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FEATURE ARTICLE

Prospective Sensemaking in the Front End of Innovation of AI Projects

Recognizing and monitoring different needs of various participants can make it easier to integrate AI in complex systems development projects and prevent the front end of innovation from being prolonged unnecessarily.

Elinor Särner, Anna Yström, Nicolette Lakemond, and Gunnar Holmberg

OVERVIEW: Using artificial intelligence (AI) to help develop new complex systems poses challenges for less tech-savvy organizations and may prolong the front end of innovation phase. Complications arise from diverging understandings of AI functionality and requirements among involved actors and the difficulties of determining the usefulness of AI in such a complex setting. This article explores a cross-industry project that entailed developing a functional prototype of an AI tool for planning (complex) energy systems in new city districts, engaging both system (domain) actors and AI developers. By analyzing prospective collective sensemaking processes in two episodes from the project, we discovered misaligned sensemaking processes between system actors and AI developers. During the project these actors alternated between "seeking" and "disengaging" sensemaking behavior. We highlight how various prototypes supported alignment in sensemaking processes concerning AI and progress in the project. Practitioners can use the managerial implications to better understand sensemaking dynamics in AI projects and implement suitable measures, like education or support at various stages of the project duration, to mitigate the problems that can arise due to misaligned sensemaking processes.

PRACTITIONER TAKEAWAYS:

- Recognize that the diverse actors in AI projects have different sensemaking needs and that gaps in knowledge may exist.
- Actively monitor for signs of seeking and disengaging among actors, and support behaviors that facilitate prospective collective sensemaking.
- Use boundary objects to facilitate prospective collective sensemaking, keeping in mind that the level of detail can support actors in different ways.

KEYWORDS: Complex systems, Artificial intelligence, Prospective collective sensemaking, Multi-actor collaboration, Front end of innovation

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The front end of innovation is characterized by great uncertainty (Chen, Damanpour, and Reilly 2010; Eling and Herstatt 2017). In many instances, overall project failure can be traced back to the front end of innovation (Khurana and Rosenthal 1998; Zhang and Doll 2001). Introducing artificial intelligence (AI) into the front end of innovation of complex systems development creates new challenges for innovation managers (Lakemond, Holmberg, and Pettersson 2024; Yu, Lakemond, and Holmberg 2024; Hutchinson 2020). Integrating AI tools such as machine learning means organizations need to manage uncertainty in the development process and potentially change human roles, tasks, and capabilities within and across organizations (Ozkaya 2020; Lakemond and Holmberg 2022; Hobday and Rush 1999; Sagodi, Dremel, and van Giffen 2023).

Integrating AI into complex systems development involves myriad actors, including system (domain) actors who make use of data and AI-developing actors who possess key implementation skills (Ozkaya 2020). In large, multi-actor projects, collective sensemaking processes play an important role in the front end of innovation phase (Eling, Langerak, and Griffin 2013; Nagaraj 2022). Collective sensemaking supports knowledge-sharing and idea generation among the actors (Enninga and van der Lugt 2016; Björk and Magnusson 2009), but it may require adapted management approaches for multi-discipline collaborations (Kane, Palmer, and Phillips 2019; Hoonsopon and Puriwat 2021). Common discrepancies in the front end of innovation that can influence collective sensemaking among actors relate to project managers and developers' diverging understandings of time (Dougherty et al. 2013) and differences in pace between internal and external processes (Brown and Eisenhardt 1997)—both of which could decelerate innovation processes. When working with complex systems, individual sensemaking needs to be turned into something comprehensible expressed verbally for motivating joint action (Weick, Sutcliffe, and Obstfeld 2005, p. 409) and contribute to setting frames of reference in early development processes (Orlikowski and Gash 1994).

When integrating AI in complex systems, sensemaking becomes *prospective* rather than retrospective, as it relates primarily to future expectations and visions of AI. Researchers are starting to discover managerial and organizational implications regarding the integration of AI, indicating that organizations underestimate the need for prospective collective sensemaking (Goto 2022; Orlikowski and Gash 1994; Poudel 2019). Accordingly, organizations need additional knowledge about how to manage development processes effectively, which includes understanding ongoing sensemaking processes. Our study focuses on this central research question: How are prospective collective sensemaking processes enacted in the front end of innovation of an AI project?

To answer this research question, we explore a Swedish AI project for urban development, engaging both system actors and AI developers (Gattringer et al. 2021). The public sector has just started integrating AI, particularly in its use of smart cities and digital twins (Kim, Ramos, and Mohammed 2017; Farsi et al. 2020; Khan et al. 2020; Deng, Zhang, and Shen 2021). We studied the sensemaking processes involved in the development of an AI tool for urban energy planning. We identified misalignment between AI developers and domain actors' sensemaking processes, and we developed managerial implications that practitioners can use in the front end of innovation in AI projects.

