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Designing Explainable Digital Decision Systems for Venture Evaluation and Public Funding: A Socio-Technical Design-Science Study

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Abstract

Decision-making in venture finance and public funding occurs under conditions of extreme uncertainty, incomplete information, and high institutional accountability. Although digital and algorithmic tools are increasingly adopted to support such decisions, evaluation processes remain opaque, inconsistent, and difficult to justify ex post. Insights are presented in this research derived from a longitudinal design-science research program conducted through VentureSense, which functioned as an applied research environment for studying digital decision systems across private investment and public funding contexts. Using a socio-technical Information Systems perspective, recurring structural limitations were identified across multiple decision-support systems, including venture evaluation, public grant assessment, contextual intelligence, and trust verification frameworks. Rather than proposing new predictive algorithms, a layered design framework is advanced for explainable digital decision systems that integrates evaluation logic, human–system interaction, workflow governance, and institutional accountability. The findings contribute to Information Systems research by reframing explainability as a core design property of decision systems and by offering analytically grounded design principles applicable to both private and public funding institutions.

Keywords: Information Systems, Design-Science Research, Explainable Decision Systems, Venture Evaluation, Algorithmic Governance

1. Introduction

Early-stage funding decisions made by venture capital firms, accelerators, banks, and government agencies significantly influence innovation outcomes, economic development, and institutional credibility. Despite their importance, it is observed that these decisions remain among the least structured organizational processes. Evaluators typically operate under conditions of incomplete data, qualitative ambiguity, and time pressure, relying heavily on intuition and informal heuristics.

The growing adoption of digital decision-support tools has not fully resolved these challenges. While algorithmic systems promise efficiency and objectivity, they frequently introduce new concerns related to opacity, lack of explainability, and weak governance [3]. In public funding environments, such deficiencies undermine auditability and accountability, whereas in private investment contexts they erode trust among stakeholders.

This study argues that the principal limitation of existing digital evaluation systems lies not in predictive capability but in design orientation. Most systems are developed as scoring or ranking tools, whereas funding decisions are inherently socio-technical processes shaped by human judgment, institutional norms, accountability requirements, and narrative interpretation [5]. Accordingly, this research addresses the following question: How should digital decision systems be designed to enable transparent, consistent, and explainable venture evaluation and public funding decisions under uncertainty?

2. Research Context and System Background

The research is grounded in a longitudinal design-science program conducted through VentureSense, which operated as an applied research laboratory rather than a purely commercial platform. Across multiple conceptual prototypes, systematic observation of evaluator behavior, workflow breakdowns, and institutional constraints was enabled across private and public funding environments.

2.1 VentureSense System Ecosystem

Vencore Engine (Venture Evaluation and Core Optimization Reasoning Engine): Revealed substantial variance in evaluator judgments across identical venture cases, exposing the absence of standardized reasoning structures.

Nirnae (Neural Intelligence and Resource Network for Assessment and Evaluation): Revealed governance gaps in public grant evaluations, particularly concerning traceability and decision justification.

Chetra (Cognitive Heuristic Engine for Trends, Reports and Analytics): Demonstrated the influence of external contextual signals on evaluation outcomes despite their exclusion from formal scoring logic.

Foresy8 (Forward Observations and Reports for Economic Strategy and Yield): Exposed the role of narrative and media signals in shaping evaluator intuition.

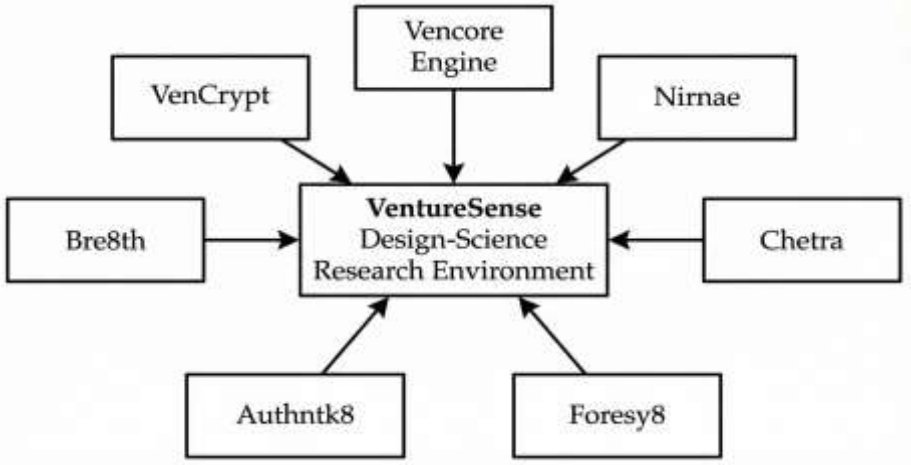
Authntk8 (Authentication Neural Trust Kernel): Identified accountability failures in multi-reviewer workflows.

Bre8th (Behavioral and Environmental Intelligence Through Holistic Technology): Illustrated the impact of environmental and locational factors on perceived venture viability.

