NOMIS Beyond Modelling: Towards Business-Centred Adaptable Information Systems

José Cordeiro[1,2,*]

[1] *Universidade Politécnica de Setúbal, Escola Superior de Tecnologia de Setúbal, Campus do IPS - Estefanilha, 2910-761 Setúbal, Portugal*
[2] *DICE Lab/Centro ALGORITMI, University of Minho, Campus Azurém, 4800-058 Guimarães, Portugal*

Abstract

Information systems are intended to support organisational work, yet assumptions embedded in interfaces, workflows, program structures and database schemas may constrain how that work is performed and changed. This position paper argues that adaptable information systems should preserve business actors' autonomy over organisational meaning and action within justified organisational, legal, security, integrity and physical constraints. Building on NOMIS, a human-centred modelling approach centred on observable Human Actions, the paper develops a business-centred design direction in which organisational concepts remain explicit and retain their continuity while the technical mechanisms that support and represent them evolve. Processes express possible courses of Human Actions, Environmental States identify selected organisational conditions that enable or constrain action, and Activities are explored as situated contexts extending their established compositional role. The paper also proposes an exploratory separation between an explicit NOMIS business description, defined and revised under organisational authority, and responsibilities for interaction, application support, semantic and model support, and technical infrastructure. Persistent identity, multiple representations and temporality are examined as complementary means of preserving organisational continuity and history across technical change. The Vortex Combat case provides initial implementation-based evidence for selected mappings only: selected Human Actions can remain explicit as application-level use cases or services and selected Environmental State checks as Specifications or validation objects. The resulting principles define a research agenda for business-centred adaptable information systems, not a completed reference architecture or model-to-code framework.

Keywords

Human-centred information systems; socio-technical systems; NOMIS; adaptable information systems; Human Actions; Environmental States; business-centred design; conceptual traceability.

1. Introduction

Information systems are intended to support organisational work, yet the technical structures through which that support is delivered can constrain how work is performed and changed. Assumptions about business practice become embedded in interfaces, workflows, program structures and database schemas. When practices evolve, actors may be required to

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* Corresponding author.
jose.cordeiro@estsetubal.ips.pt (J. Cordeiro)
0000-0001-9071-8873 (J. Cordeiro)
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accommodate existing technical arrangements. This is a socio-technical problem: organisational work depends on people interpreting situations and deciding how to act, while computer-based support formalises selected aspects of that work [1]–[3]. Socio-technical design has long emphasised the joint consideration of human, organisational and technical concerns, including in contexts of continuing organisational and technological change [4].

This paper argues that adaptable information systems should preserve business actors' autonomy over organisational meaning and action. Such autonomy is exercised within organisational, legal, security, integrity and physical constraints. Computer-based systems should provide the information, services and infrastructure needed to support Human Actions and enforce constraints whose technical implementation has been explicitly justified through an organisational decision, without converting contingent organisational expectations into compulsory technical behaviour.

NOMIS—NOrmative Modelling of Information Systems—is a human-centred modelling approach grounded in Human Relativism and centred on *human observable actions* [5], [6]. It regards an information system primarily as a human activity system that may be supported by computer technology. This perspective is consistent with approaches that distinguish technical data processing from the human interpretation through which data acquire informational meaning in organisational contexts [7]. Human Actions, the central concept of NOMIS, identify what organisational actors do and connect their work to the information and services through which it may be supported. Environmental States represent selected, relatively stable organisational conditions that enable or constrain Human Actions, while Activities group related Human Actions [5], [8].

Building on established NOMIS work and recent implementation experience, this paper develops a business-centred direction for adaptable information systems. Processes are understood as possible courses of Human Actions. Environmental States are treated as organisational conditions distinct from their informational evidence and from the mechanisms used to evaluate whether those conditions hold. Activities are explored as situated organisational contexts extending their established compositional role. The paper also outlines an exploratory separation between an explicit NOMIS business description defined and revised under organisational authority and responsibilities for interaction, application support, semantic and model support, and technical infrastructure. At the persistence level, persistent identity, multiple representations and temporality are examined as complementary means of preserving organisational continuity while technical representations evolve.

