration of generative AI use

OpenAI ChatGPT was used under author supervision for language editing, structural refinement and editorial drafting support based on author-developed research materials. It was not used to select the case corpus, create or code case evidence, perform calculations, determine legal applicability, or decide the study conclusions. All sources, coding decisions, calculations, legal references, interpretations and final wording were reviewed and approved by the authors, who take full responsibility for the manuscript.

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