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Assessment criteria for inter-organizational collaboration in interconnected infrastructure projects

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Abstract

Purpose – Societies depend on interconnected infrastructures that are becoming more complex over the years. Multi-disciplinary knowledge and skills are essential to develop modern infrastructures, requiring close collaboration of various infrastructure owners. To effectively manage and improve inter-organizational collaboration (IOC) in infrastructure construction projects, collaboration status should be assessed continually. This study identifies the assessment criteria, forming the foundation of a tool for assessing the status of IOC in interconnected infrastructure projects.

Design/methodology/approach – A systematic literature study and in-depth semi-structured interviews with practitioners in interconnected infrastructure construction projects in the Netherlands are performed to identify the criteria for assessing the status of IOC in infrastructure construction projects, based on which an assessment tool is developed.

Findings – The identified assessment criteria through the literature and the practitioner's perspectives results in the designing and development of a collaboration assessment tool. The assessment tool consists of 12 criteria and 36 sub-criteria from three different categories of collaborative capacity: individual, relational, and organizational.

Originality/value – The assessment tool enables practitioners to monitor the status of IOC between infrastructure owners and assists them in making informed decisions to enhance collaboration. The assessment tool provides the opportunity to assess and analyze the status of collaboration based on three categories (i.e., individual, relational, and organizational).

Keywords Inter-organizational collaboration, Horizontal collaboration, Assessment tool, Interconnected infrastructure, Construction industry

Paper type Research paper

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1. Introduction

The construction industry, including the infrastructure sector, has a great influence on various aspects of society such as the economy, safety, and environment (Grafius *et al.*, 2020; Yong and Mustaffa, 2012). Infrastructures, as the main part of the construction industry, provide essential services for society and serve as a vital foundation for promoting economic growth (Gondia *et al.*, 2022; Hatema *et al.*, 2022). The proper development and functioning of various critical infrastructures are therefore essential for ensuring societal welfare (Laugé *et al.*, 2015).

The intricate and dynamic nature of infrastructures presents a continuous challenge to their design, development and exploitation, principally because they face various obstacles such as aging, natural and technological disasters, and limited resources (Croope and McNeil, 2011; Hertogh, Bakker, van der Vlist and Barneveld, 2018). The challenges encountered by infrastructure systems, specifically in relation to the aging process, emphasize the necessity of implementing measures aimed at their development, upgrading, and replacement. However, the next generations of infrastructures are becoming more complex due to the continuous advancement of new technologies (Grafius *et al.*, 2020; Organek John, 2017). Moreover, infrastructures are becoming strongly interconnected (*e.g.,* road and railway infrastructure crossing waterways) and can affect each other's performance directly (Carhart *et al.*, 2018; Rinaldi *et al.*, 2001). Consequently, global challenges, such as climate change, pandemics, and population growth, can impact interconnected infrastructures and lead to a potential cascade of failures (Grafius *et al.*, 2020; Pamidimukkala *et al.*, 2021). Therefore, it is crucial to ensure that these complex and interconnected infrastructures are developed in a resilient manner to tackle both current and future challenges.

Interconnected infrastructures are considered, in the present study, as a bilateral relationship, wherein each infrastructure exerts a reciprocal influence upon the other. Despite the strong interdependencies between infrastructures, the development of infrastructures has often been executed relatively independently in silos (Carhart *et al.*, 2018; Grafius *et al.*, 2020). Additionally, the literature addressed the unsatisfactory performance of infrastructure projects, revealing that significant proportions of projects within the infrastructure sector fail to meet their intended budget and/or schedule (Cantarelli *et al.*, 2022; Edwards, 2021; Eriksson *et al.*, 2017; Lo *et al.*, 2022). The complex interdependence and dynamic characteristics of interconnected infrastructure projects make them particularly challenging and risky to manage (Gondia *et al.*, 2022). Moreover, developing resilient interconnected infrastructures requires significant resources, substantial budgets, diverse set of specialized and multidisciplinary skills, which cannot be accomplished by working individually (Emmitt and Ruikar, 2013; Gondia *et al.*, 2022; Pamidimukkala *et al.*, 2021). Therefore, it can be argued that multidisciplinary collaboration across infrastructure organizational boundaries is essential to manage interconnected infrastructure projects (Grafius *et al.*, 2020).

The management of interconnected infrastructure projects is challenging, requiring the coordination of tasks, and the application of multidisciplinary knowledge and skills from various infrastructure owners (Grafius *et al.*, 2020; Nezami *et al.*, 2022). The chance to enhance the efficiency and resilience of infrastructures largely hinges on establishing collaboration between infrastructure owners (Eriksson *et al.*, 2017; Grafius *et al.*, 2020). Next-generation interconnected infrastructures are expected to require even closer collaboration between infrastructure owners to tackle the challenges of more integrated construction projects during their design, development, implementation, and management of the projects (Eriksson *et al.*, 2017; Organek John, 2017).

Collaboration between different infrastructure organizations, in other words, inter-organizational collaboration (IOC), promises to optimize the efficiency of infrastructure construction projects. IOC enables these organizations to overcome the scarcity of resources and lack of competencies during the project (Dietrich *et al.*, 2010; Eriksson *et al.*, 2017) and gain core values and potential benefits (Keung and Shen, 2013). IOC across national, cultural

and political boundaries is considered even more essential in large-scale projects (*e.g.,* infrastructure projects) to cope with high degrees of uncertainty and complexity (van Marrewijk and Smits, 2016). The present work focuses specifically on the horizontal collaboration between various infrastructure owners as IOC. "Horizontal collaboration" in this research can be defined as a synergistic relationship between two or more independent organizations with an equal distribution of power that work jointly to pool resources and knowledge towards the attainment of a shared goal, resulting in mutual benefits.

