Enterprise-Level IS Research – Need, Conceptualization, Exemplary Knowledge Contributions and Future Opportunities

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Abstract

Enterprise solutions, specifically enterprise systems, have allowed companies to integrate enterprises' operations throughout. The integration scope of enterprise solutions has increasingly widened, now often covering customer activities, activities along supply chains, and platform ecosystems. IS research has contributed a wide range of explanatory and design knowledge dealing with this class of IS. During the last two decades, many technological as well as managerial/organizational innovations extended the affordances of enterprise solutions—but this broader scope also challenges traditional approaches to their analysis and design. This position paper presents an enterprise-level (i.e., cross-solution) perspective on IS, discusses the challenges of complexity and coordination for IS design and management, presents selected enterprise-level insights for IS coordination and governance, and explores avenues towards a more comprehensive body of knowledge on this important level of analysis.

Keywords: Enterprise-level IS, Organizational level, Enterprise systems, System of systems

1. Introduction

1.1. Enterprise (Information) Systems

The history of enterprise (information) systems (EntIS) can be traced back to the 1970s. Their basic innovation was to integrate functional information processing "islands" to make complex functional tasks or processes more efficient and to avoid problems caused by inconsistencies or media breaks. Initially, the scope of integration was limited to a single functional domain, such as production planning, invoicing, or inventory management. Since a functional integration focus cannot efficiently support cross-functional, end-to-end business processes (e.g., order-to-cash), the 1990s brought a new generation of EntIS, which supported complex business processes (Scheer & Schneider, 2005). Extending the scope of integration and leveraging the benefits of seamless information processing, later generations of EntIS integrate not only internal operational functions, but also customer activities and partner activities along supply chains (Österle et al., 2001). Today's EntIS (e.g., SAP S/4 Hana) go even further by integrating operational functions of the *extended enterprise* with advanced business analytics.

IS research has contributed a wide range of explanatory and design knowledge dealing with EntIS. However, during the last two decades, this knowledge (mainly related to integration and adoption) has been challenged not only by technological but also by organizational innovations. On the technological side, cloud computing can enable easier and more flexible integration of functionality across solutions, platforms, and/or vendors (Maliza Salleh et al., 2012). Digital innovation platforms (e.g., the Salesforce platform) allow the use of customized complex services (of the platform core and complementors) without having to deal with their integration (Staub, Haki, et al., 2021b). On the *management side*, decentralized control approaches (e.g., agile operations and agile development) not only influence the way organizations are structured, but also allow for faster changes and concurrent variations of processes and supporting systems. Last not least, the increasingly relevant ecosystem level of management creates new integration affordances, but also introduces more heterogeneity of data and supporting systems.

1.2. Integration: The foundation for efficient digitization and digitalization

Like most evolving systems, IS development in companies started with the creation of *local* information processing solutions, such as for payments, payroll processing, or inventory management. Later developments connected these solutions to reduce media breaks, integrate data, and support "straight-through" processing. A complex network of connected local solutions emerged that is expensive to maintain and hard to keep consistent.

EntIS successively integrated such *local* solutions, transforming their complex fabric into a *system of systems* (Figure 1). Although integration reduces inter-

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faces (and thus operating costs) while supporting faster, more consistent information processing, the integration effort itself is costly and creates an additional conceptual layer.

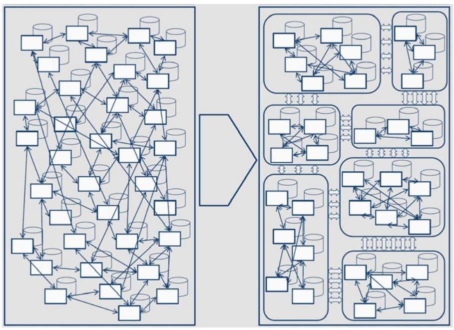

Figure 1. Integration principle "systems of systems" (Murer et al., 2010, p. 127)

Over nearly 50 years, the EntIS journey continued to provide ever increasing opportunities to improve effectiveness and efficiency. The scope of integration expanded from function to process to "extended enterprise" to ecosystem, while conceptual integration layers were successively added, such as a shared operational data layer, a workflow management layer, an infrastructure integration layer, or a business networking layer. Not only did computing power and digital capabilities explode, but so did the complexity of EntIS in general. Since many fundamental issues of business/IT alignment seem to have not been fundamentally addressed yet (Kappelman et al., 2022), complexity and governance challenges may increasingly impose limitations to the current and future efficacy and efficiency gains of enterprise integration.

1.3. The need for a dedicated enterprise perspective

For integrated extended enterprise (or ecosystem) IS, existing IS research discourses can only partially explain the trade-off between integration gains and complexity challenges, and innovative designs can only be partially grounded on such knowledge. While sociologically oriented research distinguishes between individual, group, and organizational levels of analysis (March & Simon, 1958), technologically oriented research distinguishes between systems and systems of systems (Carlock & Fenton, 2001), and organizational design distinguishes between activities/tasks, processes, and value streams (Martin & Osterling, 2014). To sufficiently understand multiple levels of integration and their complexity implications from an IS perspective (and thus to better understand enterprise computing and enable innovative designs that address the aforementioned trade-off), the dominant sociological levels of analysis need to be aligned with the technological and organizational levels of granularity. A perspective is needed that combines all three disciplines and allows the discussion of integration and complexity *beyond enterprise systems*.

The purpose of this position paper is to propose such a perspective. We designate it as "Enterprise Level" to distinguish it from existing, disciplinary concepts such as the organizational level.