Literature Review

Few studies address the implications of integrating AI in the front end of innovation, especially ones exploring the context of complex systems development (Kim and Wilemon 2002; Eling and Herstatt 2017). One critical concern regarding integrating AI in complex system development is the involvement of both system actors and AI-developing actors (Ozkaya 2020). While AI developers possess much needed implementation-oriented skills, system (domain) experts' ability to make use of data and the availability and quality of data are equally important. Previous research has suggested that actors need to overcome such differences in understandings, intensified by AI's inherent characteristics, by bridging gaps in knowledge, trust, and expectations in their communication during the development (Piorkowski et al. 2021). Introducing AI in the front end of complex systems development could prolong the development process (Eling, Langerak, and Griffin 2013), because many actors perceive AI as a black box with complex internal operations and probabilistic outcomes that are difficult to understand (Berente et al. 2021; Weber et al. 2023). This can imply additional time and increased consumption of human and material resources.

Prospective sensemaking links "what is going on" with "what should we do about it" (Nagaraj 2022), driving the search for new knowledge, enabling convergence of various individual interpretations, and catalyzing action in response to triggering events (Thomas, Sussman, and Henderson 2001; Calvard 2016). It has gained attention in recent years centering on future-oriented sensemaking around potential development paths (Cornelissen and Clarke 2010; Gephart, Topal, and Zhang 2010; Sandberg and Tsoukas 2015; Nagaraj 2022; Maitlis and Christianson 2014). For example, anticipating intended use and users of new technologies (Jacobs, Steyaert, and Ueberbacher 2013) has been shown to improve project outcomes (Dougherty et al. 2000; Wright et al. 2000). Prospective sensemaking can have a critical role in AI projects given the high degree of uncertainty perceived by the actors and stakeholders involved when integrating AI in existing development processes (Goto 2022; Poudel 2019; Benbya, Pachidi, and Jarvenpaa 2021).

A *prospective collective sensemaking* process entails the interaction between actors to make sense of the future and involves several steps, including *exposing ideas and understandings* (Beverland, Micheli, and Farrelly 2016); *articulating* and ordering experiences for emerging new understandings; and collective *elaboration* into more complex interpretations (Stigliani and Ravasi 2012), which can result in *sensegiving* targeting external stakeholders (Gioia and Chittipeddi 1991). In cross-industry collaborations, management's facilitation—especially of the *articulating* step—significantly impacts the sensemaking process (Gattringer et al. 2021), and sensegiving becomes essential in situations where ambiguity is high (Maitlis and Lawrence 2007).

Although sensemaking processes depend fundamentally on dialogue and discussion (Weick 1995; Garud, Dunbar, and Bartel 2011), they can be supported by artifacts—for example, sketches and prototypes serving as material memories offloading the human mind, disposed for elaboration (Stigliani and Ravasi 2012; Carlile 2002). As such, artifacts become boundary objects supporting communication between diverse actors, bridging glitches between functions and stages in the development process (Cai et al. 2021). Overcoming glitches and differences may require boundary objects with different levels of detail (Majchrzak, More, and Faraj 2012). Ayobi et al. (2021) identified analogical narratives as boundary objects in AI development projects with actors of different backgrounds explaining how machine learning works. It appeared important with the right balance between flexibility and robustness in the boundary objects to adapt to individual experiences, reflective capacities, and information needs. Still, making boundary objects too simplistic or too generalized for the context at hand may be problematic: non-technical actors often have difficulties in translating general possibilities of AI into possibilities in their own field (Adobe et al., 2021).

The Case of Mälarporten

Mälarporten is a collaborative initiative striving to find ways to use AI in the planning phase for a new city district in Västerås, Sweden. After its initial exploration of possible innovation paths, the 11-member core project team decided to build a functional prototype of an AI tool for energy system planning, including the electricity system and district heating/cooling system (Table 1, Figure 1). This complex system is situated within the multifaceted context of city development. An energy system is an example of a typical multi-layered complex system with characteristics such as emergent system behaviors situated in a greater context of city development (Davies and Hobday 2005). Energy systems have intertwined dependencies and long lifespans requiring continuous development, constrained to accommodate both existing system demands and future demands.