The success of complex infrastructure projects heavily relies on the quality of collaboration between infrastructure organizations (Kokkonen and Vaagaasar, 2018). Emmitt and Ruikar (2013) argue "the better the collaboration, the better the outcome of the project". However, collaboration is not a straightforward process and can be challenging to achieve, especially in complex construction projects (Faris *et al.*, 2022; Nezami *et al.*, 2022). More often than not, lack of close collaboration, poor communication, and deficient participation from team members are identified which necessitates an increased capability of assessing collaborative practices and promoting measures to facilitate IOC (Faris *et al.*, 2022; Ibrahim *et al.*, 2011). Thus, more attention to the design of the collaboration as well as assessment of IOC during a project can assist practitioners with realizing collaboration and potentially enhance the performance of collaborative projects. Accordingly, an increased capability to design (*ex ante*), assess and evaluate (ex-post) IOC by tracking the status of the collaboration using recorded pieces of evidence is considered a critical component of managing collaborative projects. To this end, assessment tools need to be developed to assess IOC. They provide an overview of collaboration and enable practitioners to discover the strengths and weaknesses of the specific IOC. Marek *et al.* (2015) claim that the identification of the strengths and weaknesses of IOC via an assessment tool can contribute to effective collaborations. Moreover, the outcomes of collaboration assessments can assist practitioners and policymakers in efficient decision-making (Thomson *et al.*, 2009). However, collaboration between various organizations (*i.e.,* horizontal collaboration) and identifying the criteria and providing the assessment tool for IOC in infrastructure construction projects is understudied (Hetemi *et al.*, 2022; Keung and Shen, 2013; Longoria, 2005; Parung and Bititci, 2008).

The present work focuses on horizontal collaboration between various infrastructure owners and aims to identify IOC assessment criteria for interconnected infrastructure construction projects in order to design an inter-organizational collaboration assessment tool (ICAT). To this end, firstly, a literature study was carried out to assess IOC in construction projects and identify assessment criteria, and secondly, in-depth interviews were performed to collect practitioners' opinions on how to assess the collaboration between different infrastructure owners. Further details of these two approaches are explained in Section 2 (research methodology). Section 3 presents the literature review, Section 4 explains the results of in-depth interviews. Section 5 discusses the findings and the tool development. Finally, the concluding remarks in Section 6 highlight how utilizing ICAT would contribute to enhancing IOC in infrastructure projects.

2. Research methodology

Qualitative research was performed to identify criteria to assess the status of IOC in infrastructure construction projects. The research was conducted in two subsequent steps: (1) a systematic literature review was conducted to identify assessment criteria to develop a conceptual assessment tool and (2) an inter-organizational assessment tool (ICAT) was developed and refined based on the practitioner's perspectives.

2.1 Systematic literature review

A systematic review of empirical studies was performed to identify the criteria for assessing IOC in the construction industry. This list of criteria was used as a basis for the development

of the ICAT. To perform the systematic literature review, the Scopus and Web of Science databases were searched to retrieve relevant articles published between 2000 and 2022. The search used keywords and Boolean operators such as: "Inter-organizational collaboration" OR "Horizontal collaboration" OR "Collaborative relationship" AND "Criteria" OR "Indicator" AND "Assessment" OR "Evaluation" OR "Measurement". The combination of these keywords was used as a starting point. A number of filters were applied (fields of study: management, engineering, and social sciences; language: English; and type of document: articles), which resulted in one hundred and ten papers. Initially, the titles and abstracts of these articles were screened to select relevant papers that specifically addressed the assessment of collaboration between different organizations. Articles focusing solely on specific aspects of a collaborative project without addressing collaboration assessment were excluded, reducing the number of articles to eighteen. Further examination of these eighteen articles revealed that some in the field of health management focused on collaboration assessment, but primarily in the context of inter-professional collaboration, such as the consistent collaboration between physicians and nurses to improve patient outcomes. Since inter-professional collaboration between individuals fell outside the scope of our study, these articles were also excluded, resulting in a final selection of seven articles. The main objective of the present study is to assess collaboration between different organizations, particularly within the construction industry where infrastructure owners engage in "horizontal collaboration". Accordingly, four articles were identified that specifically addressed the assessment of horizontal collaboration between organizations. This literature selection formed the basis for the list of criteria to assess IOC. Based on our previous study (Nezami *et al.*, 2023) the identified criteria were categorized into: individual collaborative capacity (ICC), relational collaborative capacity (RCC), and organizational collaborative capacity (OCC).

2.2 In-depth interviews

Because studies of collaboration between different asset owners in infrastructure construction projects are scarce and an assessment tool for cross-infrastructure collaboration was missing (Keung and Shen, 2013; Longoria, 2005; Parung and Bititci, 2008), a practical assessment tool had to be built by making use of practitioner's perspectives. To this end, in-depth interviews were performed to gain insight into practitioners' perspectives on IOC and how to assess the status of collaboration between infrastructure owners. The interviews were used to check the criteria identified via the literature study from the previous step and develop the ICAT.

The main data collection method employed involved conducting semi-structured interviews. These interviews were carried out with individuals actively engaged in inter-organizational collaboration (IOC), as detailed in Table 1. The participants included practitioners from diverse infrastructure organizations, spanning various roles and possessing a range of experience levels, ranging from fifteen to thirty-three years. A total of twenty practitioners, representing Rijkswaterstaat, Waterschap Aa en Maas, and ProRail, were interviewed. During the interviews, the respondents were asked to list their criteria for assessing the status of IOC. This was done to complement the criteria identified in the literature. Next, the conceptual assessment tool was presented to the respondents, and they were asked to rank the importance of identified criteria from the literature based on a Likert scale (1: Very unimportant, 2: Somewhat unimportant, 3: Neutral, 4: Somewhat important, and 5: Very important). Accordingly, the results of the ranking for the importance of each criterion for IOC assessment were collected and analyzed statistically including the minimum, maximum, mean, and standard deviation values. Additionally, the respondents were asked to express their opinions about their ranking for each criterion. Each interview

took approximately one hour and was recorded and transcribed. To analyze the interview results and accomplish the research objective, a qualitative-interpretive approach was selected (O'Connor and Gibson, 2003). The interview transcripts were summarized manually to capture principal insights based on key terms relevant to the main themes (collaboration, the inter-organizational context, and assessment). For confidentiality purposes, the names of the respondents are kept anonymous.