With our proposal, we aim to provide a conceptual structure for analyzing, understanding, designing, and managing a complex and relevant IS phenomenon, for identifying research opportunities, for organizing knowledge (both descriptive and prescriptive), and for positioning research projects. In the following, we first conceptualize what we propose as the enterprise level of analysis. Important concepts and models are described in section 3. Section 4 presents exemplary IS knowledge contributions for selected topics and contexts, before the concluding section 5 outlines specific research opportunities at this level of analysis.

2. Conceptualizing the "Enterprise Level"

Before discussing the challenges for IS design and management, and avenues towards a more comprehensive body of knowledge on the enterprise-level of IS research, we need to specify how the enterprise-level differs from other levels of analysis and how EntIS research themes relate to existing IS discourses.

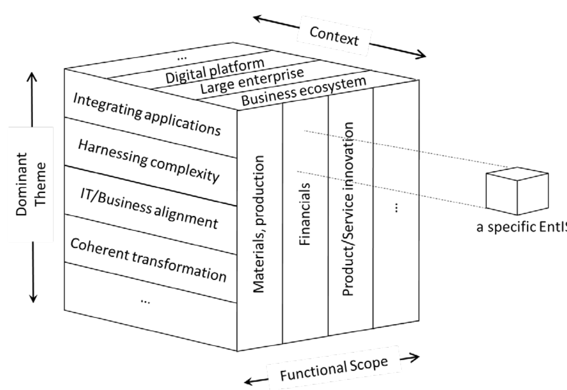

Figure 2. Conceptualization of the enterprise level

A specific EntIS covers certain functional areas, such as production, financials or even their integration. It has a dominant purpose, such as operational efficiency, and is applied in a certain context, such as a large company. Certain important purposes (or themes), such as application integration, harnessing complexity, aligning business and IT architectures, or coherent enterprise transformation, however, require abstraction from a specific context and from specific functional areas. Designing and managing IS for these purposes imply to widen the covered phenomenon from single EntIS to a holistic understanding, the enterprise-level. It covers many enterprise-related contexts, the full range of functional areas, and all the purposes/themes that are relevant at this level of analysis. Figure 2 illustrates our conceptualization of the enterprise level in IS.

People aspects of IS are commonly investigated on individual, group/team and organization levels of analysis (March & Simon, 1958). Business architecture differentiates an elementary level of tasks/activities and successively more aggregate levels of business processes, value streams, business models, and ultimately business networks and ecosystems (Martin & Osterling, 2014). Software architecture differentiates an elementary level of IT functionalities/information objects, and successively more aggregate levels of applications, domains, the enterprise, and perhaps networks of enterprises (Aier & Winter, 2009). Since IS integrate people, task, and technology, we use the generic term *enterprise level*. The relationship between top levels across IS perspectives is illustrated in Figure 3.

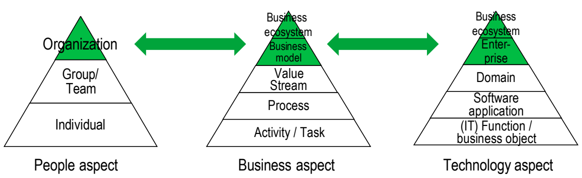

Figure 3. The enterprise level from a people, organization, and technology perspective

As the enterprise-level IS is a highly aggregate yet complex concept, understanding and designing IS on the enterprise-level is usually focused on a specific viewpoint. This perspective can be one of the component types mentioned above (people, task, and technology), but also an analysis/design perspective such as strategic issues (aspects such as objectives, outcomes), organizational issues (aspects such as processes, structures) or infrastructure issues (aspects such as software and other reusable assets). Exemplary enterprise-level IS concepts for these three perspectives are illustrated in Figure 4.

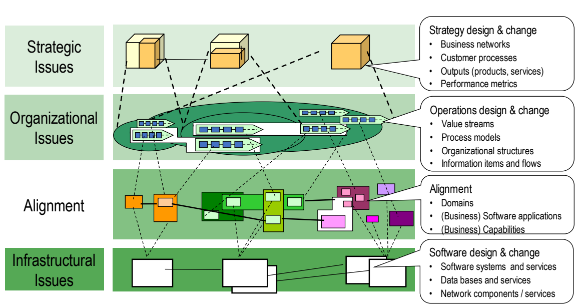

Figure 4. Exemplary strategic, organizational, and infrastructural concepts on the enterprise level

Due to the complexity of enterprise-level IS phenomena, research projects typically focus not only on one perspective, but also on a particular theme and context. Figure 2 lists exemplary themes (integrating applications, harnessing complexity, business/IT alignment, coherent transformation) and exemplary contexts (digital platform, business ecosystem, large enterprise). While there is overlap between themes and contexts, contextualization is essential to sufficiently specify research questions and to organize analysis/design knowledge.

The common denominator of the exemplary enterprise-level themes is that concepts and models (1) need to *align people, business and technology aspects* and (2) need to be meaningful enough to be *relevant across local IS views by individuals, workgroups, functions, projects, etc.*

3. Specific concepts and models on the enterprise level

While concepts such as business process, software system, organizational role or business function (and the respective models representing structure and dependencies of such concepts) are certainly relevant on other levels of IS analysis and design, they serve only as references on the enterprise level. By applying the above-stated requirements (1) and (2), we can identify genuine enterprise-level concepts (and respective models).

The first genuine concept is the way software functionalities are used (or shall be used) for supporting people and activities. At the solution level, elementary usage relationships matter. At the enterprise level, however, highly aggregated clusters of use cases that share a common context (e.g., integration of functions, shared data, common responsibility) matter. Such clusters are usually designated as "applications".

The second genuine concept is a functional description of capabilities to which both IT functionalities and business activities/tasks can be matched. Again, on the enterprise level, not elementary capabilities matter, but highly aggregate clusters of capabilities that have a common context (e.g., integration of functions, shared data, common responsibility).

