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Not all who integrate are academics: zooming in on extra-academic integrative expertise

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Solving complex problems requires integrating knowledge and skills from various domains. The importance of cross-domain integration has motivated researchers to study *integrative expertise*: what knowledge and skills help achieve cross-domain integration? Much of the existing research focuses on the integrative expertise of academic researchers who perform inter- and transdisciplinary research. However, academics are not the only ones facilitating integration. In transdisciplinary research, where academics collaborate with professionals, stakeholders, and policymakers, these extra-academic actors can contribute significantly to cross-domain integration. Moreover, many complex problems are addressed entirely outside of universities. This paper contributes to a broader, more inclusive understanding of integrative expertise by drawing attention to the diversity of extra-academic integrative expertise, providing examples of what this expertise looks like in practice, and reflecting on differences with its academic counterpart. The contributions are based on a case study of integrative expertise in Oosterweel Link, a large urban development project in Antwerp, Belgium.

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Introduction

Complex problems are caused by the interplay of various factors that are studied, managed, experienced, or regulated in different domains.¹ Only by integrating knowledge and know-how from these domains can solutions be developed that consider various causal factors as well as their interplay (e.g., Chen et al. 2011; Liu et al. 2015; Mennes, 2020). Given the importance of cross-domain integration, two critical questions are: What is cross-domain integration? And How can it be achieved?

Several scholars have provided answers to the first question. They characterised cross-disciplinary integration, for example, in terms of negotiation (e.g., Villeneuve et al. 2019), standardization (e.g., Leonelli, 2013), and co-creation (e.g., Mauser et al. 2013). Julie T. Klein, a prominent scholar of interdisciplinarity, defended the diversity of characterisations with her “Principle of Variance,” which asserts that there is “no universal formula for integration” (2012, p. 293). Meanwhile, other researchers focus on describing what instances of integration have in common. For example, Michael O’Rourke and colleagues developed a general model of integration called the ‘Input-Process-Output’ (IPO) model, which represents integration as a “process where a series of changes to inputs results in a ‘bringing together’ or combination of inputs, producing an output” (2016, p.97).

In response to the question of how to achieve integration, some researchers have developed practical tools, such as heuristics for integrative collaboration (e.g., Repko, 2012; Bergmann, 2012); toolkits for inter- and transdisciplinarity (Eigenbrode et al. 2007; Laursen et al. 2024); organizational routines and mechanisms (e.g., Zollo and Winter, 2002; Berends et al. 2006); and communication strategies (e.g., Grant, 1996; Winowiecki et al. 2011). However, this paper focuses on a different response, namely the study of “integrative expertise,” i.e., the knowledge and skills required to enable cross-domain integration.

One community that is particularly active in the study of integrative expertise is that of scholars of inter- and transdisciplinarity (‘ID/TD’). Drawing from fields such as the philosophy of science, science and technology studies, and the science of team science, they aim to understand and facilitate inter- and transdisciplinary research, often with an eye on supporting complex problem-solving (e.g., O’Rourke et al. 2016; Bammer et al. 2020). Given their interest in research across the boundaries of academic disciplines, their work on integrative expertise typically focuses on academic researchers.

However, academics are not the only ones facilitating cross-domain integration. In transdisciplinary research, where academics collaborate with professionals, stakeholders, and policymakers, these extra-academic actors contribute to cross-domain integration (Koskinen and Mäki, 2016). For example, in transdisciplinary collaborations between medical researchers and HIV patients during the 1980s pandemic, the latter suggested alternative, more ethical clinical evidence standards (Colvin, 2015). Cross-domain integration also frequently occurs outside academia. Worldwide, non-profit organizations engage in cross-domain integration, for instance, to reduce poverty (Banks and Hulme, 2012) and to empower women (Islam and Sultana, 2005). Thus, a full-fledged theory of integrative expertise should also cover extra-academic integrative expertise.

This paper contributes to such a theory by zooming in on extra-academic integrative expertise in its diversity. Based on a case study of integrative expertise in the urban development project ‘Oosterweel Link,’ it describes the extra-academic expertise of various actors in practice and reflects on how extra-academic integrative expertise differs from its academic counterpart.

The remainder of this paper is structured as follows: Section ‘Theory on integrative expertise’ reviews available resources on academic and extra-academic integrative expertise and explains what is missing. Section ‘Oosterweel Link’ introduces the Oosterweel Link project. Section ‘Case study methodology’ describes the methodology followed for the case study. Section ‘Results’ presents the results, which are discussed in Section ‘Discussion’. Section ‘Conclusions’ concludes the paper.

Theory on integrative expertise

In academia. This section reviews definitions of ‘integrative expertise’ and its cognates in the academic realm. The definitions were proposed by scholars of inter- and transdisciplinarity (ID/TD). In line with their interest in integration across the boundaries of academic disciplines, they focused on the integrative expertise of academic researchers.

For reasons of interpretability I first briefly mention five types of expertise that feature in several definitions. Harry Collins and Robert Evans characterised the types as part of their normative theory of expertise (2002). They distinguish between three degrees of expertise in a field: *no expertise*, *interactional expertise* (enough expertise to interact interestingly with experts in a field), and *contributory expertise* (enough expertise to contribute to a field) (2002, p. 254). While the types can apply more widely, Collins and Evans primarily had scientific fields in mind. Two additional types of expertise, which are not tied to scientific fields, are *referred expertise* (understanding what it means to have contributory expertise in a field without possessing it oneself) and *experience-based expertise* (specialist knowledge and skills that are not recognized through certificates or degrees) (2002, p. 257).

