A design framework for ecosystems that facilitate continuous employee skill development

A theoretical integration of interorganisational skills learning communities, modern sociotechnical systems, and network theory.

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Abstract

In today's dynamic business landscape, the continuous development of employee skills is an important driver for innovation and performance in the workplace. However, employee skillsets are often inadequate, posing a challenge for organisational innovativeness and performance. Although concepts and instruments at the organisational level are helpful, organisations need additional methods to facilitate continuous skill development. Interorganisational skills learning communities (ISLCs) have recently emerged in Europe to address this need, presenting a promising approach to enhance employee skill development. Nevertheless, designers and employees face significant challenges in ensuring long-term skill development through ISLCs. Treating ISLCs as dynamic interorganisational ecosystems that must adapt to changing contexts is essential, but learning community literature currently lacks specification on how adaptive and effective ISLCs can be designed.

In the present paper, we present a novel and comprehensive ISLC design framework underpinned by modern-sociotechnical systems theory (MSTS), network theory, and state-of-the-art literature on skills learning communities. Accordingly, an adaptable and effective ISLC can be achieved through (1) distinction of different design levels, (2) distinction between design of a learning structure and governance structure, (3) pursuit of a specific design sequence, (4) clusters of micro learning communities (LCs), and (5) an iterative, interactive and multi-level design of feedback loops. The resulting design framework breaks new ground for interorganisational learning community theory-building and offers a novel direction for researchers, HRD practitioners and policy makers to address

HRD problems in today's changing business environment. More research should be conducted on the validation of this conceptual design framework.

Keywords: interorganisational skills learning communities (ISLC), ecosystems, modern-sociotechnical systems (MSTS), network theory, workplace innovation, continuous skill development, Industry 5.0.

Introduction

In today's complex and changing world, there is an increasing need for continuous development of employee skills. Developments in information technology such as virtual reality, cloud computing and AI have led to changing demands in terms of employees' skills (e.g., Verma et al., 2023; Wilson et al., 2017). Increasingly, smart skills are needed to leverage information technology (Nair et al., 2024). Here, smart skills are defined as the abilities needed to use and appropriate technologies (Trotta et al., 2024). The rise of the Industry 5.0 (I5.0) concept sets new requirements to both the technology and the skills needed to utilise them (Oeij et al., 2024). The nature of the I5.0 context in which organisations operate implies that technology adoption is not static. Instead, technology and manufacturing processes are continuously modified and customized to meet user requirements and needs (Carroll et. al., 2003; Dix, 2007). Vice versa, skill requirements also change continuously as the use changes. Thus, employees are not only faced with a shift to smart skills but also need to continuously develop smart skills as they appropriate smart technologies.

Organisations have an important role in facilitating and enhancing the continuous development of employees' smart skills as it can drive innovation and performance in the workplace (Oeij et al., 2021). Organisations do so through adopting concepts such as workplace innovation (WPI) and human-centered design (ISO 9241-210; Oeij et al., 2017). In addition, organisations use related (HR) practices such as formal training, supervision, feedback from peers, and on-the-job training. These concepts and practices are often not effective for the continuous and multidisciplinary development of employees' skills (Torraco & Lundgren, 2020). Hence, organisations seem to lack a manner with which continuous and multidisciplinary updating of these skills can be facilitated and enhanced (e.g., Ardichvili, 2022). Additionally, organisations seem to have an internal focus when it comes to employee development, whilst an external focus has proven to be effective learning practices (Hardy et al., 2003; Koster, 2024) Thus, organisations need a novel approach to skills development that goes beyond collaboration within their own organisation and fosters continuous development of employees' smart skills.

Recently, learning communities have emerged in Europe to address the much-needed development of modern employee skills, such as smart skills (e.g., Corporaal et al., 2021; Gelten et al., 2023; van Rees et al., 2022). Especially interorganisational skills learning communities (ISLCs) seem promising as these provide employees to work in dedicated learning focused communities with different people and organisations in different but innovation-oriented contexts. Also, they can provide organisations with support and knowledge about the required smart skills that they are missing (Dingyloudi & Strijbos, 2020; Gebauer et al., 2020). We define an ISLC as an interorganisational public-private partnership in which learning, researching, working and innovating are brought together in a hybrid learning environment that offer learning to all parties involved (Dingyloudi & Strijbos, 2019; Topsectoren, 2019). We further specify learning as the extent to which all parties have achieved continuous development of their employee smart skills (from now on ISLC

effectiveness). The manner of which to achieve ISLC effectiveness can be different in every ISLC as the context changes. This context is determined by external demands and characteristics of the whole ISLC (i.e., contextual dimensions) (Daft, 2020). Examples of external demands include the specific skills that should be learned or a need for additional funding. Contextual dimensions relate to the number of participants in the ISLC, level of agreement over ISLC-goals, level of trust between participants and the difference between participants in terms of learning needs and background (Provan & Kenis, 2008; Schipper et al., 2023).

Principles for designing effective ISLCs in specific contexts and fields such as engineering (Gelten et al., 2023), the installation sector (Corporaal et al., 2021; van Rees et al., 2022), and logistics (Hofstra et al., 2021; Preenen et al., 2021) have been defined and studied. There are also first initiatives that set out to summarise these design principles for ISLCs (Kerngroep Netwerk Learning Communities, 2023). We understand design principles as general guidelines based on current knowledge that informs the specific design of the ISLC. Furthermore, recent publications have contributed by specifying design elements that are relevant to designing an ISLC (Schipper et al., 2023). Design elements, or structural dimensions, are the choices that design professionals make regarding internal characteristics of the ISLC (Daft, 2020). Overall, the growing body of literature and initiatives for ISLCs show promise regarding facilitation of employee smart skill development.

Despite the promising impact of skills LCs, current design principles do not facilitate ISLCs that aim to continuously develop employee skills. More specifically, current design principles inform the design of an ISLC given a specific set of skills that need to be developed in a given context. However, the required skills of employees continuously change, participants may change and the levels of trust amongst participants may fluctuate over time. This may result in the need to change the design of an ISLC to cater to ISLC effectiveness (Provan & Kenis, 2008). In addition, as changes in the context occur at an increasing rate the design of an ISLC would benefit from being less prone to changes in skill requirements and enhanced adaptation to continuously changing contextual dimensions as well. Therefore, ISLCs should be designed for adaptability to the context such that the ISLC remains effective over time.