In complex enterprises, thousands of applications and hundreds of capabilities exist. They refer to business activities, software functionalities, and information objects—with a magnitude more interrelationships to business and technology concepts. As a consequence, multi-level aggregate views need to be established to keep enterprise-level models accessible to humans and to support "architectural" coordination—in line with TOGAF's definition of enterprise architecture that focuses on "*fundamental* components, their inter-relationships, and the principles and guidelines governing their design and evolution over time.“ (The Open Group, 2022).

Based on general systems theory and in analogy to design theories from Computer Science, Aier and Winter (2009) proposed *alignment architecture* concepts that (1) represent interdependencies between people/business and technology concepts and (2) can be aggregated to enterprise-level models.

In analogy to application models and their references to business/people and IT concepts for an enterprise (or a business unit), capability models represent a common functional language of an enterprise (or a business unit). Both concepts (and the respective models) are used to align business/people and technology (requirement 1) and are (only) relevant beyond *local* IS views (requirement 2). Therefore, we designate them as alignment concepts (and models, respectively). They are genuine to the enterprise-level of IS analysis/design. In practice, enterprise-level models of applications and enterprise-level models of capabilities are frequently used in the context of Enterprise Architecture Management (EAM).

Based on requirements (1) and (2), the difference between enterprise-*wide* analyses and enterprise-*level* analyses becomes clear: Enterprise-*wide* models represent entities across different units of an enterprise, but not necessarily aligning business and IT aspects. In contrast, enterprise-*level* models are enterprise-wide models focusing on that alignment. Consequently, aggregate process architecture or software architecture models can be enterprise-*wide* models, but application maps and capability maps represent enterprise-*level* models.

4. Enterprise-level IS research

It is difficult to identify enterprise-level IS research that is both illustrative and representative. The exemplars in this section have been selected because they fulfil the criteria of *(1) linking people, business, and technology aspects* and *(2)* being *relevant beyond local IS views by individuals, workgroups, functions, projects, etc.* While illustrating the importance and diversity of enterprise-level IS research, our selection does, however, not claim to be representative.

For showcasing the variety of contexts, the context of a *large enterprise* is used as a setting that is underpinned by a common legal entity. Still, large enterprises may involve various business departments and operate on a global scale. *Digital platform ecosystems* encompass a platform owner, providing the platform as a central authority, and the group of complementors that contribute complementary assets to the platform (Tiwana et al., 2010), often in industry-wide settings (Jacobides et al., 2018). Platform design and governance rules are set by the central authority. The *business ecosystem context* is characterized by entities that frequently conduct business with each other, often across industry boundaries (Jacobides et al., 2018). Participation in this non-hierarchical setting is voluntary.

4.1. Integrating software applications

Context large enterprise: Integration management

A software application (designated as *application* in the following) bundles IT capabilities that are used in one or several business processes and/or that work with a common set of data. It is implemented through one or several software components (Aier & Winter, 2009). With the increasing ubiquity of IS within organizations, also the need grew to widen the perspective beyond an isolated application that serves a specific functional domain. Business processes run across several organizational units and roles, and data is shared among diverse business functions. This led to the need to integrate those formerly isolated applications.

The need for integration became a central theme in IS research and yielded integration models such as the *Architecture of Integrated Information Systems (ARIS)* (Scheer, 1991). Soon, however, the focus was not on integrating functionality by *merging* it into a (larger) application, but rather on an enterprise level integration that *links* applications through data flows along business processes (Aier & Winter, 2010). The goal was to limit complexity to a still manageable (application) level, employing integration architectures (e.g., hub-and-spoke, message broker) that link applications through an enterprise-wide middleware (Linthicum, 2000). Yet, an additional integration layer has been created to maintain flexibility on the enterprise level.

Today, linking applications easily crosses the boundaries of an organization because individual software components or entire applications are provided *as a service* through emerging cloud service providers (Hahn et al., 2016). And even if those services are used only within a particular organization, they require additional considerations, e.g., data security and privacy. Similar to the basic integration layer, these additional concepts preserve flexibility (e.g., in meeting volatile demands) and harness complexity (e.g., by encapsulating the underlying service operations) at the expense of additional coordination efforts.

Context digital platform ecosystem: Innovation platform architecture design

Innovation platforms serve as the basis for complementary innovation. As complex technological infrastructures those platforms provide integration mechanisms. Complementors are required to integrate platform-specific assets, which results in platform-related adoption investments (Bender, 2020; Tiwana et al., 2010). In contrast, transaction platforms aim at facilitating transactions and therefore use lighter forms of integration to keep barriers to participation low. Here, we focus on innovation platforms as they us allow to explore more advanced integration mechanisms.

To manage integration and coordination among different actors, platforms provide boundary resources, which allow complementors to access platform features. The group of boundary resources usually includes software development kits and application programming interfaces (APIs) (Ghazawneh & Henfridsson, 2013). Through the design parameters of boundary resources, platform owners control complementors' access to platform resources and the level of integration (Staub et al., 2022). In this regard, the challenge between devoting control to complements vs. maintaining control of the platform is a continuous task of platform management (Boudreau, 2010).

Integration practices on industry-wide innovation platforms differ from those *within enterprise* settings in that third parties are involved. Platforms rely on standardization to cope with the diversity of complements and to control related access.

Context business ecosystem: Technical integration as facilitator

A business ecosystem includes a set of actors that are not fully hierarchically controlled (Jacobides et al., 2018). To achieve integration among independent actors, coordination among them is required. For efficiency purposes,

the group of actors in an ecosystem aims for integration beyond single point-to-point integrations by leveraging common denominators within the ecosystem (Wareham et al., 2014). From a technology perspective, this may be achieved using a common data model or process integration across firm boundaries. Technical standards, such as EDI, support such integration efforts. Business ecosystems have the ability to specialize generic technical standards to the specific needs of their domain.