Integrational expertise. Mads Goddixsen and Hanne Andersen define the *integrational expertise* students require for inter-disciplinary collaboration as a combination of interactional expertise and meta-reflective skills (2014, p. 7). They characterise interactional expertise as “some degree of familiarity with concepts in a domain while not necessarily having the further skills needed to perform experiments and detailed mathematical manipulations” (2014, p.6), which is more specific than the original characterisation by Collins and Evans. For Goddixsen and Andersen, meta-reflexive skills include critical thinking abilities for analyzing argument structures and identifying assumptions. They calibrate trust when researchers do not fully understand what their collaborators are doing and enable effective inter-disciplinary communication by helping researchers become aware of the epistemological standards of their disciplines.

Expertise in research integration and implementation. For Gabriele Bammer and colleagues, *expertise in research integration and implementation* consists of interactional and contributory expertise (2020). Moving beyond the original characterisation, they describe integrative expertise as “the ability to understand disciplines, professional practice, and community experience without being trained in those disciplines or having lived in those communities” (p.2). Their notion of contributory expertise is tailored to complex problem-solving. It stands for a combination of *knowing-how*, which refers to ‘knowing which methods or processes to use in a particular context, along with skills in those methods and processes,’ and *knowing-that*, which involves “understanding what is required to deal with complex societal and environmental problems in an integrated way” (p.2). Concerning contributions to integrative processes rather than to scientific fields, Bammer et al.’s notion of contributory expertise aligns closely with Giulia Molinengo and colleagues’ *process*

expertise, which refers to the knowledge and skills required to design collaborative processes (2021, p. 3). Yet, while expertise in research integration and implementation is about doing integration, process expertise is about facilitating integration.

Integrative expertise. Julie T. Klein provides a definition of integrative expertise that applies to actors who lead collaborative efforts as well as participants. Some key components are the ability to “contribute a pertinent form of expertise,” “articulate one’s approaches and meanings in an accessible manner,” “listen actively to others and ask for translation if needed,” “provide and receive constructive feedback,” “adapt flexibly to alternative viewpoints and methods,” “negotiate differences without personalizing them” and “participate in building consensus and integrating separate inputs” (2022, p.30).

While Klein does not use the same terminology, several components of her definition align with the types of expertise Collins and Evans characterise. For example, “contributing a pertinent form of expertise” is similar to contributory expertise, and the ability to “ask for translation if needed” resembles interactional expertise.

Integration experts. Finally, Sabine Hoffmann and colleagues sketch the expertise an integration expert should have to be active in academia (2022). For them, interactional expertise and referred expertise are key. Additionally, it includes the “interactive and reflexive abilities” necessary for establishing collaborative relationships and for identifying, analyzing, and evaluating one’s perspective and its limits (Hoffmann et al. 2022, p.4).

In the professional realm. While less concentrated than the theory on academic integrative expertise, some theorizing has been done on the integrative expertise of professionals in various domains.

For example, in health and medicine, the expertise required to achieve inter- and transprofessional integration, which is considered essential for improving prevention, diagnosis, and treatment, has been analyzed (Boon et al. 2019). Instead of ‘integrative expertise,’ the term ‘adaptive expertise’ is used. It refers to an extension of the routine expertise a clinician requires to select and execute relevant procedures effectively (Hatano and Inagaki, 1986). Adaptive expertise enables clinicians to integrate input from additional sources to generate novel ideas and improve problem-solving (Boon et al. 2019). Developing adaptive expertise requires developing a deeper understanding of one’s professional procedures through “cognitive and meta-cognitive processes” (Mylopoulos and Woods, 2009), as well as skills to “develop a comprehensive understanding of patient’s complex needs and how these fit within health systems and social systems” (Sockalingam et al. 2019, p3).

Also in design and planning, where cross-domain integration is essential to combine technical inputs with stakeholder needs, preferences, and constraints, integrative expertise has been analyzed. Given the prominent role of interests in the domain, integration is often approached as a negotiation process aimed at reconciliation (Susskind and Field, 1996). Hence, the expertise required to support this process is called ‘negotiation expertise’ (Paterson, 1999).² Negotiation expertise includes the ability to select the appropriate type of negotiation process and to pick a strategy for its execution (Goltsman et al. 2009); to consider interests rather than positions (Shmueli et al. 2008); to frame decisions in terms of potential gains rather than losses (Bazerman, 1983); to distinguish decisions from (pre-existing) conflicts between stakeholders; and to foster a positive attitude towards all stakeholders (Edelman, 2007). An important technical

skill is the ability to produce representations of design options that balance promoting a shared understanding among stakeholders and inviting their questions and critique (Self, 2019).

What is missing. The available theory on integrative expertise has two main limitations. First, it is skewed. The integrative expertise of academic researchers has received significant attention, but that of professionals is mostly addressed indirectly, and that of other actors, such as interest groups and other members of civil society, is not discussed systematically. Second, there is limited knowledge of what integrative expertise looks like in practice (Bammer et al. 2020; Hood et al. 2016; Edelman, 2007). This paper addresses both limitations through a case study of integrative expertise in the urban development project ‘Oosterweel Link.’ The case study is aimed at insight into the integrative work performed by extra-academic actors in the project and the knowledge and skills underpinning their work.