In order to facilitate the design of adaptive and effective ISLCs, solitary insights of learning community literature, network theory (Provan & Kenis, 2008) and Modern Sociotechnical System (MSTS) theory (de Sitter et al., 1997) are integrated. The theoretical integration in the present study is valuable and unique for several reasons. Firstly, MSTS theory provides design elements and strategies that help an ISLC to become more adaptable and less prone to changes in the context. Secondly, MSTS theory and Network further enhance our understanding of how design elements and contextual dimensions interact with each other to attain an effective ISLC. Thirdly, MSTS theory and Network theory allow for a fine grained categorisation of terms that have been used in ISLC design literature. The proliferation of a broad array of design terms such as building blocks (Mariotti, 2012; Schipper et al., 2023; Preenen et al., 2021), principles (Corporaal et al., 2021), structural properties (Provan & Kenis,

2008), prerequisites (Van Rees et al., 2022), guidelines (Gelten et al., 2023) and success factors (Hofstra et al., 2021) underscores the fragmentation of existing literature and a need for one comprehensive overview for designing ISLCs that integrate all the aforementioned terms. Fourth, Network theory adds insights about the role that governance plays in the adaptability and effectiveness of an ISLC. This theory is particularly valuable as it further specifies which governance structures fit particular contextual dimensions of the ISLC to remain effective (Provan & Kenis, 2008).

Approach of the paper

Below, we present a novel design framework for effective and adaptable ISLCs. This framework provides clarity on how to design on micro LC-, cluster-, and ecosystem level.
We do so through (1) a literature scan of research on skills learning communities, and (2) a theoretical integration of MSTS and network theory. First, we describe the design fundamentals of learning and governance structures that contribute to adaptable and effective ISLCs. Second, we apply these insights to the design of a learning structure at ecosystem-, cluster- and micro level. Third, our understanding of design fundamentals are applied to the design of a governance structure at micro-, cluster- and ecosystem level. These findings are summarised into a comprehensive design framework for adaptable and effective ISLCs. We end with conclusions and theoretical contributions, practical implications and suggestions for future research.

1. Design fundamentals for adaptable and effective ISLCs

In this chapter, we integrate ISLC design literature with insights of MSTS and network theory to provide design principles, strategies and sequences to follow for adaptable and effective ISLCs. More specifically, we first specify the general goals we try to achieve with an ISLC design. Different levels in an ISLC design are then explained. We subsequently elaborate on the design principles that should be followed. Then the strategies that can be used to achieve this are described. Finally, we lay out the design sequence that should be followed when applying the aforementioned design strategies and principles.

1.1 General goals of an ISLC

In our study we have defined ISLC effectiveness as "the extent to which learning is stimulated and activated in employees to continuously develop their skills". Corporaal et al. (2021) describe three general ISLC goals that, if achieved, contribute to ISLC effectiveness: (1) all participants learn, (2) the collaboration is purposeful, and (3) both formal and informal learning activities are integrated. We add a fourth goal which is the ability to adapt the ISLC over time such that the former three goals are still met. An ISLC should have interactive relationships which support and reinforce each other with respect to achieving all four general ISLC goals (de Sitter et al., 1997). See table 1 for a more thorough description.

Table 1. Description of general ISLC goals based on Corporaal et al. (2021) and de Sitter et al. (1997)

ISLC goal	Description
All participants learn	A starting point is that everyone can determine what should be learned and engages in reciprocal learning in which participants alternate between the role of student and teacher. To ensure all participants learn it is important to determine what knowledge is missing in the ISLC and which learning activities fit. Based on this a shared vision and goals is created to foster commitment, mutual understanding and cooperative activities.
The collaboration is purposeful	In a purposeful collaboration the information is shared, activities are altered, resources are shared, and participants are willing to help others. Through these collaborative activities the participants learn. Collaborative learning can be further enhanced through the use of facilitators, interaction with knowledge-experts, peer guidance, group brainstorming, peer reviews or debates. Finally, collaboration is multi-disciplinary by nature given that the learnings of employees should lead to new behaviour in practice.
Formal and informal learning activities are integrated	A prerequisite for integration of formal and informal learning activities is to understand the implicit (i.e., know-how) and explicit (i.e., know-that) knowledge present in the ISLC participants. The relevant workplace goal determines what kind of learning activity the participant will participate in. Reflection is subsequently used to find out which learning activity should be chosen. This approach leads to integration of informal learning activities (e.g., observation, experimenting with new products and brainstorming) and formal learning activities (e.g., online learning modules, presentations and trainings).
General goals are met when circumstances change	Learning vision and goal, learning activities and collaboration should be organised in such a way that they can be adapted when needed. Governance activities such as reflection and expert sessions are fundamental for monitoring internally and externally a need to change.

1.2 Learning and governance structure at different ISLC levels

An ISLC is a collaboration between multiple organisations that require design on both micro-, cluster- and ecosystem level. All three levels the design should encompass a structure for shaping and execution of learning activities, and a structure for governance of learning activities. Learning structures are understood as the organisational structure and responsibilities, the learning climate, the nature of the learning activities, where these activities take place, and whether they are more learner-directed or facilitator-directed (Poell et al., 2000). Learning actors are the employees who "co-organise their learning on the basis of their ideas and interests, instead of reducing their participation to being at the receiving end of a training course" (Poell et al., 2000, p. 32). Moreover, a governance structure entails a feedback loop consisting of monitoring, evaluating, and adapting activities (de Sitter et al., 1997; Provan & Kenis, 2008). Evaluation processes have proven to be useful for knowledge

creation and learning and can differ in frequency, form and on which level is evaluated (Katz & Earl, 2010). Finally, a follow-up process warrants that suggested improvements in the evaluation a adopted (Schipper et al., 2023).

The micro-level entails the design of a single learning community that focuses on a specific skill at a specific level that an employee should learn (from now on micro LC) (van Rees et al., 2022). However, employees need a broad array of skills to work and appropriate technologies. Therefore, within an ISLC there will be several micro LCs to cover all the necessary skills that should be developed for technology usage and appropriation. The cluster-level is the design of groups of micro LCs that cover similar skills. The ecosystem level is the overarching ISLC that contains all clusters of micro LCs that cover similar skills as well as contain all participating organisation that want their employees to continuously learn skills to work with and appropriate technologies. For instance, smart skills for AI literacy can be a focus of an overarching ISLC. The ISLC would then contain several clusters that focus on specific skills that employees should obtain such as the ability to recognise AI, understand intelligence, and interdisciplinarity of AI (Long & Magerko, 2020). Overall, most literature on ISLCs have focused on the design of the micro-level (e.g., Corporaal et al., 2021; van Rees et al., 2022) whilst some have also paid attention to shaping learning activities on ecosystem level (e.g., Schipper et al., 2023). We integrated MSTS and network theory to also specify how the governance structure on cluster and ecosystem-level should be designed. See figure 1 for a visualisation of the ISLC design levels.