4.2. Harnessing complexity

Context large enterprise: Enterprise Architecture Management (EAM)

Xia and Lee (Xia & Lee, 2005) distinguish structural and dynamic, as well as technological and organizational aspects of complexity. This conceptualization is useful on the enterprise level, too (Beese, Aier, et al., 2023) as it goes beyond a solely technical view. Complexity compromises the maintainability of the overall IS architecture and organizations struggle to swiftly respond to required or desired changes (Schmidt & Buxmann, 2011). Structural complexity is positively associated with dynamic complexity, organizational complexity is positively associated with technological complexity, and EAM moderates the relations between organizational complexity and technological complexity, and thus harnesses complexity (Beese, Aier, et al., 2023).

Local business entities, such as project teams, tend to advocate for IS solutions that fit their specific needs and preferences. In contrast, entities with an enterprise-wide focus, such as strategic initiatives, aim to improve the overall efficiency and effectiveness of the entire IS from an overarching perspective (Beese, Haki, et al., 2023). Consequently, concurrent *local* change projects and increasing design/management autonomy lead to potentially inconsistent and redundant solutions (Hanseth & Lyytinen, 2010). In response to this challenge, researchers have investigated how to better control local change activities (Cram et al., 2016; Wiener et al., 2016). In practice, many organizations employ EAM for that purpose (Ross et al., 2006). While EAM activities aim at aligning "local" short-term, project activities with long-term, organization-wide objectives (Sidorova & Kappelman, 2011), decentral business structures and the prioritization of local project goals constantly create incoherencies.

Since traditional, coercive control mechanisms for architectural coordination appear to have reached their peak effectivity (Winter, 2014) and more formal control appears to be dysfunctional, *clan control* and *self-control* have been adopted by EAM and implemented in the form of informal coordination interventions in large enterprises (Beese, Haki, et al., 2023). An example is the design and evaluation of an *architectural compliance label* that, instantiated for a change project, indicates the level of harm that the project could create for the rest of the organization (Schilling et al., 2019). Published enterprise-wide, it has been shown that such labels have a coordinative aspect as they prevent local decision-makers from deviating too much or too often from architectural principles and guidelines.

Context digital platform ecosystem: Complexity-aware platform adoption

According to the theory of platform leverages (Thomas et al., 2014), digital innovation platform ecosystems promise to more efficiently meet the complexity of user requirements by providing scalable mechanisms to integrate core platform resources with complementor's resources to create innovative, yet efficient services that meet user requirements (Staub et al., 2022). Thus, the complexity that needs to be mastered by each complementor is reduced. However, this is only achieved at the expense of significant complexity on the platform owner side, both for platform design and orchestration as well as for complementor integration. Complexity has a pivotal role in determining the conditions under which innovation platforms outperform direct transactions between users and complementors (Schmid et al., 2021). Since these systems are rather new objects of analysis, it has yet to be clarified, which management mechanisms shall be applied to which aspects of complexity in digital platforms.

Context business ecosystem: Common interests serve as guidance on complexity activity

Efforts to harness complexity on a business ecosystem level require the coordination of multiple actors within the ecosystem. In contrast to *within-firm* practices, the process requires balancing the interests of ecosystem actors in a non-hierarchical context (Kim et al., 2010). To achieve standardization as leverage for harnessing complexity within a diverse set of actors, coordination among participants is required. Compared to other contexts (i.e., platform or large enterprise), the business ecosystem has no central authority. Therefore, the conceptualization and agreement on common standards require the effort of the individual participants. Usually, centralized governance is missing, which is why conflicts need to be resolved on the ecosystem level.

During their lifecycle, business ecosystems may develop standards for their respective needs that are a specialization of technological standards (e.g., data formats for big data in manufacturing). Some ecosystems are even characterized by the joint provision of technological infrastructures (e.g., tapio for the wood processing industry). Participants joining an ecosystem may be required to adopt ecosystem practices to efficiently operate within the ecosystem.

4.3. Business/IT alignment

Context large enterprise: Using dedicated models for aligning business and technology architectures

For decades, business/IT alignment has consistently been one of the top concerns of organizations, their IT leaders (Kappelman et al., 2022) as well as IS researchers (Chan & Reich, 2007). More recently, agile approaches to business and IT became an additional concern of organizations (Kappelman et al., 2022). On a *local* level (i.e., in development projects or loosely coupled value streams/processes), questions of business/IT alignment are rather effectively dealt with by composing agile teams to comprise business and IT roles. On the enterprise level, however, we see additional challenges for business/IT alignment, because technology components are increasingly standardized solutions (on-premise or in the cloud) that were not designed or customized to fit a particular business setting. Consequentially, researchers proposed business and technology-agnostic models for systematically defining application landscapes (Winter, 2003) and capability maps (Aier & Winter, 2009) to be used as a foundation to coordinate business requirements and technology solutions. The idea is to create a dedicated model category that provides a common language among business and IT stakeholders for managing the business/IT intersection on an enterprise level.

Context digital platform ecosystem: Coping with diversity alignment on industry-wide platforms

Achieving alignment on digital platforms requires explicitly stating the platform fundamentals. Alignment in industry-wide platform settings involving numerous autonomous complementors is directed toward the central platform (Hein et al., 2020). Based on a clear mission and vision, the platform owner is responsible for providing the basis for alignment.

The platform owner implicitly embeds the platform identity within the alignment practices and the platform infrastructure (Staub et al., 2022). The infrastructure includes fine-grained control of access to platform resources and options for integration such as the boundary resources offered.