Oosterweel link

Original plans. Antwerp, home to Europe’s second-largest port, is an important centre for industry, transport and distribution. In 1994, the Flemish government mandated the ‘Masterplan Mobility Antwerp’ to address long-standing mobility issues that limited its accessibility and posed a threat to the economic welfare of the city and surrounding region (BAM, 2005a).³ The Masterplan included several projects, one of which was to “close” the city’s ring road by connecting the points where it is interrupted by the river Scheldt and the docks (BAM, 2005b) (see Fig. 1). This project was named ‘Oosterweel Link’ (‘Oosterweelverbinding’ in Dutch) after the geographical area between the two ends of the ring road.

In 2000, it was decided that the river would be crossed with a tunnel, and a flyover would bridge the docks on the right bank. Concurrently, the trajectory of the new connections was determined (GRUP, 2000). In 2001, the government decided that a public company would be responsible for implementing, financing, and managing the Masterplan projects, including

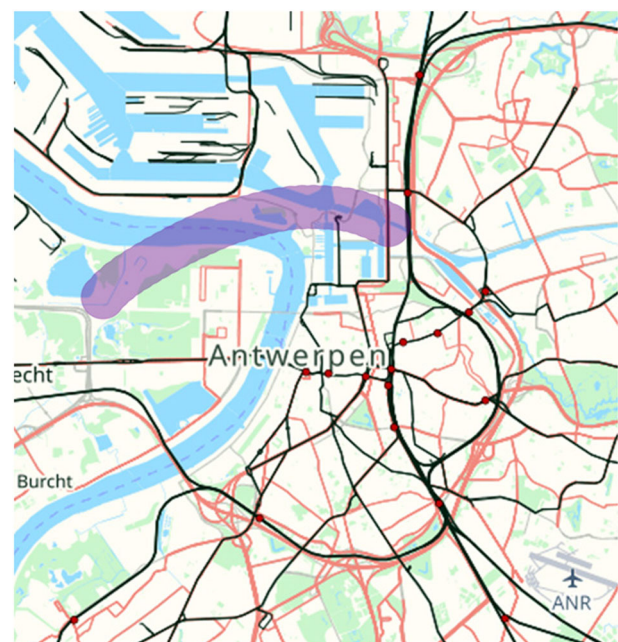


Fig. 1 Map of Antwerp with the interrupted part of the ring road in purple. The map is based on OpenStreetMap data, covered by the Open Database License (ODbL). Base map © OpenStreetMap contributors, modifications by Julie Mennes. Reproduced under ODbL.

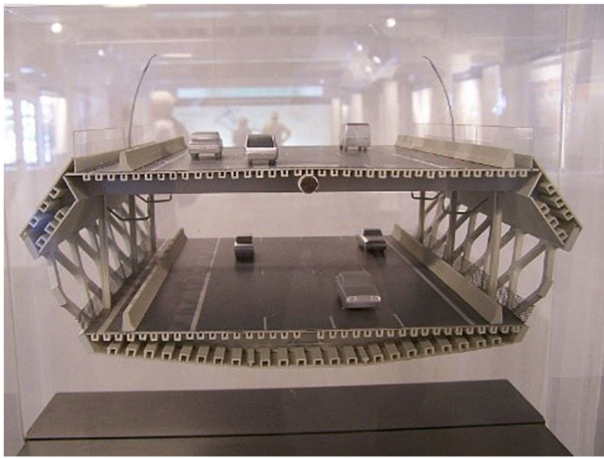


Fig. 2 Cross-section model of the flyover. This figure is covered by the Creative Commons Attribution-Share Alike 3.0 Unported (CC BY-SA 3). Reproduced with permission of WWuyts; copyright ©WWuyts, all rights reserved (<https://commons.wikimedia.org/wiki/File:LangeWapper01.jpg>).



Fig. 3 Scale model of the flyover. This figure is covered by the Creative Commons Attribution-Share Alike 3.0 Unported (CC BY-SA 3). Reproduced with permission of WWuyts; copyright ©WWuyts, all rights reserved (<https://commons.wikimedia.org/wiki/File:LangeWapper05.jpg>).

Oosterweel Link (Vlaamse Gemeenschap, 2002). In 2003, the public company ‘BAM’ (short for ‘Beheersmaatschappij Antwerpen Mobiel’ in Dutch) was created. Two years later, BAM presented their designs for Oosterweel Link. The flyover, four lanes wide and 2 kilometres long, had two decks (one above the other) supported by five 120-metre-high pillars (Timmerman, 2005) (See Figs. 2 and 3). Since the presentation, the trajectory they defined for the Oosterweel Connection, which is located relatively close to the city centre, became known as the ‘BAM trajectory.’

Reaction. The designs by BAM were met with opposition due to a range of concerns. Firstly, the flyover conflicted with the city council’s plans, announced in 2000, to regenerate the historic harbour. The implementation of BAM plans and designs would mean that a highway ramp would be built in the green area adjacent to the historic harbour. Moreover, the flyover would impact the river view (Buro 5, 2002; Claeys, 2013). Both interventions would significantly decrease the livability of the historic harbour. Secondly, the implementation of the BAM plans was

thought to merely shift mobility problems to other bottlenecks as they did not include a structural reorganization of traffic flows (Claeys, 2013). Maritime mobility was another point of contention. Critics argued that the bridge would disturb radar echoes and narrow the shipping channel, making navigation less safe (Claeys, 2013). Additionally, Antwerp would no longer be able to host tall ship races: the viaduct would cross the lock that provides access to the marina used for hosting, and with its lower deck only 30 m above the water, it would block access for tall ships. Fourthly, the noise and air pollution caused by traffic on the new section of the ring road was feared to affect a large area. There was a particular concern for a school and service centre for persons with disabilities near the flyover. The projected concentration of soot particles and nitrogen dioxide to which the centre would be exposed is known to cause pulmonary hypertension and arteriosclerosis (Lej, 2009).