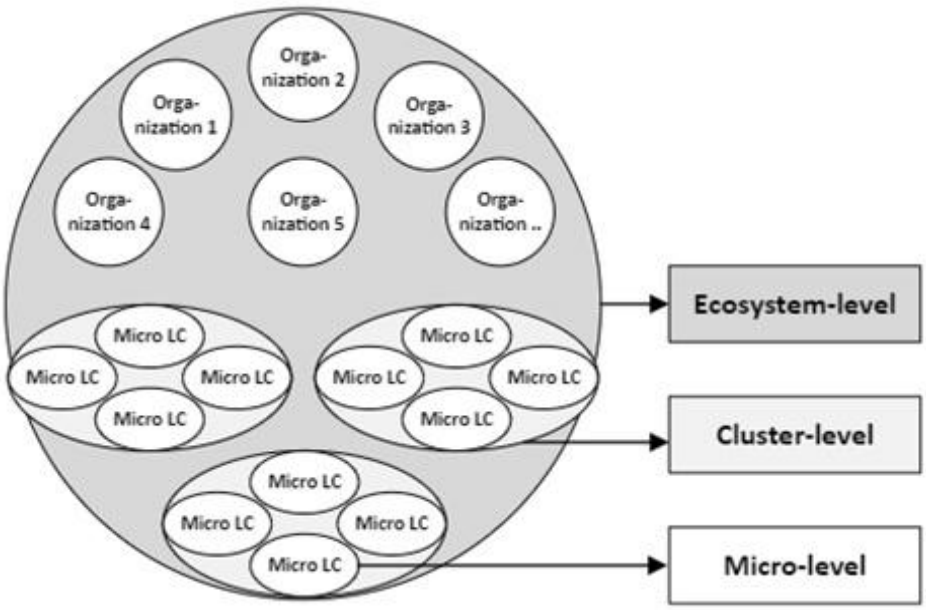


Figure 1. Overview of different design levels of an ISLC

1.3 Principles for designing ISLCs

ISLCs are complex collaborations between multiple organisations and stakeholders, with varying goals, and a structure that changes over time. Following MSTS, an ISLC structure

should jointly optimise a multitude of goals of both participating organisations and participants of micro LCs. To achieve this, interactive relationships between social and technical elements of the ISLC should be identified and designed (de Sitter et al., 1997). For instance, hosting a learning community meeting consists a set of relations between social (e.g. behaviours) and technical (e.g., facilities for the meeting) elements. These sets of relationships can differ as learning goals can vary. Depending on the learning goal of that meeting, the learning activities can differ, the role of the facilitator can be different, and a suitable physical or digital location can be chosen (Corporaal et al., 2021). However, designing interactive relationships between all social and technical elements of an ISLC would lead to an inability to deal quickly and adequately with changing demands in learning or from external stakeholders. To mitigate this, designers should follow these two principles (de Sitter et al., 1997):

1. Reduce disturbance probabilities by a reduction of impending variety;
2. Reduce disturbance sensitivity by an increase in governance capacity.

The reduction of the impending variety is addressed in the design of the learning structure. The learning structure can be split, coupled or differentiated into different learning tasks, activities and roles to limit the variation within these functions. The differentiation, split and coupling of these learning functions enhance the options for process variation (de Sitter et al., 1997). An ISLC can consequently offer flexible learning pathways, customized learning resources, differentiated instruction, or collaborative learning opportunities. De Sitter et al. (1997) indicate that the design of the governance structure should ensure that these options for process variation are utilised if required. This requires the governance structure to have sufficient governance information to effectively manage and coordinate the learning processes. This can be done by monitoring, evaluating and adapting the learning activities.

1.4 Design strategies

De Sitter et al. (1997) have formulated various design strategies in relation to the aforementioned design principles. These design strategies address the specific design of an ISLC following that particular strategy (see table 2).

Table 2. Design strategies derived from de Sitter et al. (1997)

Focus	Strategy	Description
Learning structure	Parallelization	Reduction of the impact of variation of what should be learned on the required number of relations between participants through the introduction of independent parallel learning pathways. These pathways correspond to the different external requirements of what should be learned. For example, learners with different skill levels or learning objectives may be grouped into separate cohorts or tracks, allowing for tailored instruction and support.

	Segmentation	Reduction of required number of relations, communication, and information sharing between participants through clustering of smaller learning tasks, activities and roles that have minimum interaction points with other clusters. This requires clustering of learning functions that have a maximum mutual interdependence.
Governance structure	Unity of time, location and action of governance activities	Governance activities are closely aligned with the specific time and place where learning processes occur and are selected based on close monitoring and evaluation of the learning processes (i.e., a governance cycle). Related goals are that timely feedback can be given, real-time interaction can be achieved if needed, both off-site and on-site learning can be integrated, learning events can be coordinated and the technological infrastructure can be used in a supportive manner.
	Bottom-up allocation of governance cycles	The allocation of governance cycles on workstation level or on whole-task group level. This is possible if preparatory, supporting and execution of learning tasks, activities and roles are deconcentrated independent flows of whole task segments. These are typically created through parallelization and segmentation.
	Building governance capacity in every task	Every individual for every task they execute receives sufficient governance information to steer their own learning activities such that they can achieve the individual and collective learning goals that are associated with the task.

1.5 Design sequences

The design process encompasses which design questions come first and who should be involved. To facilitate in the design process, we have adopted the design sequence rules from de Sitter et al. (1997) and applied this to the context of an ISLC. This design sequence provide clarity that designers should first set-up the learning activities in an ISLC following a top-down approach. They should subsequently design the governance structure bottom-up including appropriate governance cycles. See table 3 for more details.

Table 3. Rules for the design process of an ISLC based on de Sitter et al. (1997)

Sequence rule	Description for an ISLC
Design the learning structure first and then proceed with the design of the governance structure	The work processes in which participants learn to continuously develop employees' skills should be set-up before processes for information flow are set up form and to participants.
Design the learning structure top-down	Establish a work process by first identifying potential parallel flows. After this, learning activities can be segmented. Finally, the structure of the parallel and segmented smaller learning community learning activities that foster collaboration and engagement should be designed.

The design of the learning structure precedes the design of process technology	After establishing the work processes it can be defined who needs which process technology to assist their work processes.
Design the governance structure bottom-up	Starting with the identification and design of individual support elements, such as mentoring programs and resources, and then gradually scaling up to interlocal support systems such as intervision between micro LCs, and global support systems such as an external support network.
Design governance cycles according to the sequence: allocation, selection and coupling	Support elements should be allocated based on the specific needs and requirements of the skills learning activities, tasks and roles. The selection of support elements should consider the primary dimensions of support required in each context. Couplings between different support elements should be determined to ensure timely and effective support deliver

2. Structure for learning in an ISLC

This chapter describes the first step of designing adaptable and effective ISLCs. Here, we delve into designing the structure of learning activities for participating employees from a top-down approach. A top-down approach means that we first set up the ecosystem-level structure that enables the shaping of learning activities, then we design the clusters of learning activities and finally we design the micro LCs.

2.1 Ecosystem-level foundations for shaping learning activities

As a first step, participating organisations establish the focus of the ISLC. Then, they decide on a strategy for achieving this. Participating organisations are typically represented by professionals that are responsible for skill development at their respective organisations. At the end of this design step, participating organisations should have agreed upon the subject and strategy of the ISLC (Schipper et al., 2023). For instance, in the production sector organisations continuously digitise their organisation to the point that they start to integrate AI into their systems (Zhang et al., 2021). This pushes the need for production workers to be able to work with, and appropriate, AI. Therefore, production organisations could decide to focus on the topic of "AI literacy" for the ISLC (Long & Magerko, 2020). After this, participating organisations discuss the strategy for continuously developing AI literacy for their production workers.