Methodology

We conducted a qualitative, longitudinal case study (Eisenhardt 1989) that explores a concrete example of using prospective sensemaking processes around AI in complex

TABLE 1. Details about the Mälarporten case

	Description: Mälarporten
Project Duration	April 2021–March 2023
Project Focus	Develop a functional prototype of an AI tool for energy system planning
Actors Involved	*Domain actors:* • Västerås municipality • MälarEnergi (the local, municipality-owned energy company) *AI developing actors:* • ABB, a large company within electrification and automation, providing an optimization platform, control system, and module of the electrical system • Utilifeed, a company providing a SaaS solution for district heating and cooling • RenBloc, a startup company providing a solution to estimate the emission *Project management:* • Facilitators engaged by Smartbuilt Environment
Core Project Team Members	*11 individuals:* • 2 participants from the municipality with project management and communication backgrounds • 2 consultants employed by the municipality with a construction project management background • 3 AI developers from the 3 AI development companies • 1 business developer from an AI development company • 2 project managers • 1 participant from the energy company
Intended Use of AI Tool in the Development Process	• Combine historical data of electricity and heating/cooling usage and energy production with historical weather data to create predictions for decision support. For example, CO_2 impact and peak loads early in the city planning process where available information is scarce. • The intended user inserts information on the housing mix of the planned city district, configuration for the energy system—for example, the amount of solar energy production, battery installations, and flexibility. The functional prototype of the tool simulates the scenario providing prediction of CO_2 impact, peak loads, etc., for that configuration. Output from several simulations with different configurations can be compared and serve as grounds for decisions on the preferred design.
Project Organization	• Bi-weekly team meetings • Sprint demos every three months • Reference meetings with external stakeholders every three months

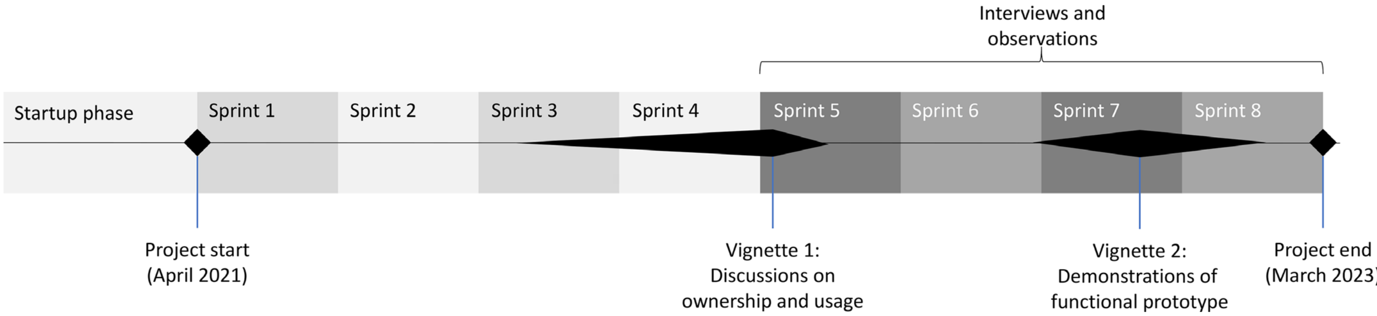

FIGURE 1. Timeline of the Mälarporten project

systems development. Mälarporten provides a unique possibility of studying sensemaking in AI projects in complex systems development. The project involved numerous occasions of prospective sensemaking, with its high ambiguity and multiple unknowns related to the potential use of AI. The longitudinal research design enabled reporting on project progress and unfolding sensemaking processes.

We conducted rounds of semi-structured interviews with 14 individuals with different roles related to the project from spring 2022 until summer 2023 (Table 2). In parallel, our observations during project sprint meetings and reference group meetings, as well as during occasional teamwork meetings, provided a firsthand look at significant behaviors and occasions relevant to the sensemaking process. We used notes taken during observations together with secondary materials (internal documents) to supplement and support data analysis and craft a case narrative. Triangulation of the data sources helped us develop a comprehensive understanding of the phenomena of interest and ensure reliability and validity of the findings (Patton 2014).

The analytical process entailed several steps. First, we made an initial interpretation of the empirical materials, paying specific attention to prospective collective sensemaking processes. Once we completed the data collection, in the second step the first author completed iterative rounds of first- and second-order coding to identify aggregate dimensions reflecting actions related to prospective collective sensemaking processes during the project (Miles, Huberman, and Saldaña 2020) (Table 3). The third step entailed outlining narrative vignettes detailing significant sensemaking events to illustrate the core issues in the rich case material (Miles, Huberman, and Saldaña 2020). We ensured rigidity and transparency through multiple rounds of discussion related to the data structure and the vignettes among the authors.

Results

In two vignettes, we outline two critical prospective collective sensemaking episodes during the project, illustrating how actors alternated between *seeking* and *disengaging* sensemaking (Table 4). We also indicate management's role in *supporting* the sensemaking process (italics refer to aggregate dimensions). The vignettes captured diverging sensemaking processes of domain actors and AI developers as the project progressed and provided insights into the role of prototypes as boundary objects facilitating prospective collective sensemaking.

Vignette 1: 'Who Will Be the Tool's Owner?'