Moreover, given that the respondents were drawn from various infrastructure organizations with different functions, an additional analysis was also conducted based on their functions. To this end, the respondents were divided into two groups: senior level (N = 9) and project team (N = 11), as indicated in Table 1, to investigate possible differences in their opinions regarding the identified criteria. For this purpose, an independent samples Mann–Whitney test was performed on the distributions of the scores of the identified criteria from the literature. Since the data is based on Likert scales (ordinal data), it may not follow a normal distribution. Therefore, the Mann–Whitney *U* test is appropriate for comparing independent samples which is a nonparametric test that does not assume normality (Field, 2013; MacFarland *et al.*, 2016).

3. Literature review

Inter-organizational collaboration (IOC) plays a critical role in the success of complex and interdisciplinary inter-organizational projects, especially in the construction industry (Kokkonen and Vaagaasar, 2018). This kind of collaboration can enable organizations to solve problems that they cannot tackle alone and to achieve outcomes that benefit all parties involved (Butcher *et al.*, 2019). Moreover, collaboration can enhance flexibility, customer satisfaction, and service quality (Daugherty *et al.*, 2006; Kumar and Banerjee, 2012; Whipple *et al.*, 2010). Some of the main drivers for collaboration are the acquisition of different resources, the reduction of risk, and the application of diverse skills and knowledge (Borgatti and Foster, 2003; Kożuch *et al.*, 2016; Phelps *et al.*, 2012; Satheesh *et al.*, 2022). However, collaboration faces challenges, particularly in interconnected infrastructure projects, where multiple infrastructure owners have to coordinate their activities and interests. Interconnected infrastructure projects are those that involve the interconnection or intersection of different infrastructures, such as energy, water, transportation, and IT-based services (Grafius *et al.*, 2020). These projects require a specific form of IOC that is characterized as "horizontal", meaning that there is no hierarchical relationship between the collaborating parties. This type of IOC has received limited attention in the literature, and there is a need for more empirical studies to understand how it can be assessed and improved. The objective of this section is to review the literature to extract the existing frameworks and

	Function	Number of respondents	Average years of experience
Senior level	Project manager	5	26
	Project director	2	30
	Members of the steering committee	2	25
Project team	Advisor	2	21
	Technical manager	2	25
	Integrator manager	2	22
	Contract manager	2	25
	Developer	2	29
	Stakeholder manager	1	20

Source(s): Authors own work

Table 1. Overview of the functions of the respondents interviewed in the present work

criteria for assessing IOC in construction projects. This provides a foundation for a comprehensive and practical tool that can help practitioners to establish and maintain a collaborative environment in interconnected infrastructure projects.

3.1 Identified criteria based on the literature

Keast and Hampson (2007) assess multidisciplinary collaboration and identify four key relational management tasks: Activating, framing, mobilizing, and synthesizing. Activating refers to the selection of appropriate members and sufficient resources to enable collaboration. Framing refers to the rules, values and norms which emphasize working together rather than individually to overcome the complexity of the construction industry. Mobilizing is related to building a collective approach and shared goals, which leads to achieving not only the shared goals but also the goals of every single party. Synthesizing refers to maintaining relationships and establishing a collaborative culture rather than a competitive culture.

Keast and Hampson (2007) consider a competitive culture one of the main barriers in the construction industry which hinders synergy between different organizations. The relational management framework of Keast and Hampson (2007) focuses predominantly on the organizational aspect of collaboration, the management, and governance of collaboration and largely ignores the softer aspects of collaboration such as trust.

Dietrich *et al.* (2010) developed a conceptual framework for multi-partner collaboration in construction projects and identified five criteria to assess its quality: communication, coordination, mutual support, aligned efforts, and cohesion. These criteria assess the relational dimension of IOC and focus on the contribution of the partners to the collaboration. However, organizational aspects such as the culture of the organizations, the importance of collaborative procedures, and the role of leadership are not considered in this list.

Keung and Shen (2013) identified key parameters to measure inter-organizational relationships within construction contexts. According to them, the assessment of inter-firm relationships is essential for practice in the field of construction. They propose a measurement model which includes five parameters: information exchange between project members, project communication system, knowledge sharing for collaboration, corporate culture for promoting networking, and learning capability in intra- and inter-organizational settings. Due to the fragmented nature of construction projects, information exchange and communication systems are the most important aspects of assessing inter-organizational relationships (Keung and Shen, 2013). Keung and Shen positively embedded the learning capacity in their measurement model denoting collaborative openness and knowledge sharing and enriching collaboration in construction projects. Although communication and knowledge sharing are crucial to assess the status of collaborative relationships, broader organizational and individual collaboration aspects are required to be considered.

Suprapto (2016a) created a relational capability (RECAP) assessment tool to assess the status of relational aspects of collaboration during different phases of a project. The RECAP tool includes six main criteria: front-end definition, collaborative practices, relational attitudes, team working quality, project performance and relationship continuity. Front-end definition is the ability to perceive the project goals and scope by the collaborative team. Collaborative practice refers to the integration of the collaborative team and jointly performing the processes. Relational attitudes are related to collaborative attitudes such as commitment, mutual trust, and no blame culture. Teamwork quality includes communication, coordination, balanced contribution, aligned effort, mutual support, cohesion, and trust. Relationship continuity refers to the willingness to continue the relationship in future. A long-term relationship indicates a satisfying collaborative

relationship and successful prior collaborative project(s) (Pellicer *et al.*, 2016; Suprapto, 2016a). Suprapto also added a project performance criterion in his proposed tool, which assesses the efficiency (planning budget and schedule) and quality of a project. However, these aspects are outside the scope of the current study because the present study focuses on the collaborative relationship. Furthermore, it should be stressed that RECAP was developed to assess the collaboration between owner and contractor. The RECAP tool assists practitioners in being aware of the soft and relational aspects of collaboration over different phases of a project. However, this tool does not consider the learning capacity in collaboration assessment, which is an indication of sharing knowledge and openness among the collaborative parties (Liu *et al.*, 2019).