Several actions were taken to halt the BAM plans, including objections during public enquiry phases of administrative procedures and referendum organization.

In 2010, the government decided to replace the flyover across the docks with a tunnel. A few years later, however, the Oosterweel Link project reached a deadlock. Years earlier, in 2005, the citizen movement *stReets-general* (‘*stRaten-generaal*’ in Dutch) had developed an alternative to the BAM plans. European Union regulations on Environmental Impact Assessment required this alternative to be considered as a “reasonable alternative” throughout the further development and implementation of the BAM plans and designs. Concerns that the alternative (and later, updated versions developed in collaboration with other partners) had not been properly considered led *stReets-general*, along with another citizen movement and three individual citizens, to file a complaint with the Council of State. In 2017, the Council of State auditors found the complaint justified (Vlaams Parlement, 2017). If the Council upheld this judgement, the government would get 30 days to resolve the problem before the newly created Regional Plan, designed to accommodate Oosterweel Link, would be annulled. Such an annulment would necessitate a full restart of the Oosterweel Link project. To prevent such an outcome, the government appointed an *intendant* to mediate a compromise among stakeholders, hoping that an agreement would allow the project to move forward.

New plans. In close collaboration with his team and various stakeholders, the intendant outlined new plans incorporating elements of BAM’s original plans and the alternatives developed by citizen movements. While the ring road would still follow the BAM trajectory, it would be used for local traffic only. Transit traffic would be diverted via a new, more northern route. All new connections would be constructed as tunnels.

The new plans were formalised in the ‘Future Pact,’ which was signed by all official partners, including the Flemish government, the city council of Antwerp, the Port of Antwerp, and three citizen movements. In addition to the projects of closing the ring road and adding a new northern route, the Future Pact included a declaration of intent to (i) completely cap the ring road and create new public spaces atop *livability projects*, (ii) achieve a modal shift to reduce car travel within the city region by 50%, and (iii) reach the goals included in the Future Pact collaboratively. With the signing of the Future Pact, the Oosterweel Link project became part of a larger urban development project called ‘The Great Connection’ (‘*De Grote Verbinding*’ in Dutch) (Vlaams Parlement, 2017). To facilitate collaboration among the signatories of the Future Pact, the intendant and his team created a layered structure that came to be known as “the working

community” (See Section ‘I3 - Communication and participation bureau in P3’) (Möbius Business Redesign NV, 2019). Table 1 presents a basic timeline of the Oosterweel Link project and its evolution.

Case study methodology

Preparatory steps. The case study aims to provide insight into the integrative work and expertise of extra-academic actors that enabled the transformation of a traffic infrastructure project into a larger urban initiative, offering a more comprehensive solution to Antwerp’s traffic issues. To study this expertise, it had to be localized first. For this study, expertise was localized indirectly, i.e., through the extra-academic integration experts exhibiting the expertise. These experts were found by selecting critical integrations that contributed to Oosterweel Link’s transformation and identifying those who played key roles in facilitating them.

To identify these integrations, the IPO model, introduced in the Introduction, was used. The IPO model conceptualises integration as a process of combining inputs into one or more comprehensive outputs. Thus, following the IPO model, integrations are integrative processes that can be identified via the sets of their in- and outputs. Since the focus is on cross-domain integration, only processes that involved inputs from different domains were considered. Moreover, for reasons of feasibility, only processes that resulted in comprehensive plans were included. This led to the selection of four key integrative processes.

The first (P1) produced an alternative for the BAM plans, integrating the Masterplan Mobility Antwerp, the city’s urban development agenda, and concerns for safety, health, and the environment. The second (P2) led to The Great Connection, described in the Future Pact. Key inputs included previous plans and the objections that had been raised against them. P3 led to aligned plans for The Great Connection based on the Future Pact, expert knowledge from various domains, and stakeholder input. P4 generated designs and technical drawings for the Great Connection projects based on plans for The Great Connection

projects, architectural expertise, and input from other technical domains and stakeholders.

Next, the extra-academic actors who took a leading role in facilitating these processes were identified. For P1, it was the citizen movement stReets-general (A1); for P2, the intendant and his design bureau specialized in complex architectural and urban projects (A2); for P3, the communication and participation bureau included in the intendant’s team (A3); and for P4, the bureaus who made the designs for the Great Connection projects (A4). While some of these actors have academic experience, none were involved in Oosterweel Link/the Great Connection in that capacity. A3 and A4 were hired via a public tender for their respective professions (communication and design). A2 was hired via the same public tender as A3, but the latter was hired as a mediator, which exceeded his professional scope. A1 got involved as an activist.

Table 2 (first two columns) provides an overview of the integrative processes and leading actors.