Discussions around ownership and use of the tool had a major role in the first part of the project. Ownership proved to be a complex issue because although the tool was still "hypothetical," project management had given the municipality and the energy company joint ownership of the AI tool. However, neither organization had any significant expertise in AI. During the project meetings, discussions often circled back to topics related to ownership. Municipality actors appointed the energy company as their experts in energy issues, and accordingly, the energy company was the natural owner of the AI tool. However, actors from the energy company as well as the team managing the project emphasized the municipality's critical role in creating system-wide usefulness of the AI tool given its mandate to influence other actors in the city planning process. Actors from the energy company and the project management team considered the municipality the only actor that could potentially influence external actors to build more sustainable energy systems based on system-level insights made available by the AI tool.

These recurring discussions that seemed difficult to settle illustrate the domain actors' *seeking* prospective collective sensemaking. In the end, the energy company assumed ownership. Although the discussions took place during team meetings that all actors attended, the discussions involved mainly domain actors from the municipality and the energy company, who were affected directly by the

Municipality actors appointed the energy company as their experts in energy issues, and accordingly, the energy company was the natural owner of the AI tool.

TABLE 2. Data sources

Data Source	When	Type of Data
Semi-structured Interviews		
12 interviews	Spring and Summer 2022	*Initial interviews* with main actors (project management, project coordinator, developers, clients, and experts) capturing impressions, perspectives, knowledge, and backgrounds.
7 interviews	Autumn and Winter 2022	*Additional interviews* to follow-up previous interviews and including a few additional project stakeholders.
7 interviews	March–June 2023	*Concluding interviews* with the main actors for clarifications and follow-up previous interviews.
Observations		
Biweekly team meetings (~30-min meetings, total ~5.5h)	Spring 2022–Spring 2023	*Notes from observations at biweekly team meetings*, following interactions and prospective collective sensemaking processes over time.
Reference group meetings (~2h meetings, total 4h)	Spring 2022–Spring 2023	*Notes from observations at reference meetings*, following project progress and discussions with external parties.
Work meetings (1h–1.5h meetings, total ~5h)	Spring 2022–Spring 2023	*Notes from observation of work meetings*, where technical solutions and usefulness were discussed.
Secondary Materials		
Internal documents (5 documents)	Spring 2022–Spring 2023	Visualizations of the tool and project documents
Public documents (10 documents)	Spring 2022–Spring 2023	Online publications, pre-study report

ownership and use of the AI tool, but who held limited knowledge of what such ownership would entail. Thus, the sensemaking process was characterized by the domain actors struggling with an unclear common vision and uncertainty regarding whether the project would reach its goals, how the development would unfold, and what was needed to develop the tool. Some domain actors had high, and sometimes unrealistic, expectations about what AI could do coupled with limited understanding of data and AI development. Even though management had organized sessions to build understanding around AI, they *disengaged* partially from the need for prospective collective sensemaking by overlooking the importance of individual understanding. Also, participants who joined the project in the later stages did not get any introduction to AI. As a result, the domain actors had difficulties identifying their role and contribution in the development process, and the prospective collective sensemaking process was disrupted partly by insufficient exposure to AI and articulation of AI's capabilities on an individual level.

While domain actors were engaged in these discussions, the AI developers remained idle. The AI developers were waiting for decisions about what the tool should do, and they lacked data and domain actors' input regarding the design of the city area. These issues inhibited progress and affected individual developers differently. One AI developer acted pre-emptively to prepare what they could, outlining a vision of their own based on experience from similar projects, focusing on speed rather than on joint understanding. This suggests that some AI developers *disengaged* from prospective collective sensemaking by not considering the outcome of the discussions as directly relevant to them, and proceeding according to their own individual sensemaking of what was needed. Another AI developer delayed implementation action in this phase because they lacked necessary information, while a third used the time to help with non-implementation-related tasks.

Vignette 2: 'We Have No Role To Play Here—Let's Leave'

As the project progressed, development of the technical solution became more urgent, shifting the discussion in the project meetings toward creating the functional prototype. Coinciding with this shift, domain actors expressed confusion about the development process, as they felt out of the loop concerning project progress, the intended outcome, and their ability to contribute. Design thinking sessions organized by a project leader in the early phases of the project had resulted in two collectively produced and elaborated low-fidelity (lo-fi) prototypes in PowerPoint. One prototype was a user interface mock-up to visualize what information to present in the AI tool. It was not intended to evaluate usability; it simply listed potentially useful end-user information as well as supporting decisions about the tool's functionality. It consisted of a web page illustration listing the information to display. The second prototype visualized the data flow between the system modules and actors, using boxes and arrows for the data flow to support the understanding of how the functional prototype would work. To mediate the confusion, in the following meeting the project management team returned to the established project plans and revisited the PowerPoint prototypes created in the design thinking phase but had thereafter not been regularly used. The project managers thus