We use the definition of Oeij et al. (2021) who described a strategy as "the determination of the long-term goals and objectives of an enterprise, the adoption of courses of action and the allocation of resources necessary to carry out these goals" (p. 201). In the context of an ISLC the challenge is to formulate a collective strategy that brings together different strategies of participating organisations as well as their own learning needs (Schipper et al., 2023). In the process of doing so, it is important to consider the following factors for building

a collective strategy: "create and align common goals between organisations, secure equal commitment from all parties involved, overcome cultural differences, establish forms of communication as well as roles, and work across organisational boundaries" (Smith & Thomasson, 2018, p. 194).

As collective long-term goals and objectives are created the next step is to build a course of action to achieve this. The learning activities of an ISLC should be shaped such that they are less prone to changes. MSTS provides valuable input for this through a parallelization strategy. This can be achieved through grouping independent learning pathways for developing employee skills (de Sitter et al., 1997). These pathways correspond to different skills that should be learned to work with a given technology. Employees with different skills or learning objectives may be grouped into separate cohorts or tracks, allowing for tailored instruction and support. For example, a micro LC about learning skills for working with AI can be grouped into learning pathways that are fitting. In addition, these learning pathways could focus on different cohorts of learning objectives of the production workers such as computer vision, Natural Language Processing (NLP) and reinforcement learning in production settings. We view the creation of a collective strategy as an ongoing and iterative design process. Commitment, individual goals, roles and forms of communication can all change over time as participants in the ISLC change, skill demands change due to technological developments, or strategies of participating organisations change. Therefore, the collective strategy is continuously monitored, evaluated and adapted to these changes. This process will be part of the ecosystem-level governance structure in chapter 3.

2.2 Clusters of learning activities

When parallel learning pathways are shaped, they can be clustered into smaller segments of learning activities which have minimum interaction points with learning activities of other clusters. If a skill requirement then changes due to technological developments then it only affects a smaller portion of the micro LCs. The whole ISLC is therefore less prone to these changes.

Segmentation requires clustering of learning functions that have a maximum mutual interdependence. For instance, in a micro LC focused on interaction skills for working with artificial intelligence the employees first learn beginner level things (e.g., fundamentals of AI), they learn moderate level things in segment 2 (e.g., AI algorithms and techniques), moderate to high level things in segment 3 (e.g., AI interaction in production), and finally advanced level skills in segment 4 (e.g., ethical and responsible use of AI in a production setting). Figure 2 shows a visualisation of clusters of micro LCs in an ISLC.

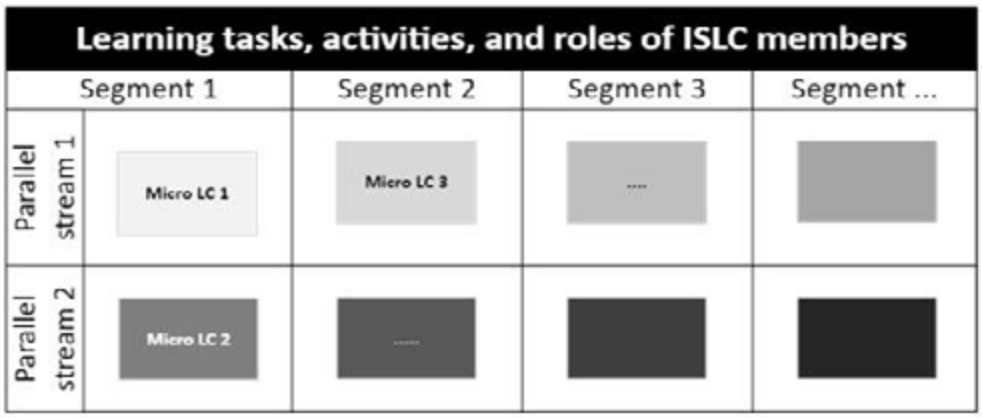


Figure 2. Overview of the clusters micro LCs

2.3 Design of micro LCs

Within every cluster there are several micro LCs that should subsequently be shaped. Micro LCs entail the actual learning tasks, activities, and roles that are executed in this ISLC. When shaping these micro LCs, designers should decide upon (1) the timespan, (2) form of meetings between participants of the micro LC, (3) the role of the facilitator, (4) the number of participants, and (5) the degree of heterogeneity of the participants in the micro LC, (Corporaal et al., 2021; Schipper et al., 2023).

The time span of an ISLC is an important consideration as it influences the time that a micro LC focuses on learning a specific skill at a given level. In the context of continuously updating skills and need for adaptability of the ISLC, it is advisable to adopt a structure that facilitates a shorter time span. The adoption of a Scrum format with cycles of ten weeks is an example of such a structure. For example, in the installation sector the participating organisations worked on achieving collective objectives during a time span of ten week (Corporaal et al., 2021). It is advised that during these ten weeks physical meetings are held between participants of the micro LC such that could foster knowledge sharing and learning. Physical meetings are preferred in contrast to digital meetings as they enhance higher levels of trust, reciprocity and identification of the group which, in turn, contribute to knowledge sharing and learning (Schipper et al., 2023).

The role of the facilitator can vary depending on the chosen collective strategy, the needs of micro LC participants, and the available (human) resources. A facilitator is tasked with the guidance of participants of a micro LC through their day-to-day activities (Li et al., 2009) and the providence of possibilities and resources without interfering in the process (Nyström et al., 2014). There are, however, several types of roles in which a facilitator can do this. They could do this in a fixed or rotating role among ISLC actors (Vangrieken et al., 2017), the facilitators could be an external or internal person (Van Rees et al., 2022), or they could have the role of a 'knowledgeable other' (Takahasi & McDougal, 2016). In sum, depending on the context, the role of the facilitator could be more content based (e.g., knowledgeable other) or process-based (e.g., scheduling and time-tracking).

The ideal number of participants within a micro LC is scarcely discussed in literature. However, there is evidence that more participants increase the likelihood of disagreement and conflict within a micro LC (Davis, 2016). In an example from the installation sector there seemed to be an indication that a lower number of participants also helps with the agility of the micro LC (Van Rees et al., 2022). In turn, Corporaal et al. (2021) indicated that a micro LC ideally includes six to ten participants. Therefore, although there is limited academic literature available there seems to be evidence that a low number of participants is ideal for adaptable micro LCs.

The degree of network heterogeneity is understood as the difference in knowledge, technology, ability, professions and number of participants in the micro LC (Xie et al., 2016). Heterogeneity of participants seems to be a double-edged sword as it can positively influence knowledge sharing (Rock et al., 2016), but seemingly also negatively influences the agility of the micro LC (Van Rees et al., 2022). Thus, it seems that heterogeneity of participants does not need to be a goal in itself but can be a means depending on the collective goals and strategy of the ISLC.

Example of a micro LC structure

The aforementioned design considerations are incorporated in an example of the design process of a micro LC for production workers (see figure 3 for a summary).