Data collection and processing. The case study data were collected through interviews with representatives of each actor. For P1, this was a key member of stReets-general (I1); for P2, a key member of the intendant’s design bureau (I2); for P3, a key member of the communication and participation bureau included in the intendant’s team (I3); and for P4, a key member of a design bureau responsible for the design of a project included in The Great Connection (I4). Table 2 (third column) provides an overview of the interviewees.

The interviews followed a semi-structured format. Each participant was asked about their academic and professional background, how they became involved in Oosterweel Link/The Great Connection, and how they would describe their role in Oosterweel Link/The Great Connection. They were also asked to explain their integrative methods, identify their key collaborators, and discuss the biggest challenges they faced when integrating inputs from different domains. All interviews were conducted via Zoom, recorded, and transcribed.

Data analysis. The data analysis was carried out in two steps.

The first step involved producing summaries of the integrative work of I1–I4 in P1–P4, respectively. To allow for easy comparison, each summary follows a uniform structure, implicitly covering four key themes in the same sequence: the interviewee’s approach to the integrative process, the concrete steps they took to achieve integration, techniques they used to facilitate knowledge exchange and collaboration, and practical tips and strategies. The themes were identified by means of a thematic analysis of the transcripts.

The interviewees reviewed the summaries for accuracy, which led to one minor adjustment. The pronouns they/they are used to protect their anonymity and reflect instances where interviewees did not distinguish their contributions from those of their collaborators. The resulting summaries are presented in the

Table 1 Basic timeline of Oosterweel Link.	
1994	Launch of the Masterplan Mobility Antwerp
2000	The infrastructure and trajectory for the new connections are determined The city of Antwerp announces plans to regenerate the old harbour
2003	Creation of BAM
2005	BAM presents its designs StReets-general files an objection and submits an alternative
2010	The government decides to replace the flyover with a tunnel
2017	The State Council sustains the complaint by the citizens and citizen movements The intendant starts the mediation process Signing of the Future Pact

Table 2 Overview of the integrative processes, leading actors, and interviewees.			
Integrative process		Leading actor	Interviewee
P1	Production of alternative plans	A1 StReets-general	I1 Key member of stReets-general
P2	Preparation of the Future Pact	A2 Intendant and his design bureau	I2 Key member of the strategy and design bureau
P3	Production of coordinated plans	A3 Communication and participation bureau	I3 Key member of the communication and participation bureau
P4	Production of designs and drawings	A4 Great Connection design bureaus	I4 Director of a design bureau

Table 3 Characterisations of the types of expertise used for analysis.

Type of expertise	Characterisation
Interactional	Enables meaningful interactions with experts in a domain
Contributory	Enables contribution to a domain
Referred	Enables understanding of what it means to have expertise
Experience-based	Enables contribution to a technical domain and is not certified
Process	Enables designing and managing collaborative processes
Adaptive	Enables incorporating input from other domains into one's professional routines
Negotiation	Enables facilitating integrative negotiation between parties with different interests

'Integrative work' subsections of Sections 'I1—Citizen movement in P1' to 'I4—Design bureau in P4'.

In the second step, the summaries and transcripts were analyzed to describe the expertise that interviewees applied in the integration process. These descriptions highlight the relevant knowledge and skills and, where applicable, connect them to the seven expertise types identified in the literature (see Section 'Theory on integrative expertise'), as shown in Table 3. The descriptions are presented in the 'Integrative expertise' subsections of Sections 'I1—Citizen movement in P1' to 'I4—Design bureau in P4'.

Results

I1—citizen movement in P1

Integrative work. I1 spearheaded the development of the alternative plans, driven by the belief that the BAM plans could be significantly improved and that doing so was important because "the quality of the urban environment directly impacts residents' well-being." According to I1, even subtle factors such as "the quality of street lighting, the liveliness of plants, the clarity of bike lane markings, and the duration of traffic light waits" influence how people interact with public spaces as well as their overall sense of safety.

I1 proposed core ideas for the alternative plans, including tunnelling the Oosterweel Link on the right bank of the river and rerouting traffic to a more northern trajectory. Some ideas, such as capping the ring road, were inspired by another citizen-led urban development initiative that I1 had participated in. I1's contributions were also informed by extensive knowledge of the BAM plans, the city of Antwerp's urban development agenda, and personal observations of urban environments in Antwerp, other parts of Belgium, and abroad.

To develop these core ideas into a comprehensive plan, I1 interacted with a range of experts, including architects, planners, and traffic, health, and safety experts. Some of these experts were stakeholders of the Oosterweel Link project, living in or near Antwerp, while others were from abroad.

To ensure the alternative plans would address the city's needs and to garner support, I1 also engaged with local government officials and organized various informational sessions for residents.

Integrative expertise. The knowledge and skills underpinning I1's integrative work in P1 are drawn from various sources. The core ideas for the alternative plans were based on knowledge and experience gained as a resident of Antwerp, an observant traveller, and an active member of citizen-led urban development initiatives. To further operationalize these ideas, I1 studied the BAM plans, the Regional Plan, and the city's urban development agenda. Since this expertise is not formally certified, it is experience-based expertise.

The development of the alternative plans was a collective effort in which I1 acted as a process manager. They coordinated

with local councils and residents to align the plans with community needs and to garner support. Additionally, I1 identified the plan's key dimensions (e.g., structural, ecological, health) and sought input and feedback from domain experts. Selecting the right experts required referred expertise and delegating tasks while maintaining local support necessitated process expertise. Convincing a wide array of actors to contribute to the alternative plans by emphasising mutual benefits required negotiation expertise. Finally, I1's prior involvement in citizen committee work and familiarisation with expert literature helped them build the interactional expertise needed to communicate effectively with experts, stakeholders, and the general public.