VenCrypt (Venture Cryptographic Intelligence Platform): Demonstrated that explanation clarity significantly affects user trust independent of analytical complexity.

Across these systems, recurring deficiencies were observed in explainability, workflow transparency, governance, and human–system interaction.

Figure 1: VentureSense System Ecosystem As A Design-Science Research Context

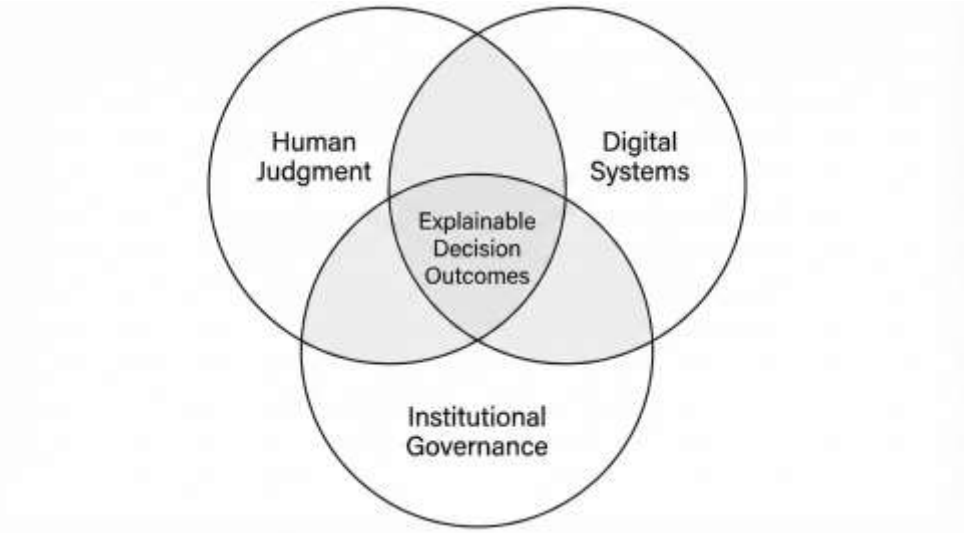


Across these systems, the observed limitations were not attributable to data insufficiency or algorithmic complexity, but rather to the absence of explicit reasoning structures, explainability mechanisms, and governance-aware workflows. This pattern suggests that the core challenge in digital funding decisions is architectural and socio-technical rather than computational.

3. Theoretical Foundation

This study is positioned at the intersection of established Information Systems research streams, including design-science research, socio-technical systems theory, algorithmic governance, human–algorithm interaction, and decision support systems. While existing literature emphasizes predictive accuracy and automation, limited attention has been given to the design of explainable and governable decision systems in high-uncertainty funding contexts.

Figure 2: Explainability As A Socio-Technical Construct



4. Research Methodology A Design-Science Research methodology was employed [1, 2].

4.1 Design Objectives

- Improve transparency and interpretability of decisions
- Reduce evaluator inconsistency
- Enable post-decision accountability
- Support, rather than replace, human judgment

4.2 Artefact Development Conceptual artefacts were developed, including evaluation logic maps, explanation templates, workflow governance structures, and accountability layers.

4.3 Evaluation Approach Artefacts were evaluated through reflective practitioner analysis, cross-system comparison, consistency checks, and alignment with institutional governance requirements.

This approach aligns with established Design-Science Research guidelines emphasizing artefact relevance, rigor, and theoretical contribution [1,2].

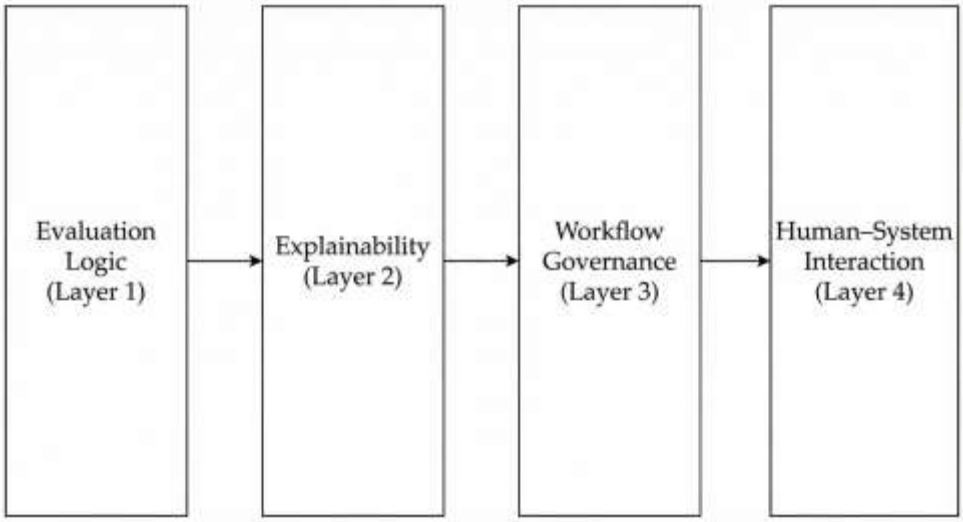
5. Proposed Explainable Decision System Framework The study proposes a four-layer framework:

1. **Evaluation Logic Layer:** Explicit criteria and rationale
2. **Explainability Layer:** Human-interpretable reasoning outputs

3. **Workflow Governance Layer:** Traceability and accountability
4. **Human–System Interaction Layer:** Trust and adoption mechanisms

This structure positions explainability as a foundational design requirement.