The Vortex Combat case provides initial implementation-based evidence for only part of this direction: selected Human Actions remained explicit as application use cases or services, and checks associated with selected Environmental States remained explicit as Specifications or validation objects [9]. The case does not validate the architectural separation, the situated interpretation of Activities or the persistence direction. The unifying contribution is a design direction for keeping business concepts explicit and preserving their continuity while the technical mechanisms that support and represent them evolve. It defines a research agenda, not a completed reference architecture or model-to-code framework.

Section 2 distinguishes established NOMIS concepts, earlier implementation directions and current implementation-based evidence. Sections 3–5 develop the business-centred perspective; Sections 6 and 7 examine architectural and persistence implications; and Sections 8 and 9 present the design principles, research agenda and conclusions.

2. From NOMIS Modelling to Adaptable Information Systems

NOMIS models information systems from the perspective of *human observable action*. Its foundation in Human Relativism distinguishes perception from interpretation and uses observability as a basis for greater precision [5], [6]. Its conceptual development also integrates selected contributions from Organisational Semiotics, the Theory of Organised Activity and Enterprise Ontology/DEMO [10]–[12]. Human Actions are performed by Actors and may involve Bodies, which are physical things in NOMIS. Information Items concern the information used or produced in Human Actions; this information becomes available through the interpretation of observable data representations [5], [8]. This distinction between information and its data representations is consistent with the infological view that data belong to the technical domain while information depends on interpretation within an organisational and user context [13].

NOMIS organises these elements through four complementary views. **The Interaction View** addresses communication and interaction between human actors. **The Physical View** concerns Human Actions, their relationships with Bodies, and their organisation into Activities and processes. **The Information View** considers the information required, accessed or produced in Human Actions. **The State View** represents Environmental States and their existential dependencies, capturing organisational conditions that enable or constrain Human Actions. **Norms** complement the four views by expressing expected patterns of human action without determining how actors will behave [5], [8]. The resulting views constitute a NOMIS synthesis of these theoretical influences under Human Relativism, integrating their contributions into a coherent human-centred modelling approach.

Earlier work explored how NOMIS models could inform computer-based support. An e-learning prototype separated interaction, application functionality and business information through an Interface System and NOMIS Middleware, but the models guided implementation mainly through manual interpretation [8]. A subsequent Model-Driven Systems Development proposal connected Human Actions to system services and outlined transformations for interface support, persistence, state handling and Norms [14]. These works established implementation directions without providing a validated transformation framework.

The Vortex Combat case subsequently examined candidate mappings between selected NOMIS artefacts and software structures. The clearest correspondences were between selected Human Actions and application-level use cases or services, and between checks associated with selected Environmental States and named Specifications or validation objects [9]. Mappings involving Bodies, Information Items, Actor roles, Norms, existential dependencies and persistence remained partial or open. The software architecture provided a practical setting for examining conceptual traceability; it was not evaluated as an architecture for NOMIS-based systems [9]. The following sections therefore use the case as evidence for selected mappings while treating the broader conceptual, architectural and persistence directions as exploratory.

3. Business Autonomy and Technical Support

Business autonomy concerns organisational authority over the interpretation of situations and the selection of action. Organisational actors assume or negotiate responsibilities and decide how to act within the constraints applicable to their work. Computer-based systems may inform

those decisions, make capabilities available and enforce explicitly justified constraints. Expected organisational practice should remain guidance unless a corresponding organisational, legal, security, integrity or physical requirement calls for technical enforcement [1]–[3].

Technical support may capture, generate, transform, maintain, retrieve and communicate data, and provide the information, services and resources needed for Human Actions. The central issue is whether decisions about organisational work remain explicit and governable. An interface, workflow or program structure should not become organisational policy merely because it offers a convenient technical implementation. In particular, implementing a Norm as compulsory control flow requires an explicit and accountable organisational decision that the expected behaviour must be enforced. Expressing a Norm at business level does not by itself make that decision: the Norm may remain guidance for human action rather than a compulsory technical restriction.