Platform governance as the set of rules for platform operation is designed to achieve alignment on the organizational level through a set of standardized rules that serve as coordination practices given the numerous complementors (Huber et al., 2017).

By means of their technological design and governance rules, platforms specify the range of possible application scenarios. Complementors choose from the range of possibilities offered, the solution that fits their individual circumstances best (Bender, 2020).

Context business ecosystem: Support value creation within a common business context

Business ecosystems include a diverse set of actors that operate on the basis of a common business context. While some ecosystems attract similar actors to achieve greater capacity, in the general case ecosystems are characterized by complementary actors. Diverging interests in business ecosystems (e.g., regarding transparency, inter-organizational exchange) require coordination among ecosystem participants.

The common denominator is the overall benefit the ecosystem provides to its participants. To support value creation on the ecosystem level, infrastructures on the ecosystem level may initiate changes in the business context. Alignment may be triggered by contextual practices such as regulation (i.e., supply chain transparency) as well as changes among the ecosystem participants (ecosystem openness) or a change in the value proposition (ecosystem product portfolio).

4.4. Managed evolution and transformation

Context large enterprise: Enterprise Transformation Methods

Enterprise transformations are often referred to as fundamental changes of one or several key constituencies of an enterprise (Rouse, 2005). By definition, such transformations are hardly *local*, as they often have significant (i.e., not just evolutionary) effects on the enterprise level (Proper et al., 2017). Due to the variety of challenges, stakeholders, and tasks in enterprise transformations, monolithic enterprise transformation models and methods often inappropriately address specific needs. Instead, based on a meta-management perspective, researchers have developed frameworks that structure and integrate different techniques for analysis and design tasks in enterprise transformations (Abraham et al., 2017; Uhl & Gollenia, 2012; Winter, 2011). Based on the characteristics of a specific transformation endeavor, a specific set of techniques may then be selected (Winter & Labusch, 2017).

Context digital platform ecosystem: Transformation and evolution of platform infrastructures

Platform change may occur as small evolutions or fundamental transformations (Teece, 2017). Given the dependence shaped by their technological basis, fundamental transformations constitute a challenge for platforms. Platform transformations are characterized by a technical modification and organizational practices that accompany and support the transformative activity. In a hierarchical platform ecosystem setting, the platform owner usually initiates changes. For transformation to succeed the group of independent complementors need to adopt or leave the platform.

The continuous evolution of platform infrastructure serves as the basis for their competitive advantage. Dynamic capabilities serve as the basis for sustained platform success (Teece, 2017). Both users and complementors chose platforms depending on their attractiveness. Next to the market-related dynamics of platform settings, the technical platform design and the related functional value are crucial (Kim et al., 2016). The platform core provided by the platform owner and third-party complements define an interdependent setting for evolution. Platform owners may integrate features of complementors into the core as part of their evolution strategy, to allow for broader access of complementors (Li & Agarwal, 2017; Parker & Van Alstyne, 2018; Wang, 2021). Functional similarities between core and complements may be the result of the platform owner entering complementors spaces (Wen & Zhu, 2019). To do so, platforms may acquire related complementary assets as a part of their transformative activities (Staub, Haki, et al., 2021a).

Context business ecosystem: Managed Co-Evolution in business ecosystems

The evolution of business ecosystems (in contrast to platform ecosystems with a central authority) is characterized by decentral decision making. The cooperative and at the same time competitive practices of co-evolution are fueled by the mutual influence of actors within the ecosystem (Riasanow et al., 2020).

The dependencies of ecosystem actors influence transformative activities within the ecosystem (Henningsson & Hedman, 2014). Support of transformations in a non-hierarchical business ecosystem depends on the advantages perceived by ecosystem actors. Business ecosystem transformations are directed towards achieving greater value for participants or adjusting to changes in the business landscape.

From a process perspective, a coordination and negotiation phase precedes coordinated evolutionary activities in the business ecosystem. Ecosystem partners need to agree on evolutions for the benefit of the ecosystem. Interests need to be balanced prior to the integration of changes.

The transformation in the ecosystem can be the result of changing requirements in the underlying business landscape. For example, changes in the value chain may trigger transformative activities (e.g., local sourcing to ensure a high level of supply security).

The evolution itself may occur within the ecosystem by introducing new technologies, standards, or other practices (e.g., adoption of standards within the ecosystem). Changes in the openness of the ecosystem may also represent changes in that actors join or leave the ecosystem. For example, ecosystems may require certification and qualifications from participants (Huang et al., 2013).

5. Conclusion: Towards a Research Agenda for Enterprise-level IS

The goal of this paper was to provide a conceptual structure for analyzing, understanding, designing and managing enterprise-level IS. The applicability of the enterprise-level perspective in diverse contexts is showcased by the three exemplary contexts *large enterprise*, *business ecosystem*, and *platform ecosystem*. We have shown that enterprise-level IS share some common characteristics. In contrast to many other classes of IS, enterprise-level IS are comprised of various artefact types, due to their requirements for integration and alignment as well as their complex nature. The enterprise level also implies that diverse stakeholders and stakeholder perspectives need to be considered, across business and IT boundaries, across corporate functions, and often even across legal entities. The complexity of enterprise-level IS is not only embodied in their number of components and the interdependencies between these components, but also in the resulting dynamics and emergence over time.