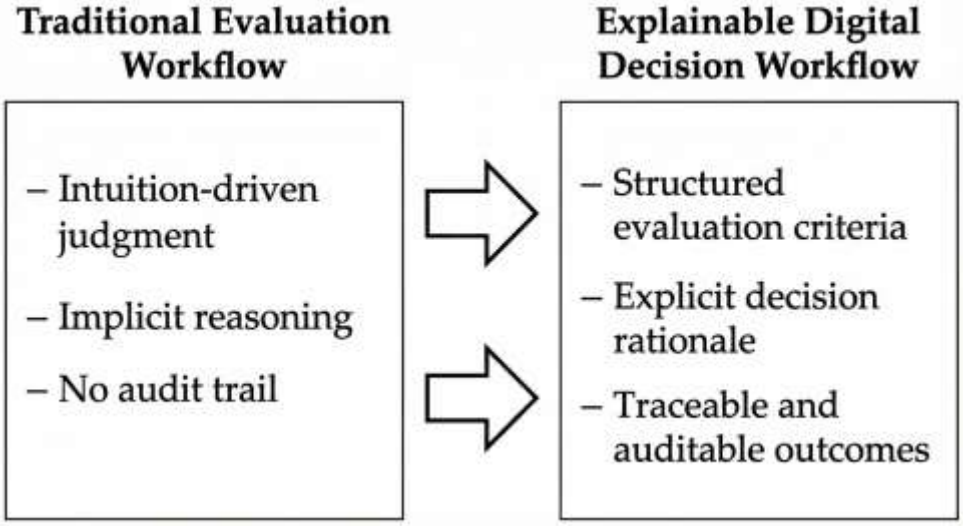
Figure 3: Layered Framework For Explainable Digital Decision Systems



6. Practical Implications

For venture capital and private investors, the framework improves internal alignment and transparency toward founders. For public funding agencies, it supports defensible and auditable decisions. For system designers, it encourages governance-aware, explanation-centric system development.

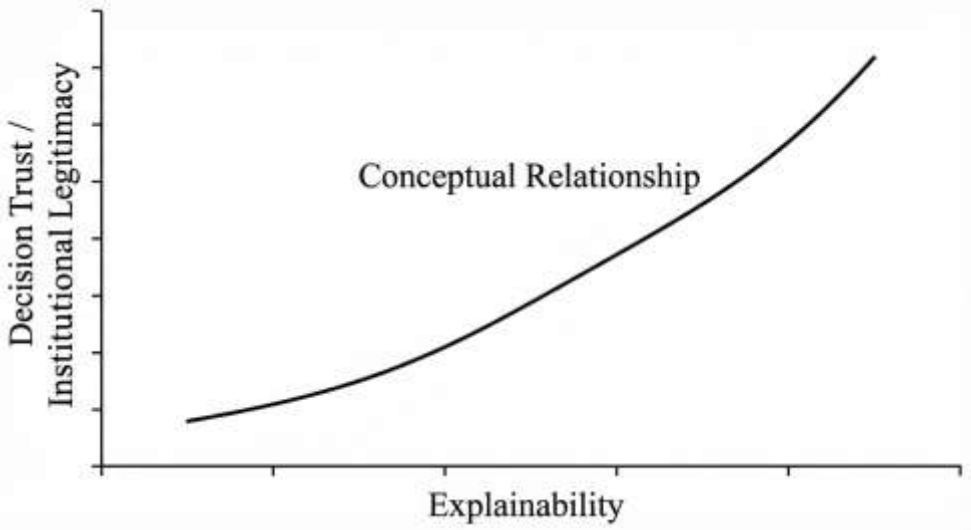
Figure 4: Comparison Of Traditional And Explainable Digital Decision Workflows



7. Theoretical Contributions

This research contributes by extending design-science research into high-uncertainty funding contexts, reconceptualizing explainability as a socio-technical property, and bridging private and public decision-system design.

Figure 5: Conceptual Relationship Between Explainability And Decision Trust



8. Limitations and Future Research

The study is conceptual and design-oriented rather than statistically empirical. Future research should empirically validate the framework across institutional contexts and examine long-term adoption effects.

9. Conclusion

As digital systems increasingly mediate capital allocation, their legitimacy depends less on analytical sophistication and more on explainability, governance, and trust. This research demonstrates that effective funding decision systems must be designed as socio-technical artefacts embedded within institutional contexts. The proposed framework offers a principled pathway toward transparent and accountable funding decisions.

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