The boundary between the business and technical domains is therefore primarily semantic. An explicit NOMIS business description identifies Human Actions, Actors and roles, Bodies, Information Items, Environmental States, Norms and Activities. Making these concepts explicit provides observable representations that organisational participants can examine, discuss and revise. Technical mechanisms present, process, store, communicate and protect representations of those elements. Their organisational meaning can remain stable while particular interfaces, services, code structures or persistence schemas change, provided that the relationships between the business description and its technical support remain explicit and traceable [5], [8]. Changes in organisational meaning or practice should be represented in the business description and subsequently reflected in the supporting mechanisms.

This separation also entails a division of responsibilities. Organisational actors and those responsible for governing the work define its meaning, relevant conditions, expected practices and enforceable constraints. Technical specialists design and maintain the corresponding services, representations and infrastructure, while interaction specialists adapt interaction mechanisms to organisational language and work contexts. These responsibilities interact: technical designs affect which actions and information are available and may reveal unresolved organisational decisions. Making their relationship explicit allows such decisions to be examined and revised instead of remaining dispersed across technical structures.

This position is consistent with the broader socio-technical tradition, exemplified by approaches such as ETHICS, which emphasise the joint consideration of human, organisational and technical concerns in information systems development [4], [15]. The NOMIS direction developed here treats business autonomy as a continuing socio-technical concern, extending this joint consideration beyond the design phase through an explicit and revisable relationship between organisational work and computer-based support throughout system use and evolution.

4. Human Actions, Processes and Environmental States

Business processes in NOMIS are modelled as sequences of Human Actions [5], [16]. A modelled sequence expresses a possible or expected course of action. Actors may interpret circumstances, depart from that course or select another action, within applicable constraints and Norms. The process model therefore describes organisational possibilities and expectations; it does not define compulsory execution.

Environmental States shift attention from courses of action to organisational conditions. An Environmental State is a selected, relatively stable condition represented through a configuration of relevant NOMIS elements and their states. Its definition may involve Actors, Bodies, Information Items and other Environmental States connected through existential dependencies. Different courses of Human Actions may establish the same Environmental State, and a state that holds may enable several Human Actions. Its organisational significance can therefore survive changes in the processes used to establish it [5], [16].

Selecting Environmental States requires judgement. States associated only with the operation of a particular application, such as a form being empty, partially completed or displayed, need not represent organisational conditions. An Environmental State should be selected when it is meaningful in the business domain, sufficiently stable for the modelling purpose and consequential for available Human Actions. It holds while the relevant elements, states and existential dependencies that define it continue to hold.

For computer-based support, the organisational condition, its definition, the available evidence and the evaluation mechanism must remain distinguishable. The Environmental State names the condition of interest. Its definition identifies the NOMIS elements, states and dependencies on which the condition relies. Evidence consists of data stored by the system, derived from several representations or obtained externally. Such evidence reflects what is available to the supporting system and may be incomplete, outdated or inconsistent with the organisational situation it is intended to represent. An evaluation mechanism examines that evidence and determines whether the supporting system treats the condition as holding. Because the evidential basis and its relation to the Environmental State remain explicit, organisational actors can identify discrepancies and, when appropriate, correct the underlying data or revise the relevant mappings or business definitions. Database fields, queries and program predicates may participate in this evaluation, but none of them alone constitutes the Environmental State.

The Vortex Combat case investigated this distinction in the attendance-registration scenario. Registering attendance was modelled as a Human Action performed by a master instructor and required Environmental States indicating that the workout had been scheduled and that the student was enrolled. The corresponding back-end use case evaluated these conditions before recording attendance. Named Specifications or validation objects made the checks explicit, inspectable and traceable to the Environmental States represented in the Existential Dependency Diagram [9]. The implementation therefore provides initial evidence for explicit Environmental State checks; the state definitions themselves remained in application code.