TABLE 3. Data structure

Actions Related to Prospective Collective Sensemaking Processes During the Project (Aggregate Dimensions)	**Grouped Behaviors (2nd-order codes)**	**Identified Behaviors (1st-order codes)**	**Representative Quotes**
Seeking prospective collective sensemaking	Struggling with unclear common vision	Struggling to envision the project result	"When I start [a project] with an order from someone, I have an idea about that we will build, for example, an arena for football events with 30,000 person audiences. Then you add architects and constructors and everything that is needed. I can easily form an opinion about where we are heading . . . but I have a hard time visualizing what this kind of project will result in."—Domain expert B
		Disillusioned about the future	"It's unclear where we are and where we are heading. I get the feeling we will not reach the goal."—Developer C
	Confusion about the development process	Not understanding everyone's contribution	"It's hard to see the goals. They feel unclear. I don't know how to contribute."—Domain expert A
		Lacking understanding of the technical progress	"I don't feel I keep up with the technical parts. Goals that were put in place before the sprint. How will it look and what is the outcome? How does this demo fulfill the goals? Are we closer to a tool now?"—Domain expert A & Business developer A
		Trusting the experts in blind faith	"We have had to step back. Sometimes we just hope that we are on the right track and that they [the AI developers] know what they are doing and then we contribute as much as we can when they ask us for things, facts."—Domain expert C
	Lacking language and relevant knowledge	Struggling to understand technical language	"Those that understand the technology have a harder time explaining [than the domain people]. Some are better than others, but they often focus a lot on details, explain very fast and technical, in a way that even I hardly understand . . . especially when regarding their own solution. Then it's hard to understand for others."—Project manager B
Disengaging prospective collective sensemaking	Focus on speed rather than joint understanding	Acting preemptively before discussions	"Even if not everyone in the project has decided the exact output in the end, we know that they will want operating cost. They will want some kind of CO_2 equivalents per year. So, we can start building. . . . It took around 10 months for us before we agreed on what to do. Then it was according to us, the same picture we had from the start."—Developer A
	Overlooking individual understanding for prospective collective sensemaking	Minimizing the need to increase AI awareness	"We have [built sufficient understanding of AI]. Although new people have come in that did not get it from the base, but I don't think anyone brought up that it was hard to understand. We usually don't get into details in the technologies in these meetings, but we talk a lot about data and data flows. Who collects what and what does everyone need? How do they move? That's not so hard to understand."—Project manager A
Supporting prospective collective sensemaking	Encouraging dialogue	Bringing clarity through interaction	"When we have noticed that we don't know what we are doing, goal, problem statement, then we have had more focused meetings and workshops."—Project manager B
		Acting as sensegiver	"Many turn to me, 'now it is confusing,' so they call me. We have had very short sprint meetings where we just tick off, not keeping the whole picture together. I have had to chip in every now and then. Reminding what should be solved."—Project manager A
	Building joint vision through prototypes	Achieving holistic perspective through low-fidelity prototypes	"We have drawn pictures and reminded ourselves what we have done to understand the problem and how we solve it, how we reason. Summarize why we do this and that. This is how the prototype looks like roughly, and then we have developed as we go. You need some recap every now and then because people forget, but you also narrow in on the part that you work on. Then you need to lift the gaze."—Project manager A
		Increasing clarity about outcomes through functional prototype	I feel we had better dialogue today. It became visual today [when demonstrating the first parts of the functional prototype]. It is clear that we are making progress and that work is ongoing between sprint meetings. The bases are there, and the tempo is better."—Domain expert A

TABLE 4. Prospective collective sensemaking behaviors

Seeking	Actors are actively seeking prospective collective sensemaking by participating actively in meetings and asking questions to articulate and elaborate their understanding.
Disengaging	Actors are disengaging from prospective collective sensemaking by not participating in meetings and discussions and not considering the outcome relevant to them.
Supporting	Actors are supporting prospective collective sensemaking of the other actors by introducing boundary objects such as prototypes and sharing previous experiences that can help actors elaborate their understandings.

demonstrated effort to *support* prospective collective sensemaking. All actors appreciated this meeting, especially domain actors who had been less involved in the technical development.

As the functional prototype became more mature, the AI developers were given the opportunity to demonstrate what they had done. These demonstrations did not show the final user interface, as the integrating module was not developed until the very end of the project. Instead, the AI developers demonstrated the separate modules while explaining what would be presented in the integrating user interface. The first demonstration elicited an immediate response from a municipality actor that "Now, there is progress," which cleared up confusion experienced in the previous joint meeting. Despite this, the municipal actors withdrew from subsequent project meetings after the first demonstrations, as they did not feel they were contributing. The meetings were perceived as slow, and even though the AI developers seemed to progress better, it was not rewarding for them. Many actors perceived the municipal actors' failure to attend as unfortunate, as the demonstrations in later meetings sparked many discussions around how to use the tool. AI developers and project management actors requested input from the municipality regarding the district requirements and design.