Thus, enterprise-level IS research may specifically address (i) theories or concepts that provide *structure* to the phenomenon, such as classification schemes, archetypes, or taxonomies (Blaschke et al., 2019; Greenwood & Hinings, 1993; Staub, Haki, Aier, & Winter, 2021), integration approaches (Aier & Winter, 2010; Li & Agarwal, 2017), or more general architectural descriptions such as enterprise level meta models (Aier & Winter, 2009; Alter, 2013). Beyond those structural contributions, enterprise-level IS research may also address (ii) theories or concepts that provide *coordination* and *control* within enterprise-level IS (Brosius et al., 2017; Schilling et al., 2019), addressing the challenges of alignment (Beese, Haki, et al., 2023) within and governance (Staub et al., 2022) of enterprise-level IS. A particular focus may be given to methods and techniques for handling conflicts and dealing with tradeoffs when designing, managing, and evolving enterprise-level IS, such as artifacts and techniques for creating common ground among diverse stakeholder groups (Abraham et al., 2015; Avdiji et al., 2020). In parallel to these (and further) topical foci, enterprise level IS research also employs and may even evolve *research methods* that are particularly suited for Enterprise-level IS analysis, understanding and design. Examples are methods that are particularly suited to capture and embrace the dynamics and emergence of complex systems such as longitudinal case studies (Haki et al., 2022; Ployhart & Vandenberg, 2010; Schreieck et al., 2021). For linking enterprise-level IS research with IS research on the individual and group levels, truly multilevel research should be considered (Bélanger et al., 2014; Kozlowski et al., 2013). Simulation experiments (Beese et al., 2019; Za et al., 2018) may be a fruitful and not yet mainstream way to do so (Haki et al., 2020; Nan & Tanriverdi, 2017; Rietsche et al., 2021).

While enterprise-level IS research already has some significance and achievements (e.g., in the fields of integration management, EAM and IS governance), new *enterprise* phenomena constantly emerge, with digital platform ecosystems being a recent one. This offers various opportunities for knowledge contributions, such as the *projections* of knowledge to new contexts in various directions. An example would be to investigate what we can learn from digital platform research for the current development of internal analytics and AI platforms in large enterprises (Shah et al., 2015). We may generalize and abstract from the diverse instances of enterprise-level IS that have been researched over the years for understanding common mechanisms and for building projectable problem solutions. Finally, and with digital platform research gathering tremendous attention recently, we may see fresh accounts for some of IS research's grand challenges (Becker et al., 2015; Winter & Butler, 2011).

References

Abraham, R., Aier, S., & Winter, R. (2015). Crossing the line: overcoming knowledge boundaries in enterprise transformation. *Business & Information Systems Engineering*, *57*(1), 3-13.

Abraham, R., Weiss, S., Labusch, N., Aier, S., & Winter, R. (2017). Transformation Intelligence Capability Catalogue. In H. A. Proper, R. Winter, S. Aier, & S. de Kinderen (Eds.), *Architectural Coordination of Enterprise Transformation* (pp. 175-181). Springer.

Aier, S., & Winter, R. (2009). Virtual Decoupling for IT/Business Alignment: Conceptual Foundations, Architecture Design and Implementation Example. *Business & Information Systems Engineering*, *1*(2), 150–163.

Aier, S., & Winter, R. (2010). Fundamental Patterns for Enterprise Integration Services. *International Journal of Service Science, Management, Engineering, and Technology*, *1*(1), 33-49.

Alter, S. (2013). Work System Theory: Overview of Core Concepts, Extensions, and Challenges for the Future. *Journal Of The Association For Information Systems*, *14*, 72-121.

Avdiji, H., Elikan, D., Missonier, S., & Pigneur, Y. (2020). A Design Theory for Visual Inquiry Tools. *Journal Of The Association For Information Systems*, *21*(3), 695-734.

Becker, J., Vom Brocke, J., Heddier, M., & Seidel, S. (2015). In Search of Information Systems (Grand) Challenges. *Business & Information Systems Engineering*, *57*(6), 377-390.

Beese, J., Aier, S., Haki, K., & Winter, R. (2023). The Impact of Enterprise Architecture Management on Information Systems Architecture Complexity. *European Journal of Information Systems*, forthcoming.

Beese, J., Haki, K., Schilling, R., Kraus, M., Aier, S., & Winter, R. (2023). Strategic Alignment of Enterprise Architecture Management – How a Decade of Corporate Transformation shaped the Portfolio of Control Mechanisms at Commerzbank. *European Journal of Information Systems*, *32*(1), 92-105.

Beese, J., Haki, M. K., Aier, S., & Winter, R. (2019). Simulation-Based Research in Information Systems: Epistemic Implications and a Review of the Status Quo. *Business & Information Systems Engineering*, *61*(4), 503-521.

Bélanger, F., Markham, S. E., Cefaratti, M., & Carte, T. (2014). Multilevel Research in Information Systems: Concepts, Strategies, Problems, and Pitfalls. *Journal Of The Association For Information Systems*, *15*(9), 614-650.

Bender, B. (2020). The Impact of Integration on Application Success and Customer Satisfaction in Mobile Device Platforms. *Business & Information Systems Engineering*, *62*(6), 515-533.

Blaschke, M., Haki, K., Aier, S., & Winter, R. (2019). *Taxonomy of Digital Platforms: A Platform Architecture Perspective* 14th International Conference on Wirtschaftsinformatik (WI2019), Siegen, Germany.

Boudreau, K. J. (2010). Open Platform Strategies and Innovation: Granting Access vs. Devolving Control. *Management Science*, *56*(10), 1849-1872.

Brosius, M., Haki, K., Aier, S., & Winter, R. (2017, 08.05.2017). *A Literature Review of Coordination Mechanisms: Contrasting Organization Science and Information Systems Perspectives* EEWC 2017, Antwerp, Belgium.

Carlock, P. G., & Fenton, R. E. (2001). System-of-Systems (SoS) Enterprise Systems for Information-Intensive Organizations. *Systems Engineering*, *4*(4), 242-261.

Chan, Y. E., & Reich, B. H. (2007). IT alignment: an annotated bibliography. *Journal Of Information Technology*, *22*(4), 316–396.