Figure 3. The design process of a micro LC (based upon Corporaal et al., 2021)

First, participating organisations should identify employees who want to and need to develop skills in relation to the chosen subject. Participating organisations should hold orientation talks to identify which micro LCs fit the learning needs of their employees (Corporaal et al., 2021). Consequently, the employees are placed in the micro LCs that fit their learning needs. The learning needs of participants of a specific micro LC should subsequently be the central topic when shaping the learning tasks, activities and roles within this micro LC. Based on the accumulation of learning needs of all participants, the micro LC is shaped in week 1 (Corporaal et al., 2021).

After this, the micro LCs are assembled, including six to ten participants. In the first session, participants discuss their personal learning goals and revisit the shared goal of the micro LC, so that they are clear to all participants. The participants in the learning micro LC remain the same over the ten-week duration and the members can differ in knowledge, abilities, and professions (Corporaal et al., 2021). If the group of participants is relatively homogeneous

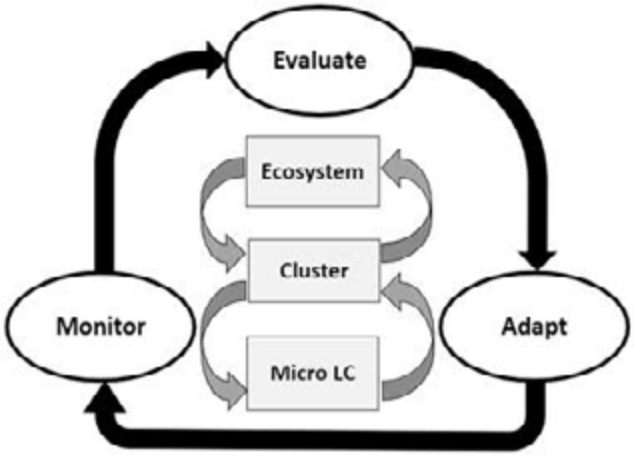
then a facilitator can more likely focus on a role of knowledgeable other. In a heterogeneous group the facilitator should focus more on process guidance (Schipper et al., 2023).

After the assembly of the micro LC, there will be weekly physical work sessions alternating fitting learning activities (< 45') under the guidance of a facilitator. The facilitator guides the participants through the process and adds content knowledge if needed. These weekly work sessions will continue for eight weeks. In the tenth week, a final session will summarise the learnings from the previous nine weeks and preview potential next steps. After completing the learning micro LC, participants will apply the learnings in their daily work (Corporaal et al., 2021). Adaptability is achieved through reflection on the learning process and outcomes after each cycle. Following the reflection, they will then decide whether to initiate a new cycle and what the learning topic will be. This aligns with the viewpoint of Schipper et al. (2023), who emphasised the importance of evaluating and following up on learning activities and outcomes. Chapter 3 further elaborates on the design of these governance mechanisms.

3. Governance structure of an ISLC

This chapter outlines the second step in designing adaptable and effective ISLCs. We examine a multi-level, iterative governance structure using a bottom-up approach, starting with micro LC governance, moving to cluster-level governance, and finally ecosystem-level governance. All governance levels should include iterative monitoring, evaluation, and adaptation of learning activities. Furthermore, governance loops at different levels should interact with one another to provide governance information to all levels (de Sitter et al., 1997; Provan & Kenis, 2008). For instance, facilitators might receive feedback on the specific needs of micro LC participants, such as additional knowledge from extra participants or additional funding for more learning activities. This governance information can be shared by facilitators of a micro LC with cluster-level governance professionals, enabling them to identify broader needs within the cluster. Subsequently, this need can then be shared by cluster-level governance professionals to the ecosystem level, allowing them to determine how to address it through, for example, the acquisition of additional funding, external information, or new learning pathways. See figure 4 for an overview.

Figure 4. Overview of an iterative and multi-level governance structure of ISLCs



In this chapter, we first describe the set-up of the micro LC governance structure. Second, we elaborate on the design the governance structure of the various clusters of micro LCs in the ISLC. Finally, we detail the ecosystem-level governance structure options.

3.1 Governance structure of micro LCs

On the micro LC-level, the governance structure should contribute to the timely delivery of feedback, real-time interaction when needed, integration of both off-site and on-site learning, coordination of learning events, and the use of technological infrastructure in a supportive manner (Corporaal et al., 2021; de Sitter et al., 1997). The participants of a micro LC (1) have their role(s) and responsibilities to support these goals, and (2) they are supported by a facilitator of the micro LC (Corporaal et al., 2021; Schipper et al., 2023).

Firstly, participants of a micro LC can contribute to ISLC governance through their roles in the broader ISLC at both the cluster and ISLC levels. They can undertake twelve role-related tasks, such as initiating network connections, making decisions, influencing others, and balancing actions and relationships within the network to prevent conflicts (Schipper et al., 2023). Additionally, participants may also take on formal or informal leadership roles, which is a crucial determinant of the collaboration process (Nyström et al., 2014). Typically, leaders do not hold formal leadership position within the ISLC structure (Schruijer, 2021). They often facilitate and support members, with roles being either permanent or rotating. However, the literature is unclear on how these leadership styles impact processes and outcomes (Schipper et al., 2023). Nonetheless, MSTS theory indicates governance roles should be allocated from the bottom up, with the governance structure at both cluster and ecosystem levels emerging from this (de Sitter et al., 1997).

Secondly, every participant of a micro LC should receive sufficient information, autonomy, and stimulus to monitor, evaluate, and adapt their learning tasks and activities. To achieve this, employees should first evaluate if they possess the resources to execute their learning activities to achieve their personal and micro LC goals. This can be done through a task and interdependence analysis. First, they analyse all the tasks and required resources related to the learning activities. Then, they establish which interdependencies they might have to supporting tools and technologies for executing the learning activities (Johnson et al., 2019). A facilitator is vital for guiding participants of the micro LC through this feedback loop. A facilitator is tasked with guiding micro LC participants through their day-to-day activities (Li et al., 2009) and providing possibilities and resources without interfering in the process (Nyström et al., 2014). For instance, a facilitator can monitor and evaluate during weekly work sessions of a micro LC. A facilitator has the following tasks that empower participants and contribute to meaningful work (Corporaal et al., 2021; de Sitter et al, 1997):

- Guidance of participants with personal goal-setting.

- Facilitation of mutual shaping of a broad and meaningful set of learning activities of participants that relate to both personal and organisational-level goals.
- Guidance for learning activities that engage both thinking and doing, catering to various participant preferences.
- Support indirect learning activities that enhance participants' work meaning. For instance, a production worker operating a welding machine can also learn quality control or equipment maintenance tasks.
- Guidance of participants in sharing ideas and knowledge related to these activities with other participants of the micro LC.