In this vignette, we noticed a clash between *seeking* prospective collective sensemaking and ongoing development activities *disengaging* from the sensemaking process. The withdrawal by the municipality actors from the project meetings, the main forum for sensemaking, indicates their *disengagement.* This disengagement coincides with the AI developers more frequently *seeking* prospective collective sensemaking, asking for municipal input to ensure system-wide usability of the tool. Management encouraged dialogue and gave clarity by revisiting the lo-fi prototypes illustrating their role as sensegiver more actively *supporting* the sensemaking process. The confusion expressed by domain actors and actors less involved in the daily development suggests diverging understandings of the project goals and the functional prototype.

The withdrawal by the municipality actors from the project meetings, the main forum for sensemaking, indicates their *disengagement.*

A latent need for active *support* of prospective collective sensemaking by the project managers emerged. The lo-fi prototypes seem to have built a joint vision to mediate the experience of uncertainty for those new to AI development. The first demonstration of the functional prototype similarly seems to have *supported* the sensemaking process, increasing the clarity about the outcomes and triggering discussions around usefulness and requests for further input. However, the participants from the municipality did not re-engage but withdrew from the project meetings shortly after the first demonstrations.

Discussion

The vignettes illustrate prospective collective prospective sensemaking processes, and individual alternations between *seeking prospective collective sensemaking* and *disengaging from prospective collective sensemaking.* We highlight two main insights on how to manage the sensemaking processes in AI projects with multi-actor collaborations while avoiding prolonging the front-end-of-innovation phase. First, given the asymmetries in AI-related knowledge among the actors involved in the complex systems development, misalignment in prospective collective sensemaking processes can be expected and need to be actively managed. Our second insight concerns how prototypes as boundary objects can support project managers in handling misaligned sensemaking processes, where the quality and timing of the use of prototypes matters in terms of their usefulness to overcome issues like knowledge asymmetries concerning AI.

Misaligned Sensemaking Processes

In the front end of innovation phase, project teams need to find a balance between dedicating more time to reduce uncertainty and not prolonging it unnecessarily (Ellwood, Grimshaw, and Pandza 2017; Eling and Herstatt 2017). Our findings show that uncertainty and misaligned sensemaking processes hinder prospective collective sensemaking—especially in AI-development projects in complex systems that entail uncertainties added to an already complex context.

The nature of AI as a rapidly evolving phenomenon suggests a need for *supporting* the sensemaking process (Berente et al. 2021). Project management and AI developers' engagement in sensegiving to *support* domain actors' prospective collective sensemaking as they participated in developing the lo-fi prototypes seemed important for the domain actors as highlighted in vignette 1. Even though the AI developers did not actively engage in elaborating around ownership, their *support* was significant for the sensemaking process of the domain actors. Thus this support can be critical for them to move from articulation to elaboration and could be an important factor to avoid disengagement and secure conditions for engagement in prospective collective sensemaking further on (see icons indicated with "1" in Figure 2).

In the second vignette, AI developers were *seeking* prospective collective sensemaking during demonstrations of the functional prototypes, articulating a need to expose and articulate around the functionality and usefulness of the AI tool. While domain actors participated in the early phases of articulating a joint understanding, they decided to exit the project meetings in the midst of elaboration poked by interactive demonstrations of the functional prototype. They *disengaged* from the continued sensemaking (see icons indicated with "2" in Figure 2). Management's initiative to revisit the lo-fi prototypes and early demonstrations of the functional prototype seem to have *supported* prospective collective sensemaking in pushing for articulation and elaboration, however, it was not sufficient to keep all actors committed to the sensemaking process. The functional prototypes appear to have *supported* elaboration in the sensemaking by providing a sense of security for domain actors, despite their lack of understanding of AI development and of what the AI developers were doing. The prototypes proved useful in prompting questions from AI developers to domain experts.

Recognizing the presence of misaligned sensemaking processes extends previous research on identifying potential causes of prolonging the front-end-of-innovation phase by specifically highlighting the sensemaking needs present in multi-actor AI projects in complex system development. It contributes to our understanding of internal-external speed

The low-fidelity prototypes proved useful in prompting questions from AI developers to domain experts.

misalignment in the innovation process (Brown and Eisenhardt 1997), diverging time conceptions between management and project team (Dougherty et al. 2013), and mismatch in anticipating time allocation for different tasks among different users (Jacobs, Steyaert, and Ueberbacher 2013). Our findings and analysis of the impact of such misalignment adds to previous findings on reducing risks in the front end of innovation discussed by Eling, Langerak, and Griffin (2013) and Ellwood, Grimshaw, and Pandza (2017). Our study indicates that managing misaligned prospective collective sensemaking processes is an important activity in the front end of innovation to prevent prolonging this phase and overextending the use of human and material resources.