Cram, W. A., Brohman, M. K., & Gallupe, R. B. (2016). Information Systems Control: A Review and Framework for Emerging Information Systems Processes. *Journal Of The Association For Information Systems*, *17*(4), 216-266.

Ghazawneh, A., & Henfridsson, O. (2013). Balancing Platform Control and External Contribution in Third-party Development: The Boundary Resources Model. *Information Systems Journal*, *23*(2), 173-192.

Greenwood, R., & Hinings, C. R. (1993). Understanding Strategic Change: The Contribution of Archetypes. *Academy Of Management Journal*, *36*(5), 1052-1081.

Hahn, C., Huntgeburth, J., Winkler, T. J., & Zarnekow, R. (2016, 2016). *Business and IT Capabilities for Cloud Platform Success* 37th International Conference on Information Systems (ICIS 2016), Dublin, Ireland.

Haki, K., Beese, J., Aier, S., & Winter, R. (2020). The Evolution of Information Systems Architecture: An Agent-Based Simulation Model. *MIS Quarterly*, *44*(1), 155-184.

Haki, K., Blaschke, M., Aier, S., Winter, R., & Tilson, D. (2022). Dynamic Capabilities for Transitioning from Product Platform Ecosystem to Innovation Platform Ecosystem. *European Journal of Information Systems,* forthcoming.

Hanseth, O., & Lyytinen, K. (2010). Design Theory for Dynamic Complexity in Information Infrastructures: The Case of Building Internet. *Journal Of Information Technology*, *25*(1), 1-19.

Hein, A., Schreieck, M., Riasanow, T., Soto Setzke, D., Wiesche, M., Böhm, M., & Krcmar, H. (2020). Digital Platform Ecosystems. *Electronic Markets*, *30*, 87-98.

Henningsson, S., & Hedman, J. (2014). Technology-based Transformation of Digital Ecosystems: The DETT Framework. International Conference on Information Resources Management (CONF-IRM 2014), Ho Chi Minh City.

Huang, P., Ceccagnoli, M., Forman, C., & Wu, D. J. (2013). Appropriability Mechanisms and the Platform Partnership Decision: Evidence from Enterprise Software. *Management Science*, *59*(1), 102–121.

Huber, T. L., Kude, T., & Dibbern, J. (2017). Governance Practices in Platform Ecosystems: Navigating Tensions Between Cocreated Value and Governance Costs. *Information Systems Research*, *28*(3), 563-584.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a Theory of Ecosystems. *Strategic Management Journal*, *39*(8), 2255-2276.

Kappelman, L., Torres, R., McLean, E. R., Maurer, C., Johnson, V. L., Snyder, M., & Guerra, K. (2022). The 2021 SIM IT Issues and Trends Study. *MIS Quarterly Executive*, *21*(1).

Kim, H., Lee, J.-N., & Han, J. (2010). The role of IT in business ecosystems. *Communications Of The ACM*, *53*(5), 151–156.

Kim, H. J., Kim, I., & Lee, H. (2016). Third-party mobile app developers' continued participation in platform-centric ecosystems: An empirical investigation of two different mechanisms. *International Journal of Information Management*, *36*(1), 44-59.

Kozlowski, S. W. J., Chao, G. T., Grand, J. A., Braun, M. T., & Kuljanin, G. (2013). Advancing Multilevel Research Design: Capturing the Dynamics of Emergence. *Organizational Research Methods*, *16*(4), 581-615.

Li, Z., & Agarwal, A. (2017). Platform integration and demand spillovers in complementary markets: Evidence from Facebook's integration of Instagram. *Management Science*, *63*(10), 3438-3458.

Linthicum, D. S. (2000). *Enterprise Application Integration*. AWL Direct Sales.

Maliza Salleh, S., Yen Teoh, S., & Chan, C. (2012). *Cloud Enterprise Systems: A Review Of Literature And Its Adoption* Pacific Asia Conference on Information Systems (PACIS 2012), Ho Chi Minh City. http://aisel.aisnet.org/pacis2012/76

March, J. G., & Simon, H. A. (1958). *Organizations*. Wiley and Sons.

Martin, K., & Osterling, M. (2014). *Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation* McGraw-Hill.

Murer, S., Bonati, B., & Furrer, F. J. (2010). *Managed Evolution: A Strategy for Very Large Information Systems*. Springer.

Nan, N., & Tanriverdi, H. (2017). Unifying the Role of IT in Hyperturbulence and Competitive Advantage Via a Multilevel Perspective of IS Strategy. *MIS Quarterly*, *41*(3), 937-958.

Österle, H., Fleisch, E., & Alt, R. (2001). *Business Networking – Shaping Collaboration Between Enterprises* (2 ed.). Springer.

Parker, G., & Van Alstyne, M. (2018). Innovation, Openness, and Platform Control. *Management Science*, *64*(7), 3015-3032.

Ployhart, R. E., & Vandenberg, R. J. (2010). Longitudinal research: The theory, design, and analysis of change. *Journal Of Management*, *36*(1), 94-120.

Proper, H. A., Winter, R., Aier, S., & de Kinderen, S. (Eds.). (2017). *Architectural Coordination of Enterprise Transformation*. Springer.

Riasanow, T., Flötgen, R. J., Greineder, M., Möslein, D., Böhm, M., & Krcmar, H. (2020). Co-evolution in business ecosystems: Findings from literature. *40 Years EMISA 2019*.

Rietsche, R., Aier, S., & Rivera, M. (2021). *Does Real-Time Feedback Matter? A Simulation Study to Link Individual and Organizational Performance* Workshop on Information Technologies and Systems (WITS), Austin, TX.