I2—intendant in P2

Integrative work. I2 began working on P2 when the government tasked the intendant with resolving the deadlock in the Oosterweel Link project by developing new plans acceptable to all stakeholders. Drawing on prior experience with large-scale urban projects, I2 recognized the importance of addressing not only the "technical and financial risks" but also the "spatial and social risks" arising from the convergence of various domains, ideologies, and interests. To mitigate these risks, I2 adopted a collaborative approach that involved bringing stakeholders together.

I2 started with a preparatory phase, during which they conducted one-on-one conversations with stakeholders to learn about their interests, dealbreakers, and areas of flexibility regarding Oosterweel Link. These stakeholders were identified through a power analysis informed by the project's history. I2 organized their findings into "knowledge topologies." These topologies outline the causal relations that structure the stakeholder's knowledge and the values that shape their perspective. In the next phase, I2 organized larger meetings with strategically compiled stakeholder groups to discuss specific parts of Oosterweel Link.

Stakeholders were encouraged to invite experts who share their worldviews and values. I2 moderated these meetings with support from the communication and participation bureau included in the intendant's team. Between meetings, I2 prepared discussion points, for example, by developing new options for consideration or conducting engineering evaluations of already-identified options.

I2 strategically planned these meetings, initially focusing on less contentious parts of Oosterweel Link, enabling the stakeholders to build trust; later, agreements could be reached on more "hot" issues.

Integrative expertise. Much of the integrative expertise I2 utilized in P2 stems from their professional background in architecture and design and their experience with complex projects.

Their contributory expertise in architecture allowed them to create and evaluate designs. Especially in the later stages of P2, many of these designs were created to support negotiation

processes by representing different choice options and enabling the exploration of ways to reconcile stakeholders' needs and preferences. I2 also used their design skills to contribute to the new plans. Both creating negotiation-oriented designs and contributing to new plans required adaptive expertise.

To enable collaboration, I2 helped reconcile stakeholders who had been in conflict over the Oosterweel Link for many years. Achieving this reconciliation, while also working towards new plans, required process expertise. Using this expertise, I2 distinguished a preparatory and collaborative phase. During the preparatory phase, I2 engaged with stakeholders, which required interactional expertise in various domains. In meetings with individual stakeholders, I2 used their negotiation expertise to identify factors that would have to be addressed in the collaborative phase of P2. In the collaborative phase, process expertise overlapped with negotiation expertise and enabled I2 to determine optimal configurations and goals of meetings and to foster trust and confidence before initiating more challenging conversations. I2 also needed interactional expertise to facilitate communication among stakeholders by flagging the use of jargon, clarifying underlying assumptions, and translating between domains. Finally, referred expertise was required to ensure balanced expert and stakeholder representation.

I3—communication and participation bureau in P3

Integrative work. I3 enabled the collaborative development of plans for the projects included in The Great Connection. As a coordinator, I3 was responsible for managing the process's "social complexity," which they distinguished from "construction and financial-legal" complexities. I3 described their main task as "identifying relevant actors and involving them in a process where they start working together and develop solutions."

To accommodate the collaborative process, I3, in collaboration with their colleagues of the communication and participation bureau and other members of the intendant's team, created a layered structure that became known as the 'working community.' Each layer in this structure had a specific configuration (e.g., including or excluding elected politicians) and distinct responsibilities (e.g., administrative or creative tasks). Three critical layers were (i) the steering group, composed of key administrative actors; (ii) the *step consultation* layer, which included the signees of the Future pact; and (iii) the *workbenches* layer, with a dedicated workbench for each project. Each project workbench included the intendant's team, government representatives, the citizen movements, and a responsible design team. Additional stakeholders and experts were brought in as needed.

At the workbench level, I3 facilitated cross-domain integration alongside the intendant by organizing meetings, setting agendas, preparing questions, and assigning preparatory tasks. The first meeting of a new workbench was always aimed at establishing house rules to create a safe space for collaboration. Subsequent meetings focused on co-defining objectives, and later sessions focused on negotiating how to reach those objectives. During meetings, I3 acted as a moderator, enforcing the house rules, managing speaking turns, and ensuring clarity regarding participants' interests and preferences.

To ensure qualitative outcomes, I3 continuously tracked progress and the levels of agreement reached.

Integrative expertise. I3 specializes in process direction and stakeholder management in collaborative projects, which means that their contributory expertise overlaps with process expertise. This expertise enabled I3 to plan and prepare meetings effectively: early meetings prioritized creating a safe space and co-defining

objectives, while later meetings leveraged this foundation to achieve the objectives.

I3's process expertise also enabled them to develop the working community. To tailor the collaborative process and structure to a project's specific needs, I3 also employed adaptive expertise to incorporate stakeholder feedback to refine and adjust their approach.

During the meetings, I3 acted as a neutral facilitator who monitored and stimulated progress towards the co-defined objectives, for example, by making sure conversations stayed on topic. Doing so required negotiation expertise to track whether all relevant requirements included in the objectives were met and whether workbench participants pushed themselves to find high-quality solutions rather than settling for compromises. It also required interactional expertise, for example, to engage participants in meaningful conversation, to address ambiguous phrasings, and to promote clarity and transparency.