This paper explores a further step: representing Environmental State definitions as explicit business-level artefacts that can be evaluated against persistent, derived or externally obtained evidence. This remains an open architectural and model-driven development problem. It requires a representation for state definitions, links between definitions and evidence, mechanisms for evaluating dependencies, and business-governed evolution of definitions without requiring every change to be compiled into the supporting application.

5. Activities as Situated Business Contexts

In established NOMIS work, an Activity is a composition of related Human Actions [8]. This paper explores whether the same construct can also delimit a situated context for a recognisable

area of organisational work. This interpretation preserves the compositional structure while relating Human Actions to the circumstances in which they are performed and supported.

An Activity context may associate the Actors and roles involved, the relevant Human Actions, the Bodies and Information Items used or produced, the applicable Norms, and the Environmental States that characterise the work situation. These elements need not be exclusive to one Activity. The same Actor, Body, Information Item or Environmental State may participate in several Activities, with different relationships, responsibilities and relevance in each context. Activities may also be related hierarchically, allowing broader and more specific contexts to coexist and share selected elements.

Processes, Environmental States and Activities serve different purposes. A process expresses a possible course of Human Actions, an Environmental State expresses a condition that enables or constrains action, and an Activity would delimit the organisational scope in which these elements are considered together. An Interface System could use that scope, together with the Actor, role and relevant Environmental States, to make relevant Human Actions and information available. NOMIS semantic and model support could link the interaction mechanisms and application services to the corresponding business elements.

Earlier NOMIS work associated Activities with interface contexts and proposed using Activities and Human Actions to inform interface support [8], [14]. The earlier e-learning prototype also represented activity–subactivity relationships for partial context sharing and treated roles as dependent on the Activity context, allowing the same person to assume different roles in different Activities [8]. These antecedents did not validate the situated interpretation explored here. In the Vortex Combat case, related interactions were grouped in the interface layer, but Activities were not implemented as explicit situated business contexts [9].

This extension requires criteria for delimiting Activities, representing shared elements and overlapping contexts, determining which Activities are relevant in a work situation, and refining the corresponding relationships in the NOMIS metamodel. It must also address how hierarchy, authority, division of labour and conflicting interpretations influence the definition and evolution of Activity contexts. Where contexts overlap or conflict, their interpretation and reconciliation should remain organisational concerns rather than predefined technical resolutions. Further implementations must assess whether explicit Activity contexts improve adaptability, interaction support and conceptual traceability while leaving organisational interpretation and action selection with business actors.

6. A Business-Centred NOMIS Architecture

Figure 1 presents an exploratory separation between an explicit NOMIS business description and four technical responsibilities: interaction, application support, semantic and model support, and infrastructure. It also distinguishes two continuing organisational relationships: organisational actors and governance define and revise the business description, while actors use and interact with computer-based support. The connections express semantic association and responsibility; they do not prescribe control flow or a particular layering, topology, component structure or deployment. Following the general principle of localising design decisions [17], the separation seeks to limit the impact of changes in particular technical mechanisms.