Prototypes as Boundary Objects Facilitating AI Projects

Prospective collective sensemaking requires prior knowledge in both the domain field and AI to form sufficient frames of reference. This is essential to be able to engage in articulation and elaboration and consequently to take part in sensemaking processes. However, the misalignment occurring between actors increases the importance of facilitators. Our study extends previous research on facilitators in the front end of innovation as described by Gattringer et al. (2021): it explains how the use of lo-fi prototypes supporting actors with limited prior knowledge of AI seem

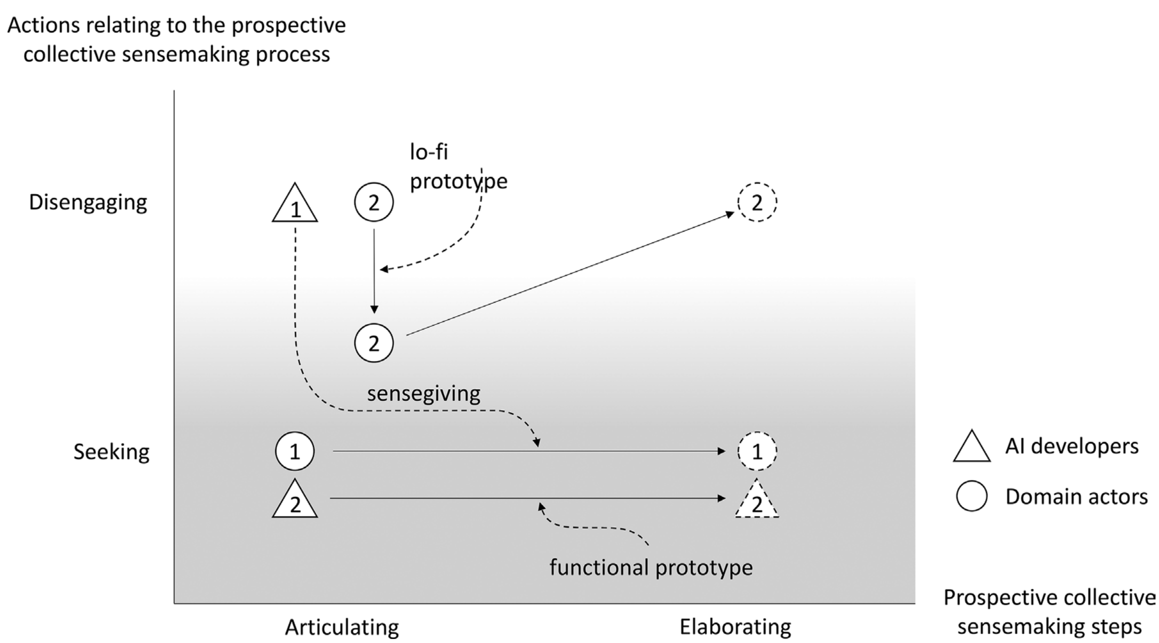

FIGURE 2. Illustration of misalignment in the prospective collective sensemaking process

to facilitate their participation—that is, to expose and articulate—in the prospective collective sensemaking process. Mindful use of different types of prototypes can help bridge the asymmetry of knowledge between actors, as indicated by Piorkowski et al. (2021). It seems particularly important to engage the *disengaged* actors as sensegivers—for example, through exposing where AI developers could share previous experiences and participate in articulation in the early discussions on the use and development of the lo-fi prototypes. As such, the AI developers helped the project managers facilitate domain actors' sensemaking of what AI could do, as well as what this project should do drawing on prototypes as boundary objects and material memories, as described by Carlile (2002) and Stigliani and Ravasi (2012).

The difficulty of specifying AI functionality and requirements up front emphasizes the potential facilitating value of prototypes to gain an initial understanding of AI in complex system development. However, the low-fi prototypes might simultaneously have been slightly overdeveloped and too underdeveloped to fully *support* AI developers' elaboration (Majchrzak, More, and Faraj 2012). A more continuous use of lo-fi prototypes would have increased their flexibility (Ayobi et al. 2021), and the level of detail of the boundary objects could have mediated misaligned sensemaking processes, thereby allowing actors with less knowledge in AI to relate the technology better to their field of work (Cai et al. 2021). This would have reduced some of the uncertainties and enabled domain actors to engage more fully in the prospective collective sensemaking process.