3.2 Governance structure of micro LC clusters

The governance structure of micro LC clusters entails the monitoring, evaluation and adaptation of learning activities within the cluster. The governance structure has two main functions: (1) governance of the fit between micro LCs in the cluster, and (2) enhancement of governance interactions between micro LC and ecosystem level (de Sitter et al., 1997; Provan & Kenis, 2008). There is limited literature regarding how the cluster governance should be shaped. However, based on design guidelines of de Sitter et al. (1997) and Provan and Kenis (2008) we can establish that the role of a cluster-level governance professional can be either a participant, the lead organisation, or an external party. In that sense, we have taken the role description of a governance manager by Provan and Kenis (2008) and applied the principles of de Sitter et al. (1997) regarding putting responsibilities low in the ISLC hierarchy to enhance governance capacity.

The governance of the fit of the micro LCs with the cluster can be enhanced through the interaction between a micro LC's facilitators and the cluster's responsible governance professional. Governance interactions between micro LCs and ecosystem level can be enhanced through a ‘pass-through’ role of the cluster-level governance professional. It is important to establish interactions between processes on different levels to align governance activities (de Sitter et al., 1997). In addition, frequent interactions between members of the ISLC on different levels can stimulate active participation and facilitate a cohesive network with high trust, learning intention, and explicit and tacit knowledge sharing (Filieri et al., 2014). Cluster-level governance professionals can gather information from facilitators of the respective micro LCs and share a broader need from micro LCs in their cluster with the ecosystem-level governance professionals.

3.3 Governance structure of ISLC ecosystems

After establishing the micro LCs' governance structure, we can design the overarching ISLC ecosystem governance. This includes (1) an appropriate governance form and (2) a structure to govern the ISLC ecosystem during runtime.

The selection of an appropriate governance form

An ISLC ecosystem can be participant-governed or externally governed. Participant-governed networks are, at one extreme, governed either collectively by the members themselves (i.e., shared) or, at the other extreme, by a single ISLC participant that takes on the role of a lead organisation. Externally governed networks are governed by a unique network administrative organisation (NAO) which may be either voluntarily established by network members or mandated as part of the network formation process (Provan & Kenis, 2008) (see Table 4).

Table 4. Governance Forms of an ISLC Adopted From Provan and Kenis (2008)

Governance form	Governing party	Description
Shared governance	Multiple to all participants	Smaller, multi-firm strategic alliances and partnerships in which multiple or al participating organisations collaborate intensively and share ecosystem-level governance activities.
Lead organisation	One lead Participant	There is a core provider organisation that assumes the role of network leader because of its central position in the flow of clients and key resources. For instance a common supplier for all participants. In this form, lead organisations take most strategic and operational governance decisions.
Network administrative organisation (NAO)	External party	An external party executes all ecosystem-level governance activities. It requires greater involvement by at least a subset of participating organisations (often, NAO governing board members for monitoring governance actions of the NAO) that are committed to ISLC-level goals and have a strategic involvement with the network as a whole. Other participating organisations are less involved. This typically enhances network legitimacy, helps with dealing with unique and complex network-level problems and issues, and reduces the complexity comparted to governance. Additionally, government run NAOs stimulate growth through targeted funding and/or network facilitation to achieve goals.

The chosen governance form of the ISLC should accommodate the characteristics of the whole ISLC. More specifically, (1) trust, (2) number of participants, (3) goals consensus, and (4) need for network level competencies should be considered when choosing an appropriate governance form for the ISLC (Provan & Kenis, 2008).

Trust is "the willingness to accept vulnerability based on positive expectations about another's intentions or behaviours" (McEvily et al., 2003, p.92). For understanding network-level interactions, however, the distribution of trust is critical and whether or not it is reciprocated among network members. High density of trust is when trust across members is widely distributed across members, and low density of trust is when trust is only narrowly distributed such that it is occurring differentially within individual dyads or cliques (Provan &

Kenis, 2008). As it takes time to establish these relationships and trust, this is a vulnerable process when members join or leave the ISLC (Vangrieken et al., 2017). This is the case as the power of members in the ISLC shapes both group dynamics and team learning (Yorks et al., 2003). In addition, there can be knowledge boundaries between and across organisations depending on the elements such as differences in beliefs, content expertise, industry expertise, language, interests and other team diversity elements (Schipper et al., 2023). As mentioned before, A way to tackle these challenges could be to design for frequent interactions between members of the organisation such that active participation is stimulated and a network with high trust, learning intention, and explicit and tacit knowledge sharing is developed (Filieri et al., 2014). Overall, high-density trust seems more crucial for participant-governed ISLCs, which require a lot of collaboration and decrease in importance as collaboration decreases.

The number of participants in an ISLC can be defined as the number of organisations participating in the ISLC (Provan & Kenis, 2008). There is evidence that more partners increase the likelihood of disagreement and conflict and therefore increases the complexity of governing the ISLCs (Davis, 2016; Provan & Kenis, 2008). Disagreement and conflict can have several negative consequences such as a disturbance in the professional and reflective dialogue in the ISLC or a reduced identification with the community which, in turn, could lead to reduced learning outcomes. A suitable network form can mitigate risks of a high number of participants through reduced number of interactions required for ecosystem-level governance (Provan & Kenis, 2008). For instance, the lead organisation form is highly centralised and requires less interactions between participating organisations about governance activities which reduced the chances of conflict and, in turn, increases the number of participants that this governance form can effectively operate with.

Goal consensus is the extent to which participating organisations agree on ISLC-level goals. Provan and Kenis (2008) describe examples such as reducing conflict among participants, attracting funding for the ISLC, addressing community needs, or improved service to participating individuals. However, goal consensus does not mean that the goals of participating organisations should be similar. Goal consensus allows participants to perform better when there is conflict whilst conflict can also be a stimulant for innovation. High goal consensus can lead to more commitment of network members and collaboration amongst network members. However, high goal consensus is not always required as networks can still be effective when they have a suitable governance form (Provan & Kenis, 2008). A highly centralised governance structure requires lower goal consensus as interactions between participating organisations are less frequent. In this sense a shared governance structure would require high goal consensus, and a lead organisation form requires low goal consensus.

Network-level competencies are competencies required to achieve network-level goals and different network governance forms require the members of the network to provide different competencies and different levels of these competencies. Network-level competencies can

be divided into internal and external competencies. Internal competencies refer to the nature of the tasks that are performed by network members and external competencies refer to the competencies to deal with external demands and needs the network is faced with. Internally, if the network's task is one that requires significant interdependence among members, then the need for network-level coordinating skills and task-specific competencies will be great, meaning that governance needs to facilitate interdependent action. Externally, demands may also range from high to low, requiring varying degrees of competencies at the network level. External tasks may include the roles of buffering, or protecting the network from environmental shocks such as shifts in funding or new regulations, and bridging, which might include the roles of lobbying, seeking out new members, acquiring funding, building external legitimacy, and so on (Provan & Kenis, 2008). In the context of an ISLC external network-level competencies may include the competencies to deal with changing requirements in terms of the skills that participants of micro LCs should learn. As we reason under the assumption that ISLCs should deal with constantly evolving smart skills requirements, an ISLC should have a high level of external network-level competencies. In this case, an NAO seems best equipped to deal with high need for network-level competencies as an NAO deploys network-level staff to develop the skills that are needed for network-level actions. This means that members are better equipped to deal with high competency demands such as interdependent tasks and external demands.