The identified criteria to assess IOC based on the literature study are listed in Table 2, forming the basis for the conceptual assessment tool.

Individual collaborative capacity assesses the collaborative capacity among the members. The ability and attitude of involved members and their knowledge and expertise have a great influence on collaborative work (Foster-Fishman *et al.*, 2001). The individual collaborative capacity includes three criteria: (i.1) attitudes and motivations, (i.2) attitudes about other project participants, and (i.3) ability to work with others. Attitudes and motivations refer to the commitment of collaborative members to contribute their specific knowledge and expertise and to devote their own skills and knowledge to collaborative work. Contribution of resources such as information and expertise is the aspect of the quality of the collaborative work (Suprapto, 2016b), and the integration mechanism of a collaborative network (Keast and Hampson, 2007). Attitudes about other project participants represents the attitude of members in collaborating with other parties and includes two sub-criteria: having a collaborative culture rather than a competitive culture (Keast and Hampson, 2007) and personally trusting each other (Suprapto, 2016a). Ability to work with others refers to the ability of the involved parties to deal with conflicts during the collaborative project. The skilled members work constructively with the potential tensions and conflicts that lead to facilitating the collaboration.

The second category, **relational collaborative capacity** refers to the relationship between involved parties. The relational level is an important aspect of collaboration as IOC depends on the interaction of the involved parties. The relational collaborative capacity includes five main criteria: (r.1) Working climate, (r.2) Shared vision, (r.3) Knowledge sharing, (r.4) Relationship continuity, and (r.5) Value diversity. A working climate is one of the fostering keys to a collaborative relationship (Foster-Fishman *et al.*, 2001), including eight sub-criteria: cohesion, involvement of the relevant members, stressing the collaboration benefit, mutual trust, the champions and one another's support, mutual flexibility, and welcoming of new information and innovative ideas, warranted to create a positive collaborative environment. Cohesion stems from possessing a collaborative spirit and integration between parties from different organizations (Dietrich *et al.*, 2010; Suprapto, 2016a), without which collaboration is impossible (Hoegl and Gemuenden, 2001). Selecting and involving relevant collaborative parties bring various resources and competencies together, and create synergistic interactions (Keast and Hampson, 2007; Powell *et al.*, 1996). Stressing the benefit of working together convinces the parties that they can achieve more together than individually; without collaboration complex and interconnected projects cannot be realized (Keast and Hampson, 2007). Suprapto (2016a) identified mutual trust as a criterion to assess the relational attitude in collaboration, which is a relationship quality indicator not only between the members but also the involved organizations (Meng, 2012). According to Keast and Hampson (2007), in addition to a coordinator and director of a collaborative project as champions of collaborative projects fostering collaboration, who should be supported to bring the parties and ideas together, the involved parties should also support each other to attain common goals (Dietrich *et al.*, 2010; Suprapto, 2016a). Moreover,

Table 2.
Assessment criteria based on selected literature (Conceptual assessment tool)

Category	Criteria	Sub-criteria	Literature			
			Keast and hampson	Dietrich, eskerod *et al*	Keung and Shen	Suprapto, M
Individual collaborative capacity (ICC)	Attitudes and motivations	Commitment to devote skills, knowledge, and resources	✓	✓		✓
	Attitudes about other project participants	Having a collaborative culture rather than a competitive culture	✓			
		Trust personally each other				✓
	Ability to work with others	Deal constructively with conflict	✓			
Relational collaborative capacity (RCC)	Working climate	Cohesion		✓		✓
		Involve the relevant members	✓			
		Stressing the benefit of working together	✓			
		Mutual trust between organizations				✓
		Support the champions of the collaborative project	✓			
		Supporting each other		✓		✓
		Existence of mutual flexibility		✓		
		Welcome new information and innovative ideas	✓			
	Shared vision	Mutual understanding of the goals, related activities and interdependencies between the activities		✓		✓
		Establish a common vision and mission	✓			
		Have joint working processes				✓
		Alignment of contributions provided by collaborating actors with the expectations of the contributions		✓		✓
	Knowledge sharing	Encouraging the collection and dissemination of knowledge among members			✓	
		The willingness and ability to transfer explicit and tacit knowledge			✓	
		Gaining and applying new knowledge from the representatives of other organizations			✓	

(*continued*)

Table 2.

Category	Criteria	Sub-criteria	Literature: Keast and hampson	Dietrich, eskerod *et al*	Keung and Shen	Suprapto, M
	Relationship continuity	The level of engagement of the organizations in various steps of the project	✓			
		Continue the relationship in future				✓
	Value diversity	Understand and examine the perspectives of others	✓			
		Understand the cultural differences between organizations			✓	
Organizational collaborative capacity (OCC)	Leadership	Connecting the members to the network and driving the relationship to achieve outcomes by senior management	✓			
		Commitment of senior management to support the collaboration				✓
		Actively work of senior management together to resolve potential conflicts				✓
	Communication	Have a free flow of communication between all members	✓		✓	✓
		Have a system to facilitate high volumes of information sharing	✓	✓		
		The ability of collaborative actors to share their ideas openly		✓		✓
		The frequency of communication		✓	✓	
	Formalized procedures	Clear roles and responsibilities of team members	✓			✓
		Clear procedures and guidelines of processes in a collaborative work	✓			
		Clear values, norms and rules	✓			✓
	Improved orientation	Monitor actions, needs and resources to meet common goals	✓			

Source(s): Authors own work

effective collaborative projects warrant the ability of involved parties to adapt to unforeseen circumstances and changes (Dietrich *et al.*, 2010). Being open and championing new information and innovative ideas are enabled by synergistic interactions which foster collaborative processes (Keast and Hampson, 2007).