Finally, I3 prepared questions for meetings. Formulating these questions required referred expertise, as crafting focused and stimulating questions had to be based on a clear understanding of the expertise of workbench participants.

I4—design bureau in P4

Integrative work. As the director of a landscape architecture bureau, I4 was responsible for the design and technical drawings for a project included in The Great Connection. In this role, I4 acted as the "designing partner," synthesizing structurally sound infrastructure, effective water management, and optimal acoustic conditions, all while adhering to budgetary constraints, complying with relevant legislation, and improving the urban landscape. Acknowledging that they are "not all-knowing," I4 collaborated with experts in other domains. Yet, I4 always maintained control over the design process, stating that they would "never give their pencil out of hand."

When collaborating, I4 actively engaged with experts by asking questions and applying their input to the project. I4 also often challenged experts to justify their recommendations and encouraged them to consider alternative perspectives. Rather than relying on a fixed group of experts, I4 selected specialists from an extensive network tailored to the project's specific needs. For the project included in The Great Connection, I4 collaborated with experts from their network as well as with those involved in the project's workbench.

During workbench meetings, I4 gathered input from stakeholders, often by identifying potential design restrictions (e.g., the course of a stream in a park) and bringing these to the table for discussion (e.g., 'Can we move the stream?').

I4 also presented different design options, solicited feedback, and incorporated this feedback into the ongoing project development.

Integrative expertise. The integration process led by P4 exemplifies interprofessional integration. I4 contributed to the design, spatial, and structural aspects of the plans through their contributory expertise in architecture and urbanism, as well as experience-based knowledge of the local area. A key aspect of I4's role was integrating input from various professionals (e.g., hydrology or ecology consultancy firms) and stakeholders (included in the working community) into their designs and drawings, which required adaptive expertise. Identifying the right experts required referred expertise and obtaining the necessary input at the right time, process expertise. I4's engagement with experts and stakeholders required interactional expertise, including the ability to critically reflect on their processes and results to present their results, ask useful questions, and process

the answers they received. I4's capacity to synthesize input from diverse actors into their designs is a core component of their contributory expertise. Because reconciliation of the needs and preferences of stakeholders were mostly reconciled at the workbench meetings, P4 involved limited negotiation expertise.

Discussion

Lessons from Oosterweel link. In the previous section, the integrative expertise of the interviewees is analyzed in terms of the types of expertise defined in the literature. This section reflects on how these types fall short in describing the knowledge and skills of the interviewees and hypothesizes on differences between academic and extra-academic integrative expertise. It concludes with reflections on the limitations of the case study.

Translational expertise. Interactional expertise, as characterised by Collins and Evans, is the expertise required to interestingly interact with field experts in a field. However, for some contexts, this notion was too reflexive to accurately describe the expertise displayed by an interviewee. For example, in conversations leading up to the Future Pact, I2 used their interactional expertise to have meaningful exchanges with experts and to enable meaningful exchanges between these experts. Similarly, I3 required interactional expertise to track and manage developments at workbench meetings but also to enable exchanges between participants. Thus, on top of being able to interpret what experts in certain domains said, I2 and I3 could also translate between domains. This type of expertise is more extensive than interactional expertise and could be referred to as 'translational expertise.' Note that the more directly conversations are aimed at reaching an agreement or finding a compromise, the more the translational expertise will overlap with negotiation expertise.

Translational expertise may be especially critical in extra-academic contexts because, in contrast with scientific disciplines, the basics of professional and experience-based domains are not standardly included in elementary education. Integration experts operating in extra-academic contexts might require more translational expertise, with the jargon, methods, objectives, and values of the domains involved being less commonly known.

System expertise. The concept of process expertise emphasises the dynamic component of integration, i.e., the one that involves change and transformation. It also obfuscates more static components, such as structures that support integration. Yet, the importance of such structures was well-illustrated in the interview with I3. To create more space for static components, 'process expertise' could be replaced by 'system expertise,' which points towards dynamic (process) and static (structure) components.

Also, system expertise may be especially important in extra-academic contexts because they lack the tried-and-tested structures for cross-domain integration that are present in academia (e.g., projects with PIs, workshops, and research visits). Research on epistemic structures that enable cross-domain integration, such as boundary objects (e.g., Star and Griesemer, 1989) and research platforms (Griesemer, 2013), could inform the development of the notion.

Know-who. Several interviewees emphasised the importance of identifying collaborators with the right expertise who were ready, willing, and able to contribute. For example, I1 sought experts with personal stakes in the Antwerp region, while I4 had built a network of experts from which they could select collaborators to fit the needs of a project. This suggests that *know-who* is also a crucial component of various types of expertise, including process and negotiation expertise.

In extra-academic contexts, where formal structures for identifying relevant experts (e.g., associations with faculties and departments, personal pages on university websites, databases of publications) are absent, *know-who* might play an even more critical role.

Existing research in business and management (e.g., Hulme, 2014; Seet et al. 2018) could provide a foundation for the study of *know-who* in extra-academic integrative expertise.

Normative expertise. All interviewees underscored the role of values, ideologies, political views, and philosophies in their integrative work. On the one hand, they explained how personal values influenced their work. For example, influenced by a liberal political philosophy, I2 found it important to be aware of how public infrastructure reflects ideological and political values. Convinced that participatory approaches should support democratic decision-making, I3 attached great importance to the inclusion of underrepresented groups. On the other hand, there are the worldviews of contributors. Both I2 and I3 mentioned the importance of making these worldviews explicit to enable mutual understanding among collaborators and, hence, productive discussion.