Overall, trust, number of participants, goal consensus, and the need for network-level competencies affect which governance form of the ISLC is effective. For instance, as trust becomes less densely distributed throughout the network, as the number of participants gets larger, as network goal consensus declines, and as the need for network-level competencies increases, brokered forms of network governance, like lead organisation and NAO, are likely to become more effective than shared-governance networks (Provan & Kenis, 2008). Table 5 shows the possible combinations contextual dimensions and governance forms leading to effective ecosystem-level governance.

Table 5. Configurations that lead to effective ecosystem-level governance (Adopted From Provan & Kenis, 2008)

Governance forms	Trust	Number of participants	Goal consensus	Need for network-level competencies
Shared governance	High density	Few	High	Low
Lead organisation	Low density, highly centralised	Moderate	Moderately low	Moderate
NAO	Moderate density, NAO monitored by members	Moderate to many	Moderately high	High

Governance of the ISLC-ecosystem during runtime

The characteristics of the ISLC develop over time. Therefore, a fit between governance forms and ISLC characteristics is crucial, not only during design phase but also during runtime.

Practitioners should distribute governance tasks among ISLC members if a shared governance form is chosen, or assign a governance manager if a lead organisation or NAO form is adopted (Provan & Kenis, 2008). In both cases, these professionals should follow the principles listed below (adopted from Provan & Kenis, 2008):

- *Principle 1:* ensure consistency between characteristics of the whole ISLC and the governance form.
- *Principle 2:* adopt shared network governance if trust is widely shared among network participants, when there are relatively few network participants, when the network-level goal consensus is high, and when the need for network-level competencies is high;
- *Principle 3:* adopt lead organisation governance if trust is narrowly shared among network participants, when there are a relatively moderate number of network participants, when network-level goal consensus is moderately low, and when the need for network-level competencies is moderate
- *Principle 4:* adopt NAO network governance if trust is moderately to widely shared among network participants, when there are a moderate number to many network participants, when network-level goal consensus is moderately high, and when need for network-level competencies is high.
- *Principle 5:* as a network manager, recognise and respond to the following three basic tensions, or contractor logics, that are inherent in network governance; (1) efficiency versus inclusiveness, (2) internal versus external legitimacy, and (3) flexibility versus stability
- *Principle 6:* periodically evaluate the contingencies of the network to change the network governance accordingly.

4. A design framework for adaptable and effective ISLCs

In this chapter, we summarise the application of design fundamentals from chapter 1 to the design of the learning structure and governance structure of an ISLC into one comprehensive design framework. With this framework we adopt both design strategies, principles and sequences from MSTS theory for shaping learning structures. In addition, we integrated design principles, strategies and sequences from both MSTS theory and network theory for designing a governance structure. These insights have been integrated with learning community literature to create a comprehensive design framework (see figure 5).

The design framework starts at the left of the model with designing the ISLC-level foundations. In this step the participating organisations of the ISLC, the subject, and the strategy are established (see chapter 2.1). In the next design step the clusters of micro LCs are formed through segmentation and parallelisation, and the design of the micro LCs themselves is shaped (see chapters 2.2 and 2.3). Finally, an iterative and multi-level governance structure is set up following a bottom-up approach (see chapter 3). This, together, creates the design of an adaptable and effective ISLC.

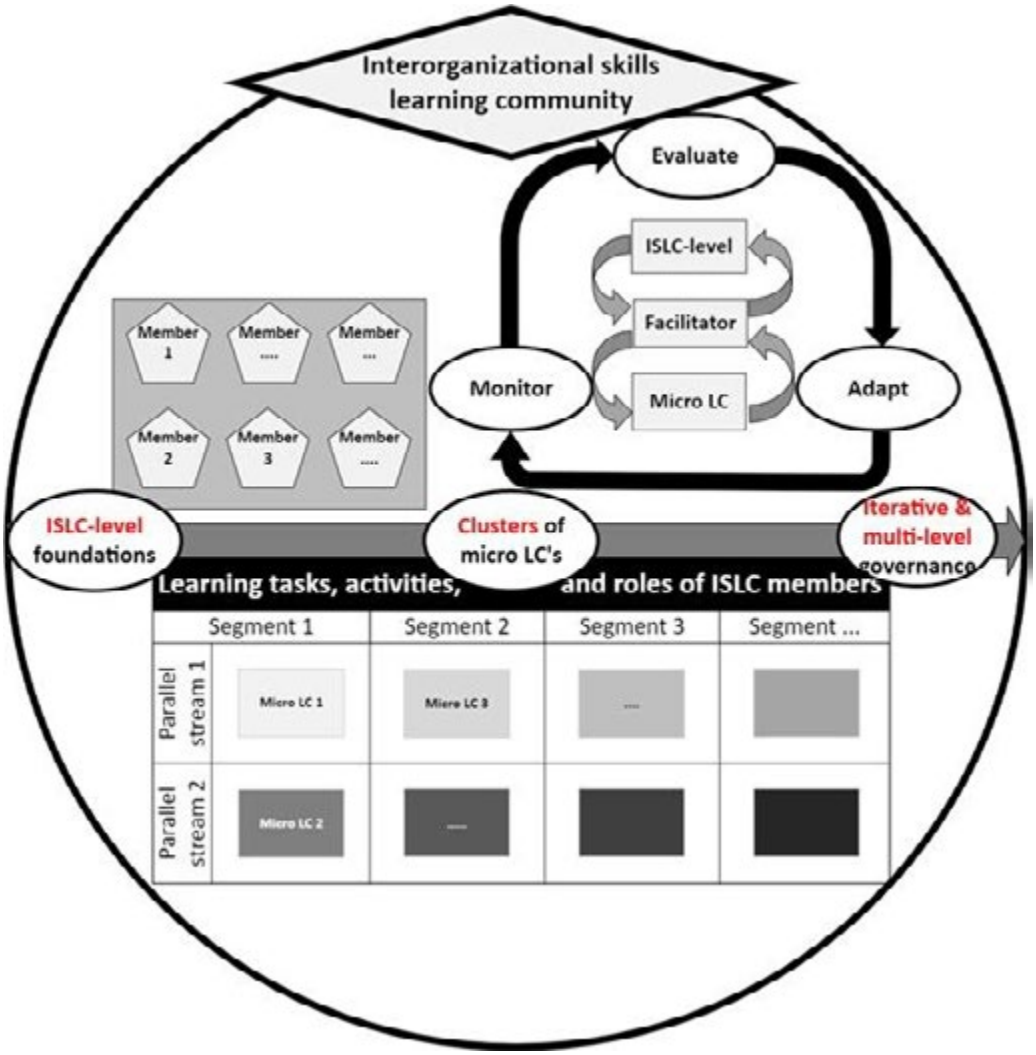


Figure 5. A conceptual design framework for adaptable and effective ISLCs

5. Conclusions and discussion

In this chapter, we discuss which conclusions can be drawn from our theoretical integration study, along with its theoretical and practical implications. Lastly, we identify limitations and outline future research opportunities.