Shared vision includes four sub-criteria: mutual understanding of the goals and related activities, establishing a common vision and mission, having joint working processes, and alignment of contributions of collaborating actors. Mutual understanding of goals and related activities leads to fluency in interactions and prevents potential conflicts in collaboration (Dietrich *et al.*, 2010). Furthermore, establishing a common vision and mission help to unite the different parties with different perspectives and values under a collective whole and creates a sense of common ownership of the collaborative project (Keast and Hampson, 2007). In this regard, having joint working processes encourages the involved parties to make joint efforts for the collaborative tasks and improve the collaborative relationship in IOC (Suprapto, 2016b) and reduce adversarial relationships. Joint working can be any collaborative practice such as joint decision-making (Chan *et al.*, 2004; Suprapto, 2016a), joint problem-solving (Chan *et al.*, 2004), jointly reviewing the plans, monitoring, reporting, and collaborative attempts for sustained improvement (Chan *et al.*, 2004; Suprapto, 2016a). These efforts should also be aligned and meet the expectations of the involved parties to prevent disappointment and possible conflicts (Dietrich *et al.*, 2010; Suprapto, 2016a).

According to Keung and Shen (2013), knowledge sharing is the activity that causes interaction among the members so the collection and distribution of knowledge should be encouraged. Sharing organizational knowledge leads to creating a learning capacity that enables involved parties to generate new ideas and innovative solutions. Sharing knowledge, willingness, and ability to gain and exploit knowledge in IOC leads to the improvement of relationships (Ekström, 2017) and facilitates IOC.

Engagement of the involved organizations and keeping them on board during the various steps of the project builds and maintains a collaborative relationship (Keung and Shen, 2013) which results in a successful collaborative project. According to Suprapto (2016b), a successful collaborative project increases the possibility of future relationships between different organizations. Collaboration between different organizations brings multiple perspectives, interests, and organizational cultures that should be understood by the involved parties. Respecting different cultures, perspectives, and investigating each other's opinions create innovative solutions which enhance IOC (Keast and Hampson, 2007; Suprapto, 2016a).

The last category of the conceptual assessment tool is **organizational collaborative capacity** which consists of four main criteria: (o.1) leadership, (o.2) communication, (o.3) formalized procedures, and (o.4) improved orientation. Organizational capacity needs effective leaders with the ability to steer the collaborative members toward the outcomes (Keast and Hampson, 2007), skilled to resolve conflicts, and committed to supporting the collaboration (Suprapto, 2016a). In addition, developing a communication system, enabling the involved parties to access the information, and the abilities of collaborative parties to share their opinions openly with a high frequency of communication indicate effective communication to enhance the organizational capacity (Dietrich *et al.*, 2010; Keast and Hampson, 2007; Keung and Shen, 2013; Suprapto, 2016a). Another proposed criterion for organizational capability based on the literature is establishing formalized procedures and structural arrangements through clarifying the roles and responsibilities, creating collaborative norms and values, and clear collaborative processes such as decision-making processes (Foster-Fishman *et al.*, 2001; Keast and Hampson, 2007; Suprapto, 2016a). Finally, monitoring the progress of the collaborative actions to achieve the agreed common goals of a collaborative project (Keast and Hampson, 2007) sheds light on the required improvement points of IOC.

The reviewed literature highlights various aspects of inter-organizational collaboration in the construction industry. While each approach provides valuable insights, there is a consistent gap in adequately addressing the softer elements such as trust and learning capacity, which are pivotal for achieving successful and sustainable collaborations. Additionally, how to measure these in practice is not being addressed in any of them. Achieving effective collaboration in construction projects necessitates a balanced integration of the components, which can lead to improved outcomes and a more harmonious working environment. This paper aims to develop a tool that allows to measure in practice collaboration and encompasses the full spectrum of collaborative elements to enhance the understanding and practice of horizontal collaboration in the construction industry.

4. Identified criteria based on the interviews

During the interviews, the practitioners alluded to multiple sub-criteria which, although being verbalized in different wording, still conformed to the criteria identified in the literature. Of the 34 sub-criteria identified in the literature, 30 were mentioned in the interviews. The four unmentioned sub-criteria are "supporting the champions", "aligning the contributions", "encouraging the knowledge collection", and "continuing the relationship in the future". The three most mentioned sub-criteria are "cohesion", "understanding and examining the perspective of others", and "clear roles and responsibilities of team members". According to the respondents, cohesion is a sign of the health of collaboration and of working together as a team. One of the project managers said, "*We are working together, and we speak with one mouth and you could say we collaborate as one*". The manager believes that without team cohesion, collaboration will fail when faced with problems.

Collaborating with various organizations exposes the involved parties to different perspectives and ideas. According to the respondents, understanding and examining the perspectives of other parties indicates openness and respect among the parties. As such, a technical manager expressed that discussing the perspectives and giving feedback to each other, means that the team discusses the issues openly, takes each other seriously, and support exists among the team. One of the managers mentioned that "*by understanding the perspectives of others, you get to know each other better and you can understand the reasons behind the actions. It can prevent irritation among the team*".

As reported by the respondents, having clear roles and responsibilities among the collaborative parties indicates the existence of a clear structure in collaboration, and is an important criterion to assess the status of IOC. Clarity of roles and responsibilities facilitates referencing responsible roles for decision-making, particularly in unexpected events. A technical manager expressed that "*it is important to be clear who is responsible for what. It helps to decide efficiently. Clarity of roles and responsibilities can smoothen the decision process which is an indication of good collaboration*".

The respondents mentioned four criteria besides those identified in the literature to assess the status of IOC; willingness, achieving common goals, satisfaction of the parties with collaboration, and having no hidden agendas in collaboration. Willingness among the parties is a criterion mentioned by respondents to assess collaboration. One of the project managers argued that good collaboration among different parties depends on their energy, motivation, and willingness to collaborate. A technical manager supported this argument by stating that through this energy and willingness among the parties, collaboration runs at a high speed. A project manager also mentioned that "*if there is a willingness in a collaboration, that means they are trying to do the best for the collaborative work and they are eager to fix the possible problems among them*". According to the respondents, willingness to collaborate promises smooth problem-handling and realizing the best out of the collaborative work. It drives problem-solving and efficiently discussing potential conflicts among parties.