The functional prototype's ability to build a sense of trust between domain actors and AI developers indicates the importance of visualizing the technical progress through evolving boundary objects. Moreover, the functional prototype advanced questions and discussions initiated by the AI developers, which shows the usefulness of prototypes to kick off the prospective collective sensemaking process. The level of detail of the prototype needs to continuously increase to entice the AI developers to remain committed to the sensemaking process.

Managerial Implications

Project managers in multi-actor AI projects can actively support the prospective collective sensemaking processes and alignment of actors in several ways (Figure 3):

1. Recognize that different actors may have different sensemaking needs during the project, especially if there is asymmetry in knowledge about AI among the actors. Pinpoint these asymmetries in knowledge and create opportunities to bridge them through education, training, and team activities.
2. Recognize the strength in actors possibly taking turns in *seeking* prospective collective sensemaking, but actively monitor signs of actors *disengaging* in joint processes. This awareness and tracking is especially important considering the fact that AI is an evolving phenomenon causing additional uncertainties, evolving capabilities, and shifting understanding.

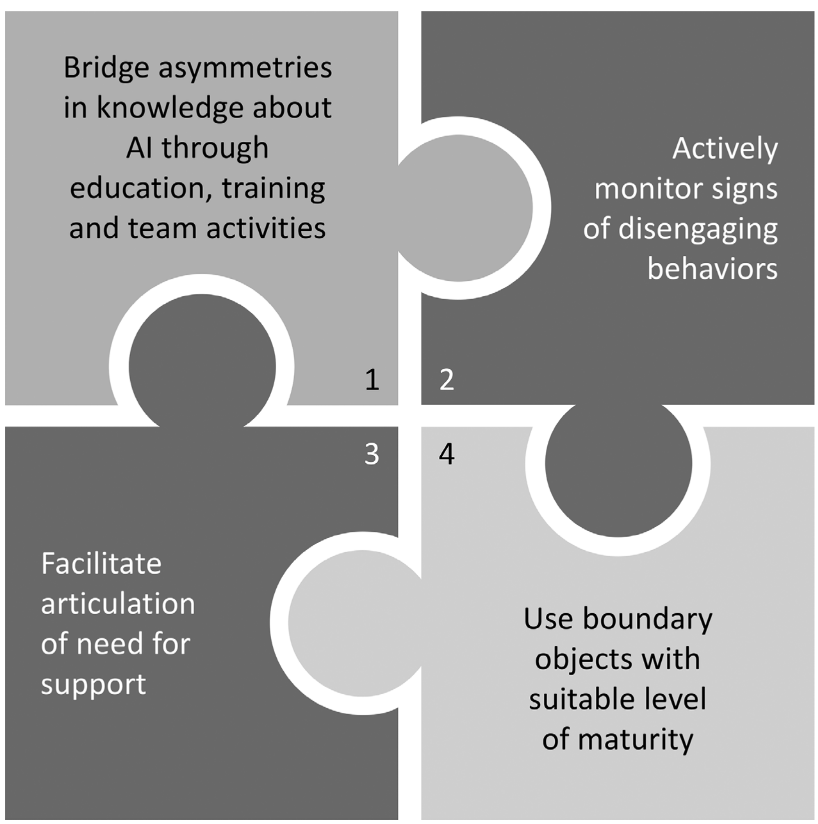

FIGURE 3. Implications for managing misaligning prospective collective sensemaking processes

3. Create opportunities for actors to articulate their needs for support, keeping all actors engaged throughout the project by addressing potential frustration and conflicts early on. Doing so can prevent confusion and time-consuming discussions, thereby reducing the risks of prolonging the overall innovation process unnecessarily.
4. Actively use prototypes as boundary objects to facilitate the prospective collective sensemaking process, but be mindful to use prototypes of suitable maturity depending on the project phase, specific context of application, and AI-related knowledge among the actors. The level of detail of the prototype seems to be important to engage AI developers in the sensemaking process. Using too static or simplistic prototypes may not have the desired outcome.

Future Research

We encourage further studies to investigate other projects involving AI-related knowledge asymmetries or other contexts. We also recommend further research that explores boundary conditions and requirements to determine the usefulness of various prototypes in AI projects.

Conclusion

This study has increased the understanding of misaligned prospective collective sensemaking processes in the front end of innovation of multi-actor AI projects, as we conceptualized how actors alternate between engaging in *seeking* and *disengaging* from prospective collective sensemaking. Prototypes are important boundary objects that can bridge imbalances in AI-related knowledge and facilitate alignment of sensemaking processes, but their usefulness is dependent on the level of detail and timing of their use. Our study offers timely insights for both practitioners and academics regarding the integration of AI in the specific context of complex systems development that can prevent the front end of innovation from being prolonged unnecessarily.

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