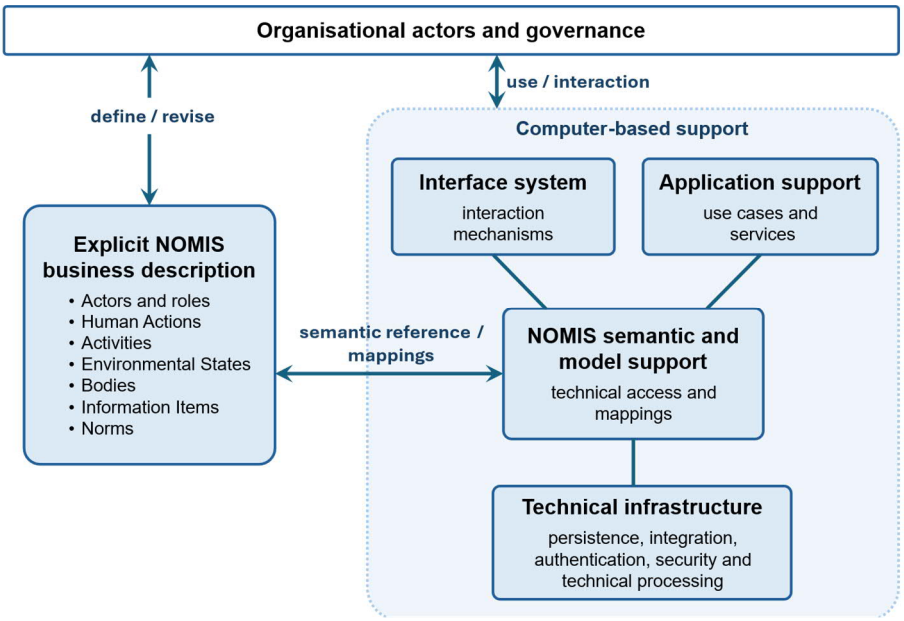


Figure 1: Exploratory separation of organisational governance, the explicit NOMIS business description and computer-based support responsibilities.

The explicit NOMIS business description contains Human Actions, Environmental States, Activities, Actors and roles, Bodies, Information Items and Norms, together with their relationships. It provides the semantic reference for the computer-based support and for tracing technical artefacts to organisational work. As organisational work evolves, the description remains subject to definition and revision under organisational authority, with corresponding technical mappings adapted as required.

The Interface System manages interaction with business actors. It may use the Actor, role, Activity context and relevant Environmental States to present Human Actions and information through different interaction mechanisms. Alternative interfaces can use the same business definitions and supporting services.

Application support provides use cases or services for selected Human Actions and coordinates the technical operations needed to support them. It may request the evaluation of relevant Environmental States before completing those operations. Interface events remain distinguishable from Human Actions. The Vortex Combat case offers initial evidence only for this part of the direction: selected Human Actions were implemented as application-level use cases or services, and selected Environmental State checks as named Specifications or validation objects [9].

NOMIS semantic and model support provides technical access to business definitions and relationships and maintains mappings from them to interaction mechanisms, application services and evidential representations. Earlier work assigned some of these functions to NOMIS Middleware [8], [14]. In this paper, NOMIS Middleware denotes an architectural responsibility that may be distributed across components or services. Its internal structure and implementation remain open.

Technical infrastructure supplies persistence and data representations, communication, integration, authentication, security and technical processing. Changes to these mechanisms should preserve traceability to the corresponding business elements and relationships. Section 7 examines persistent identity, multiple representations and temporality as one possible basis for that continuity.

7. Flexible Representation and System Evolution

The continuity of an organisational element should not depend on a particular record, schema or data format. This section explores three complementary characteristics for representation and persistence: persistent identity, multiple representations and temporality. They define a design direction in which storage technologies and concrete schemas remain open. Their use is justified where organisational continuity, history or traceability must be preserved.

Organisational identity results from decisions made within the business domain. Once such a decision has been made, a persistent identifier records it in the computer-based system and provides a stable reference across technical changes. Different names, attributes, locations or domain identifiers may therefore be associated with the same organisational element over time. Matching values alone do not establish common identity, and a change in values does not necessarily indicate a different element.

Multiple representations allow the same Actor, Body or other organisational element to be described in several forms. These may coexist for different purposes or succeed one another as requirements change. They may differ in structure, granularity, source or format while remaining associated with the same organisational element. Representation-specific structures may retain their own integrity constraints and be optimised for particular technical purposes; a universal or schema-free repository is not required.

Temporality qualifies representations, classifications, compositions and relationships across time. Earlier NOMIS work used starting and finishing timestamps to retain successive database records and associations [8]. The mechanism considered here is primarily transaction-time-oriented: it preserves what the system treated as current and when. The organisational period to which a change applies may be recorded separately as an effective date, corresponding to the valid-time dimension recognised in temporal data management [18]. An earlier effective date does not automatically alter the system's previous records or the consequences of actions already supported. Retrospective corrections or compensations require explicit organisational decisions and traceable implementation.