A good collaboration is the one in which the involved parties are satisfied. A project director stated that satisfaction with collaboration shows that the collaborators understand each other, respect each other's way of working and agree with the current collaborative work. According to an advisor, being unhappy with the collaboration flags issues in working together. The advisor mentioned that the collaboration could be assessed by asking the involved parties "*are we still happy with this collaboration? If not the relevant problems and issues should be identified and solved together*". Hence, the satisfaction of the parties with the collaboration is taken up as an assessment criterion for IOC.

As collaboration is the quality of a relationship to achieve common goals among parties, the third suggested criterion is assessing the status of IOC based on common goals fulfillment. As reported by the respondents, achieving common goals shows that the collaboration is on track and also expresses commitment and a good relationship.

Another criterion mentioned by respondents was transparency (no hidden agendas) among the involved parties from various organizations. As quoted by a respondent "*if there is no double agenda and we put the issues on the table, that means you are on the right track and a good atmosphere exists in a collaboration*". A project manager added that risk awareness is an important element of collaborative work which is a result of being transparent "*we should not have hidden agendas and inform each other on the predicted risks*". It helps to understand each other's risks and learn from each other to deal with the identified risks, which not only can prevent conflicts but also can build a good collaboration. Therefore, based on the interviews, transparency is an indication of trust and good relationships among parties.

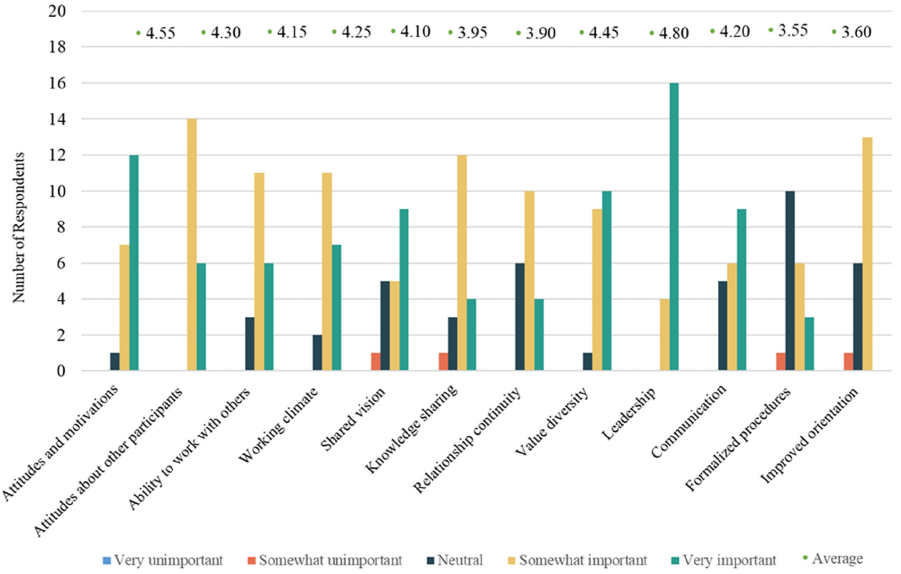
To capture the practitioners' perspectives on the identified assessment criteria from the literature, they were asked to rank the importance of each criterion on a Likert scale (see section 2.2). The results were analyzed and the statistical analysis of the ranking, including the minimum, maximum, mean, and standard deviation values are presented in Table 3. Figure 1 shows the frequency distribution of scores for each criterion and provides a visual representation of the level of agreement among the participants on the importance of each criterion.

Based on the mean value of each criterion shown in Table 3 and Figure 1, leadership, attitude and motivations, and value diversity are the most important criteria to assess IOC. Figure 1 provides insights into the level of agreement among the participants regarding the importance of criterion "leadership". Sixteen out of twenty respondents consider leadership

Table 3. Descriptive statistics based on the respondents' ranking for each criterion

Identified criteria	Minimum	Maximum	Mean	Std. Deviation
Attitudes and motivations	3	5	4.55	0.60
Attitudes about other participants	4	5	4.30	0.47
Ability to work with others	3	5	4.15	0.67
Working climate	3	5	4.25	0.64
Shared vision	2	5	4.10	0.97
Knowledge sharing	2	5	3.95	0.76
Relationship continuity	3	5	3.90	0.72
Value diversity	3	5	4.45	0.60
Leadership	4	5	4.80	0.41
Communication	3	5	4.20	0.83
Formalized procedures	2	5	3.55	0.83
Improved orientation	2	4	3.60	0.60
Valid N (listwise)	20			

Source(s): Authors own work



Source(s): Authors own work

Figure 1.
The practitioner's perspectives on the identified criteria from the literature

as a "very important" criterion to assess IOC. As reported in Table 3, the standard deviation of criterion leadership (SD = 0.41) is the lowest value, showing relative consistency among the respondents. As quoted by a project manager and an advisor "*to know if everything goes right, if the people with* the *right capacity for collaboration are obtained, and if all noses are pointing in the same direction towards outcomes, leadership is an important criterion to assess"*. As reported by the respondents, leaders' support for collaboration and the collaborative team is an indication of a good relationship between leaders and the team, trust among them, the possibility to have good achievements, feeling safe to express different ideas and perspectives, and satisfaction of a team in collaboration. In this line of reasoning, another project manager mentioned that "*a collaborative team always looks at the leader how to act in a difficult situation, particularly in a crisis*". In this case, according to the results of the interviews, if the leaders are in contact and work together to solve the problems, collaboration can run beneficially, and all parties can be guided effectively through emerging problems.

Attitude and motivation with a mean value of 4.55 is the second important criterion to assess IOC. The standard deviation of this criterion, presented in Tables 3 and is relatively low but as shown in Figure 1, one of the respondents remains "Neutral" on the importance of criterion attitude and motivation. This respondent mentioned that "*attitude and motivation is an important criterion for any project performance. It is a general element and is not specific to assessing IOC, that is why I am Neutral*".

The respondents argue that IOC is not only about sharing specific knowledge and expertise but also about having the motivation and willingness to collaborate and devote eagerness and energy to make the best out of collaborative work. An integration manager mentioned that "*if there is no positive attitude and motivation among the parties, you are pulling on a dead horse*". The respondents added that without commitment to share the required knowledge and resources, the collaboration can be hindered and fail to achieve the desired outcomes. Due to the complexities of infrastructure projects, the interrelatedness of

designs, and the involvement of multiple actors, bringing specific knowledge, expertise and various resources together is indispensable to succeed in IOC.