5.1 Main conclusions and theoretical contributions

Our main goal was to establish a first comprehensive design framework that facilitates the design of adaptable and effective ISLCs. We found that it is crucial to reduce disturbance probabilities of the ISLC and improve governance capacity to be able to adapt to changes more effectively. In our study, we have developed a design framework that specifies how these design principles can be achieved. In sum, we found that it is pivotal to (1) distinguish

different design levels, (2) distinguish between design of a learning structure and governance structure, (3) follow a specific design sequence, (4) cluster micro LCs, and (5) design iterative, interactive and multi-level feedback loops.

We found that ISLCs are designed at the ecosystem, cluster, and micro LC levels. These design levels apply to both the learning and governance structures of an ISLC. One should first design the learning structure from the top down and then the governance structure from the bottom up. The learning structure should contain clustering of micro LCs through parallelisation and segmentation design strategies. Finally, the governance structure must include feedback loops for monitoring, evaluation, and adaptation via a bottom-up approach, interacting with loops at other levels. These findings contribute to a novel design framework for developing adaptable and effective ISLCs.

Implications for workplace innovation and learning community research in I5.0

Workplace innovation (WPI) emphasizes a skilled workforce with decent jobs as a driver for innovation and performance (Oeij et al., 2021). WPI incorporates MSTS theory and other sociological research into four aligned bundles of practices: (1) Jobs, Teams & Technology, (2) Employee-Driven Innovation & Improvement, (3) Organisational Structures, Management and Procedures, and (4) Co-Created Leadership & Employee Voice (Oeij et al., 2017; Oeij et al., 2021). This study aims to enhance workplace innovation by developing an interorganisational solution to the skills challenge organisations in the I5.0 context face. Our approach uniquely integrates principles similar to WPI, such as MSTS design, into this solution for a skilled workforce. This supports Prus et al.'s (2017) assertion that "in order to face the conceptual fuzziness and instability of workplace innovation, future research privileges a context-aware view of innovation. Scholars may learn more about possible ways to identify and justify relevant boundaries for analysis of WPI" (P. 1264). Prus et al. (2017) noted that exploring these boundaries at the ecosystem level, as in this study, adds value to concepts addressing boundaryless, ubiquitous, and digital workplaces. Thus, our contributions to workplace innovation include developing a design framework that offers an interorganisational solution to skill development in I5.0.

In this paper, we contribute to existing theory of interorganisational learning and learning community design through the integration of MSTS theory (de Sitter et al., 1997) and network theory (Provan & Kenis, 2008). This integration is particularly valuable as it can facilitate continuous skill development in I5.0 by designing adaptable ISLCs, which are currently lacking in the literature. More specifically, we add to existing ISLC literature (Corporaal et al., 2021; Schipper et al., 2023) by identifying three levels of an ISLC, distinguishing between the design of a learning structure and a governance structure, specifying the design principles, explaining the design sequence, and describing design strategies. These new insights are subsequently applied to the context of designing an ISLC that does not exist in the current literature. This approach can be particularly valuable for the dynamic and fast-changing I5.0 as the governance structure is designed to adapt to continuous changes. Therefore, this

paper not only adds to the current state of the literature but also has practical implications for design professionals.

5.2 Practical use of the design framework

Although design and governance professionals should merely use the design framework as a basis and then apply it to their context, it holds unique value for both ISLC design and governance professionals. The framework offers a step-by-step guide for design professionals for setting up adaptable and effective ISLCs. However, the design framework also provides guidance for governance professionals. ISLCs develop over time, meaning that the governance structure should be managed such that the ISLC remains effective. The responsible professional is dependent on the chosen governance form. If an NAO is adopted, then an external professional is responsible for managing the governance structure. If a shared or lead organisation governance structure is adopted, then a professional is chosen who participates in the ISLC (Provan & Kenis, 2008). According to Provan and Kenis (2008), a governance professional should have the following tasks:

- Recognise and respond to the following three basic tensions that are inherent in ISLC governance; (1) efficiency versus inclusiveness, (2) internal versus external legitimacy, and (3) flexibility versus stability;
- Continuously monitor, evaluate and adapt current governance practices on ecosystem-level;
- Continuously monitor and evaluate the characteristics of the ISLC and adapt the governance form accordingly.

We suggest that such a governance professional also be in close contact with professionals who execute governance tasks on cluster and micro LC-levels. This interaction is vital not only for executing the aforementioned tasks but also for providing information and resources to other participants in the LC who are tasked with governance activities on their respective levels.

Finally, our design framework could hold practical value for governmental and regional policymakers that are in charge of skilling issues. Examples could be enhancing continuous development of production workers' skills in eastern Netherlands (e.g., Saxion, n.d.), or the national initiative in the Netherlands to upskill and reskill workers to address the tight labour market (*Smart skills at scale*, n.d.). These policymakers could benefit from our design framework as it facilitates effective regional and national interorganisational collaborations that could strengthen the economy (Cascio, 2019).

5.3 Future research

Although our paper has significantly contributed to ISLC design literature, several issues must be addressed. First, we have done a theoretical integration that conceptually studies the subjects of adaptable and effective ISLCs. While this enriches understanding of designing ISLCs, it is not comprehensive (Elsbach & Knippenberg, 2020). This means that our design framework requires empirical research to assess its reliability and validity. Empirical research in the I5.0 context is especially necessary, as this context demands continuous skill development. More specifically, it should be evaluated which configurations should be selected for ongoing skill development for a particular set of individual and ISLC goals, and how this is governed over time.

Second, the design framework dictates what designers should do in which sequence, and under what circumstances. However, this study has not delved into the role of the designer. Future research could address this gap by specifying the ISLC-designer role, their tasks and contextual factors to consider that could influence these roles and tasks.

Third, more research should be done regarding the design elements and contextual dimensions of an ISLC, such that additions can be made to the design configurations proposed by Provan and Kenis (2008). We have partly addressed this by creating a design framework that integrates design elements and contextual dimensions that are currently known. However, this does not provide an overview of how the related design elements in the framework should look like in specific contexts. Future studies could study these various contexts such that our understanding of configurations of design elements that lead to effective ISLCs in a particular context can be broadened. The I5.0 context is especially interesting as the interconnectivity of all sociotechnical subsystems can challenge segmenting and parallelising learning activities in micro LCs. Although it takes a lot of time and resources, ideally, longitudinal field experiments following different ISLCs are needed to further enhance our understanding of effective ISLC designs in various contexts and their adaptation over time. Longitudinal research is valuable as it can be used to establish the mechanisms with which ISLCs adapt to various contexts.

Ultimately, for policy makers and practitioners, it is not about the perfectly conclusive scientific model or an all-encompassing framework for ISLC design. Above all, having a solid basis with knowledge, principles and steps to build on is important. Collaboration in ISLCs is also a matter of starting and learning by doing, and today's challenges also do not wait and need everyone's attention and collaboration now. Our paper and framework can inspire, help, and guide practice in decision making, focusing, developing and starting ISLCs that can be maintained over time.

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