Consider an Actor whose name changes in January, with the change entered in March. The new representation becomes current in the system when the March update is recorded, while January may also be stored as its organisational effective date. Documents, decisions and relationships created before the update remain as recorded unless the organisation decides that particular effects require correction. The same principle applies when the earlier name was entered inaccurately: the system preserves what was recorded and used, while an explicit decision identifies which records or dependent elements must be corrected. The Actor's address may also be represented as a single line in one context and as separately structured components in another.

Environmental States require a similar separation. Their business definitions identify the relevant organisational elements, states, dependencies and evidential requirements. Separate

mappings connect these requirements to concrete data representations, queries or external sources. When an evidential source changes but the organisational condition retains the same meaning, the mapping can change without redefining the Environmental State. A change to the condition's meaning or evidential requirements calls for the business definition to be versioned or replaced, according to whether organisational continuity is recognised. The same principle applies to Activity contexts: subsequent changes to their definition or classification should not silently rewrite the context in which past Human Actions were recorded.

The earlier NOMIS Middleware separated a person from the records containing personal information and used GUIDs and temporal associations to preserve references across structural changes [8]. NOMIS-MDSD subsequently identified the persistence and evolution of Bodies, Information Items, Activities, Human Actions and states as an open transformation problem[9] [14]. Building on these antecedents, one possible implementation direction is a semantic core that maintains persistent identifiers and typed temporal links to representation-specific structures. Such support may be distributed, need not contain all business data and does not require a single database.

This direction remains exploratory. Research must address identity resolution, including the merging or division of previously identified elements; temporal querying; organisational effective dates; retrospective corrective and compensating actions; the governance and consequences of retrospective corrections, including how superseded and corrected representations should be preserved and presented in historical queries; integrity and provenance across representations; performance; and comprehensibility. Relational, document-oriented, graph-based and hybrid implementations should also be compared.

8. Design Principles and Research Agenda

The position developed in this paper yields four preliminary design principles for business-centred adaptable information systems.

Preserve business actors' autonomy over organisational meaning and action. Computer-based systems should make the information, services and resources required for Human Actions available and enforce only those constraints for which technical enforcement has been explicitly justified through an accountable organisational decision. Norms and expected practices otherwise remain guidance for organisational actors.

Keep business concepts explicit and traceable across technical change. The explicit NOMIS business description should provide the semantic reference for interfaces, application services, Environmental State evaluations and persistent representations. Technical mappings may evolve while the meaning and identity of the referenced organisational elements remain governed within the business domain.

Represent organisational context through possibilities, conditions and situated scope. Processes express possible courses of Human Actions, Environmental States define relevant conditions for action, and Activities are explored as situated contexts relating organisational elements. These concepts may guide the information and services made available without replacing actors' interpretation of situations or their selection of action.

Preserve organisational continuity where it is relevant. Persistent identifiers, multiple representations and temporal associations may preserve identity, history and traceability across technical change. Their additional complexity should be justified by organisational needs. An

earlier effective date does not automatically revise previous system records or the consequences of actions already supported; corrective or compensating changes require explicit organisational decisions.

These principles do not have the same evidential status. Table 1 distinguishes established NOMIS positions, implementation-based evidence and the exploratory contributions developed in this paper.