Half of the respondents think that valuing diversity is also a "very important" criterion to assess IOC. Most conflicts find their roots in the existing different structures and cultures of collaborative organizational parties (van Marrewijk and Smits, 2016) which can cause misunderstanding among the parties engaged in IOC and hinder collaboration. Based on the results, understanding and appreciating the other parties' perspectives and the differences between various infrastructure organizations, not only prevents potential conflicts but also builds trust and respect in a collaboration.

According to Table 3, the criterion "formalized procedures" has a mean value of 3.55 and a standard deviation of 0.83. The results show that the respondents deem the criterion "formalized procedures" less important in comparison to other criteria. A relatively high value of standard deviation for the criterion "formalized procedures" indicates that the opinions of respondents on this criterion are partly dispersed. Figure 1 indicates that half of the respondents expressed a neutral opinion on the importance of the criterion "formalized procedures", one respondent considered it "somewhat unimportant", and three respondents considered it as "very important". The respondents with neutral opinions believe that clear procedures are necessary and important during a collaboration, but these procedures are sometimes only documented on paper and not effectively implemented within the collaborative team. The respondent with a "somewhat unimportant" opinion advocated this argument and expressed that "*even though the clarity in procedures is important, the agreed norms and rules on collaboration mostly remain on the paper. The attitude and ability of team members to share ideas openly during a collaboration are more important criteria for assessment*". The respondents who view "formalized procedures" as a "very important" criterion for IOC assessment believe that for a collaboration between various organizations, clarifying the roles and responsibilities and establishing clear procedures for a collaborative process can indicate order and structure to the collaboration. They argue that this can demonstrate the strength of the IOC.

Table 3 indicates that the criterion "shared vision" has a high value for standard deviation (SD = 0.97), indicating a considerable variation in respondents' opinions on this aspect. While nine respondents ranked shared vision as "very important" and five considered it "somewhat important" for assessing IOC, five of them remained neutral and one respondent viewed it as "somewhat unimportant". The respondents emphasized the importance of a shared vision as a criterion, believing that conflicts among collaborators often stem from a lack of shared vision and misunderstandings about collaborative project goals. A member of the steering committee mentioned that "*some conflicts happened during the collaboration, and it turned out after a while, that everybody interpreted the wording of the project goals and the requirements differently*". Assessing the IOC using a shared vision criterion can be beneficial, as the respondents pointed out that this criterion indicates that the collaborators are jointly working towards the same goals and there is a shared sense of purpose among them. However, one of the respondents argued that "*understanding the state and perspectives of the other organizations is more important than a shared vision in a collaboration*".

As explained in section 2, further analysis has also been conducted by performing the Mann–Whitney test to investigate the difference between senior level and project team perspectives on identified assessment criteria. The significance level reported in Table 4 is higher than 0.05 for all criteria which suggests assuming the null hypothesis (existence of no difference) is true. Therefore, the results revealed no significant differences between the opinions of the two groups on the identified criteria. Furthermore, for each group, Table 4 displays the mean and standard deviation values of each criterion.

Table 4 also presents no significant differences between the two groups of respondents. The high standard deviations for the criterion of "shared vision" among the members of both

Function group Identified criteria	Significance (Mann–Whitney test)	Senior level (N = 9) Mean	Senior level (N = 9) Standard deviation	Project team (N = 11) Mean	Project team (N = 11) Standard deviation
Attitudes and motivations	0.603	4.67	0.50	4.45	0.69
Attitudes about other participants	0.824	4.33	0.50	4.27	0.47
Ability to work with others	0.710	4.22	0.67	4.09	0.70
Working climate	0.766	4.33	0.50	4.18	0.75
Shared vision	0.710	4.00	1.00	4.18	0.98
Knowledge sharing	0.230	3.67	0.87	4.18	0.60
Relationship continuity	0.095	4.22	0.67	3.64	0.67
Value diversity	0.370	4.33	0.50	4.55	0.69
Leadership	0.552	4.89	0.33	4.73	0.47
Communication	0.656	4.33	0.71	4.09	0.94
Formalized procedures	0.552	3.67	0.71	3.45	0.93
Improved orientation	0.824	3.67	0.50	3.55	0.69

Source(s): Authors own work

Table 4. Descriptive statistics for two groups of respondents on the identified criteria

groups indicate a greater variability in their opinions, as previously discussed. The mean value for criteria "knowledge sharing" and "relationship continuity" are slightly different among both groups. Based on Table 4, the senior-level group views knowledge sharing as a less important criterion compared to the project team group for the assessment "*if the required knowledge is not shared, you can find it yourself and proceed with a collaborative project. Therefore, this criterion may not be considered as highly important for assessment*". In contrast, the members of the project team group argue that "knowledge sharing" among various parties involved in a collaboration demonstrates openness and trust within the team, leading to enhanced synergy in the collaborative effort.

The mean value for the "relationship continuity" suggests that the senior-level group valued this criterion more than the project team group. The result of the Mann–Whitney test in Table 4, also indicates that the significance level ($p = 0.095$) for the criterion "relationship continuity" is on the edge. The senior-level group believes that being interested in maintaining a working relationship and potentially collaborating in the future indicates the satisfaction of the team during a collaboration. Conversely, some members of the project team group expressed a neutral opinion regarding this criterion, suggesting that while engagement with involved organizations is generally considered important during a collaborative project, failure to involve them at every stage may not necessarily result in significant collaboration problems. In their view, the quality of the collaboration may be better measured by other criteria.

Based on the analysis of Table 3 and Tables 4 and it can be inferred that the identified criteria through literature are deemed to be practically important in the views of the respondents to assess the status of IOC in infrastructure projects. Furthermore, the respondents suggested the need for additional sub-criteria and minor modifications to develop an assessment tool, which are discussed in Section 5.