Ross, J. W., Weill, P., & Robertson, D. C. (2006). *Enterprise Architecture as Strategy. Creating a Foundation for Business Execution*. Harvard Business School Press.

Rouse, W. B. (2005). A Theory of Enterprise Transformation. *Systems Engineering*, *8*(4), 279-295.

Scheer, A.-W. (1991). *Architektur integrierter Informationssysteme*. Springer.

Scheer, A.-W., & Schneider, K. (2005). ARIS - Architecture of Integrated Information Systems. In P. Bernus, K. Mertins, & G. Schmidt (Eds.), *Handbook on Architectures of Information Systems* (2 ed., pp. 605-623). Springer.

Schilling, R. D., Aier, S., & Winter, R. (2019). *Designing an Artifact for Informal Control in Enterprise Architecture Management* 40th International Conference on Information Systems, Munich, Germany.

Schmid, M., Haki, K., Tanriverdi, H., Aier, S., & Winter, R. (2021). *Platform over Market: When is Joining a Platform Beneficial?* 29th European Conference on Information Systems, Marrakesh, Morocco.

Schmidt, C., & Buxmann, P. (2011). Outcomes and Success Factors of Enterprise IT Architecture Management: Empirical Insight from the International Financial Services Industry. *European Journal of Information Systems*, *20*(2), 168-185.

Schreieck, M., Wiesche, M., & Krcmar, H. (2021). Capabilities for value co-creation and value capture in emergent platform ecosystems: A longitudinal case study of SAP's cloud platform. *Journal Of Information Technology*, *36*(4), 365-390.

Shah, F. A., Kretzer, M., & Mädche, A. (2015). *Designing an Analytics Platform for Professional Sports Teams* 36th International Conference on Information Systems (ICIS 2015), Fort Worth, USA.

Sidorova, A., & Kappelman, L. A. (2011). Better Business-IT Alignment Through Enterprise Architecture: An Actor-Network Theory Perspective. *Journal Of Enterprise Architecture*, *7*(1), 39-47.

Staub, N., Haki, K., Aier, S., & Winter, R. (2021). *Taxonomy of Digital Platforms: A Business Model Perspective* 54th Hawaii International Conference on System Sciences, Kauai, HI, USA. http://hdl.handle.net/10125/71364

Staub, N., Haki, K., Aier, S., & Winter, R. (2022). Governance Mechanisms in Digital Platform Ecosystems: Addressing the Generativity-Control Tension. *Communications Of The Association For Information Systems*, *51*(1), 906-939.

Staub, N., Haki, K., Aier, S., Winter, R., & Magan, A. (2021a). Acquisition of Complementors as a Strategy for Evolving Digital Platform Ecosystems. *MIS Quarterly Executive*, *20*(4), 237-258.

Staub, N., Haki, K., Aier, S., Winter, R., & Magan, A. (2021b). *Evolution of B2B Platform Ecosystems: What Can Be Learned from Salesforce?* 29th European Conference on Information Systems (ECIS 2021),

Teece, D. J. (2017). Dynamic Capabilities and (Digital) Platform Lifecycles. In J. Furman, A. Gawer, B. Silverman, & S. Stern (Eds.), *Entrepreneurship, Innovation, and Platforms* (Vol. 37, pp. 211-225). Emerald Publishing.

The Open Group. (2022). *The Open Group Architecture Framework (TOGAF) Version 10*

Thomas, L. D. W., Autio, E., & Gann, D. M. (2014). Architectural Leverage: Putting Platforms in Context. *Academy of Management Perspectives*, *28*(2), 198-219.

Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics. *Information Systems Research*, *21*(4), 675-687.

Uhl, A., & Gollenia, L. A. (Eds.). (2012). *A Handbook of Business Transformation Management Methodology*. Gower Publishing.

Wang, P. (2021). Connecting the Parts with the Whole: Toward an Information Ecology Theory of Digital Innovation Ecosystems. *MIS Quarterly*, *45*(1), 397-422.

Wareham, J., Fox, P. B., & Giner, J. L. C. (2014). Technology Ecosystem Governance. *Organization Science*, *25*(4), 1195-1215.

Wen, W., & Zhu, F. (2019). Threat of platform-owner entry and complementor responses: Evidence from the mobile app market. *Strategic Management Journal*, *40*(9), 1336-1367.

Wiener, M., Mähring, M., Remus, U., & Saunders, C. (2016). Control Configuration and Control Enactment in Information Systems Projects: Review and Expanded Theoretical Framework. *MIS Quarterly*, *40*(3), 741-774.

Winter, R. (2003). *An Architecture Model for Supporting Application Integration Decisions* 11th European Conference on Information Systems (ECIS 2003), Naples, Italy.

Winter, R. (2011). *Business Engineering Navigator – Gestaltung und Analyse von Geschäftslösungen "Business-to-IT"*. Springer.

Winter, R. (2014). Architectural Thinking. *Business & Information Systems Engineering*, *6*(6), 361-364.

Winter, R., & Labusch, N. (2017). Situational Adaptations of ACET. In H. A. Proper, R. Winter, S. Aier, & S. de Kinderen (Eds.), *Architectural Coordination of Enterprise Transformation* (pp. 277-289). Springer.

Winter, S. J., & Butler, B. S. (2011). Creating bigger problems: grand challenges as boundary objects and the legitimacy of the information systems field. *Journal Of Information Technology*, *26*(2), 99-108.

Xia, W., & Lee, G. (2005). Complexity of Information Systems Development Projects: Conceptualization and Measurement Development. *Journal of Management Information Systems*, *22*(1), 45-83.

Za, S., Spagnoletti, P., Winter, R., & Mettler, T. (2018). Exploring Foundations for Using Simulations in IS Research. *Communications Of The Association For Information Systems*, *42*(1), 268-300.