Table 1
Maturity of the main propositions and next research steps

Direction	Current status	Next research step
Human Actions and Environmental State checks represented explicitly in software	Initial implementation-based evidence: selected Human Actions were implemented as application-level use cases or services, and selected checks as Specifications or validation objects [9]	Assess the mappings across different domains, define criteria for selecting software-supported Human Actions, and represent state definitions, evidence and dependency evaluation outside application code
Processes as possible courses of Human Actions	Established NOMIS modelling position [5], [16]	Examine its coexistence with justified mandatory workflows and technically enforced constraints
Activities as situated business contexts	Exploratory extension; related interface groupings were observed, but explicit Activity contexts were not implemented [9]	Refine the metamodel, delimit Activities, represent hierarchy and overlapping contexts, and investigate authority, division of labour and conflicting interpretations across Activity contexts
Separation of the business description from technical responsibilities	Exploratory architectural synthesis informed by the earlier NOMIS Middleware and NOMIS-MDSD proposals [8], [14]	Implement alternative configurations and assess traceability, change localisation and responsibility boundaries
Persistent identity, multiple representations and temporality	Exploratory persistence direction with antecedents in the earlier NOMIS Middleware [8]	Investigate identity resolution, structural evolution, effective dates, retrospective corrections and their consequences, historical presentation of superseded and corrected representations, provenance, integrity and alternative persistence technologies.

The resulting research agenda has three connected lines. The first concerns business modelling and semantics. Environmental States and Activities require clearer selection and delimitation criteria, together with metamodel support for their elements, dependencies and overlapping contexts. Environmental State definitions also need machine-processable representations that distinguish the organisational condition, its constituent elements and dependencies, the required evidence and the evaluation mechanism. Their evolution and versioning must preserve or explicitly revise organisational continuity.

The second line concerns operationalisation and tool support. NOMIS definitions and mappings should be accessible to interface, application and persistence mechanisms without existing only as assumptions dispersed through compiled code. Tools are needed to inspect and modify business definitions, evidential mappings and links to supporting services. Model transformations may progressively automate these mappings once stable transformation targets and preservation rules have been established.

The third line concerns empirical evaluation. Further prototypes and case studies should introduce controlled changes to organisational practices, Environmental State definitions, interaction mechanisms and data representations. Evaluation should progress towards richer organisational settings in which change, multiple representations, temporal correction or justified technical enforcement make the proposed mechanisms consequential rather than merely architectural overhead. Evaluation should examine whether the proposed separation localises technical change, preserves traceability and historical evidence, maintains integrity, remains understandable to organisational and technical participants, and avoids disproportionate implementation and operational complexity.

The immediate objective is therefore the incremental definition and evaluation of a semantic and architectural framework in which business concepts remain explicit, traceable and capable of evolving. Automatic generation of complete information systems from NOMIS models remains a longer-term possibility.

9. Conclusions

This paper has argued that adaptable information systems should preserve business actors' autonomy over organisational meaning and action. Computer-based support remains necessary for providing information, services and infrastructure and for enforcing justified constraints. Its design should, however, keep organisational decisions explicit and avoid turning contingent practices into compulsory technical behaviour. This relationship between organisational work and computer-based support should remain explicit and revisable beyond the design phase as both evolve.

The contribution is a business-centred design direction in which organisational concepts remain explicit and retain their continuity as the technical mechanisms that support and represent them evolve. Human Actions provide the primary connection between organisational work and application support. Processes express possible courses of Human Actions, while Environmental States identify relevant organisational conditions whose definitions, evidence and evaluation mechanisms should remain distinguishable. Activities retain their established compositional role and are explored as situated contexts for relating these elements. The proposed architectural separation and the persistence characteristics of persistent identity,

multiple representations and temporality extend this direction to computer-based support and system evolution.

The evidential basis remains limited. The Vortex Combat case provides initial implementation-based evidence that selected Human Actions can remain explicit as application-level use cases or services and that selected Environmental State checks can remain identifiable as Specifications or validation objects. It does not validate the situated interpretation of Activities, the architectural separation, the proposed semantic support or the persistence direction.

The resulting principles therefore define a research agenda, not a completed NOMIS architecture or model-to-code framework. Further work must refine the metamodel and business-level representations, implement alternative technical configurations, and evaluate whether they preserve traceability, localise change and remain understandable and operationally viable across different organisational domains. The central position is that information systems should remain adaptable as organisational work evolves, while business actors retain authority over its meaning and action.

Declaration on Generative AI

During the preparation of this work, the author used ChatGPT in order to check grammar and spelling. After using this tool, the author reviewed and edited the content as needed and take full responsibility for the publication's content.

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