While interactional, process, and negotiation expertise partially covers navigating non-epistemic values, the prominence of these values might warrant the use of a notion of *normative expertise*, similar to the ones introduced by Veatch (2005) or Hall and Blanton (2009).

It is likely that, compared to academic contexts, where epistemic values are important drivers for collaboration and integration, in extra-academic contexts, the more modest role of epistemic values is compensated by a more prominent role for non-epistemic values.

Distributed expertise. The integrative work of the interviewees was connected in various ways. For example, I2 played an important role in P3, where they closely collaborated with I3, and I4 contributed to P3 as an active workbench member and had previously collaborated with I1 in P1. The interviewees also explained how their integrative work was complementary and sometimes enabled by that of others. This suggests that integrative expertise should not only be studied at the level of individual experts but also as a distributed phenomenon.

Research in social epistemology, for example, on epistemic dependency in interdisciplinary contexts (Andersen and Wagenknecht, 2013) and relational agency and expertise in interprofessional contexts (Edwards, 2011), provides a valuable starting point for studying distributed integrative expertise.

Overlapping types of expertise. Finally, the data analysis revealed that instances of different types of expertise can overlap. For example, in the case of I3, contributory expertise coincided with process expertise, and I2's negotiation expertise aimed at resolving the conflict between stakeholders relied on contributory expertise and adaptive expertise to produce graphical representations of ways to reconcile stakeholder preferences. Such overlaps indicate the interconnectedness of the seven types. Exploring the relations that (can) hold between different types of expertise could further deepen our understanding of the diversity of integrative expertise profiles.

Limitations of the case study. The case study is a valuable step towards a more inclusive theory of extra-academic integrative expertise but has some important limitations.

First, the data were collected for highly specific contexts, viz. the work of four key actors (A1-A4), represented by four

interviewees (I1-I4), as part of one of four integrative processes (P1-P4) in Oosterweel Link/The Great Connection. Consequently, the integrative expertise of actors with less prominent roles in P1-P4, those involved in minor integrative processes or interactions between actors, falls outside the scope of the study.

The case study also yields limited insight into the relation(s) between integrative expertise and knowledge domains because it makes abstraction of the types of domains in which the interviewees are active (e.g., the professional domain of architecture, the experience-based domains comprised of knowledge about the city of Antwerp or administrative procedures).

Furthermore, only one interview was conducted per context, and the interview data were summarized and analyzed by a single researcher. These factors limit the representativeness of the case study.

Conclusions

Existing literature on integrative expertise has primarily focused on academic contexts. This paper broadens that scope by emphasising the importance of recognizing extra-academic integrative expertise, providing insight into its practical manifestations, and reflecting on how it differs from academic integrative expertise.

This paper examined the integrative work of four extra-academic actors through a case study of the Oosterweel Link project. It identified connections between the knowledge and skills underlying their integrative expertise and seven established types of expertise: interactional, contributory, process, referred, experience-based, adaptive, and negotiation expertise.

By analyzing the extra-academic expertise in terms of the seven types, their applicability and their limitations in fully capturing the complexity of extra-academic integrative work are assessed. To allow for a more accurate and exhaustive analysis of extra-academic integrative expertise, the paper proposed the use of additional categories: *translational expertise*, which enables translating between domains; *system expertise*, which supports both the dynamic and static aspects of integration; *know-who*, which helps identify and connect with the right collaborators; and *normative expertise*, which aids in recognizing and articulating underlying values.

Furthermore, the findings underscore the need for greater attention to the distribution of extra-academic integrative expertise and the overlaps between different types of expertise. This suggests that existing frameworks for integrative expertise may need to be reorganized to better reflect the realities of complex problem-solving, both within and outside academia.

Data availability

The participants of this study did not give written consent for their data to be shared. Due to the sensitive nature of the research, the supporting data are not available.

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Notes

- 1 In this paper, I use 'domain' to refer to a realm of knowledge sustained by a group of people who have the same occupation, educational background, interests or experiences. Domains can be of different sizes, depending on the level of detail with which the shared factor is defined. For example, both science as a whole and scientific fields or disciplines can be considered domains. Other examples are professions and trades, policy areas, civil society and interest groups.
- 2 Not all negotiation processes are integrative. Some are distributive, aimed at dividing resources to meet conflicting interests (Baarveld et al. 2015). The expertise required to support distributive negotiation processes falls outside the scope of this paper.

- 3 Belgium is a federal country with 6 governments: one federal and five governments of regions and communities. There are three economic-geographical regions (viz. Flanders, Brussels and Wallonia) and three cultural-linguistic communities (viz. Flemish, French and German). Because the territory of the region of Flanders coincides with that of the Flemish community, they fused their governments. The Oosterweel Link project was initiated by the Flemish government. Unless mentioned otherwise, 'the government' refers to the Flemish government.

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Author contributions

The author confirms the sole responsibility for the conception of the study, presented results, and manuscript preparation.

Competing interests

The author declares no competing interests.

Ethical approval

This study was performed in accordance with the principles of the Declaration of Helsinki. The Ethics Committee of the Faculty of Arts and Philosophy of Ghent University (April 27, 2021/No. 2021–20) granted approval.

Informed consent

Consent was obtained from all participants and/or their legal guardians.

Additional information

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