5. Assessment tool development

As discussed in Section 4, the identified criteria from the literature were discussed with the infrastructure practitioners. Based on the feedback from them, two sub-criteria were modified to improve the structure and clarity. One sub-criterion was "stressing the benefit of

working together". The results from the interviews show that every party should perceive the importance of collaboration "*it should be recognized by parties that they have to work together and need each other to achieve the goals and cannot do it alone. It shows that we try to realize not only our own goals but also the goals and interests of other parties, which also prevent potential friction among parties*". The results reveal that recognizing the benefit of working together indicates trust among parties to make together the best project outcomes and overcome problems during a collaboration. Therefore, the study outcome keenly offers that working together and the benefit of collaborating on a project should be recognized by a team and it should not necessarily be 'stressed' during collaborative work.

Another sub-criterion identified in the literature and further explored herein was to "support the champions of the collaborative project". Based on the results, all members of a collaborative project should be considered champions not only the coordinators of a project. Since the literature interprets a champion as a coordinator of a project (Keast and Hampson, 2007), who should be supported during collaboration, the sub-criterion is accordingly modified to "supporting the coordinators of a collaborative project" to reflect the outcomes of the study.

The additional criteria are "willingness", "achieving common goals", "satisfaction of the parties with collaboration", and having "no hidden agendas" in collaboration. As stated by the respondents, "willingness" indicates motivation and eagerness of the participants for joint efforts in a project. Therefore, according to the structure of the conceptual tool and the respondent's perspectives, "willingness" is added as a sub-criterion of attitude and motivation. They also consider having "no hidden agendas" as a sign of a good atmosphere in a collaboration. Therefore, this identified criterion is also added as a sub-criterion of working climate.

However, the other two mentioned criteria by respondents are mostly related to the results of collaboration and cannot be utilized as criteria to assess the status of collaboration in different phases of collaborative work based on the three categories mentioned. Therefore, these two criteria are used as control questions to assess collaboration.

By combining the identified assessment criteria through literature and the practitioner's perspectives, the proposed inter-organizational collaboration assessment tool (ICAT) is designed and developed, as shown in Table 5. The list of sub-criteria for the quantitative assessment of IOC in an infrastructure project can be found in appendix. Inter-organizational collaboration is assessed according to each sub-criterion based on a Likert-scale from (1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, and 5: Strongly agree). Practitioners who participated in inter-organizational collaborations are requested to evaluate their collaboration by assigning scores to each sub-criterion using a Likert scale. The analysis of the assessment results conducted with the ICAT tool reveals the state of inter-organizational collaboration within a project. Scores of 1 and 2 point to areas requiring improvement in collaboration, while scores of 4 and 5 underscore the strong aspects of the collaboration. In summary, the tool includes twelve criteria and thirty-six sub-criteria to assess the status of IOC in interconnected infrastructure projects.

The feasibility and usability of the proposed tool were discussed with practitioners during the interviews. Six of the respondents found the organizational collaborative capacity more feasible than the other categories to assess collaboration, arguing that there is more continuity at the organizational level, rendering it stable. Moreover, it is mostly based on documents and written aspects, therefore the routines in collaborative work can be tracked easily. In contrast, two of the respondents presumed organizational capacity as the hardest one to measure. They argued that these criteria are mostly related to the structure of different organizations and the results of them are accessible and measurable in the long term for a project, however, the individual capacity is the easiest one as quoted "*you can easily assess at the individual level if you can collaborate in a good way with your counterpart or not. But you*

cannot see the results at the organizational level on collaboration in a short period". Overall, most of the respondents believe that individual capacity is the hardest one to assess because it is more subjective and involves different personal opinions about collaborative work. The feasibility of assessing the relational category is between the two other categories. However, three of the respondents assumed relational capacity as a feasible one to measure. They argue that the relational capacity is assessable and observable over time and during different meetings.

The respondents assert the importance of assessing IOC using a tool. The respondents argue that "*the status of collaboration is partly discussed informally during meetings, but it would be beneficial to use a type of tool or a standard approach to assess collaboration*". It is essential to assess the status of collaboration between different organizations as quoted by a project director "*when collaboration does not go well, every project could become a disaster. So, if the collaboration is on the right track and the involved parties have a good match, then they can solve the most difficult project issues together*". The director also added that a project starts with people who have to collaborate because the results of a collaborative project are made by involved parties and if they do not collaborate well, the results of the project will go down. Therefore, an assessment tool assists the practitioners in evaluating the status of collaboration and recognizing the implicit points of a collaboration based on the identified criteria.

A project manager stated that sometimes there is an informal discussion about the collaborative work but not all points might be shared openly and discussed in a discussion which can increase the risk of collapsing a collaboration due to unawareness of the issues and unsolved issues, as quoted "*you are not always aware of what people do not share*". Therefore, it is helpful to use a tool to analyze the status of the collaboration. The results show that an assessment tool helps to obtain an insight into collaboration and awareness of the points that need to be acted upon, "*if you do not assess, you cannot have a right image of the collaboration*". Based on the results of the interviews, it is not always required to take action to improve collaboration but at least try to understand the reasons behind the identified issues and adapt them. In this regard, a technical manager stated that "*the proposed tool has touched on the main subjects of collaboration, especially in a structured way. I could give a story for each of them. Then you can see the status and improve by strengthening each of these characteristics*". According to the respondents, the proposed tool assessed the relevant criteria, and it is not difficult to answer them. Moreover, the tool gives the possibility to openly discuss the status of the collaboration without revealing private information and to learn from the discussed issues.

(ICC). Individual Collaborative Capacity	i.1	Attitudes and motivations
	i.2	Attitudes about other participants
	i.3	Ability to work with others
(RCC). Relational Collaborative Capacity	r.1	Working climate
	r.2	Shared vision
	r.3	Knowledge sharing
	r.4	Relationship continuity
	r.5	Value diversity
(OCC). Organizational Collaborative Capacity	o.1	Leadership
	o.2	Communication
	o.3	Formalized procedures
	o.4	Improved orientation

Source(s): Authors own work

Table 5. Inter-organizational collaboration assessment tool (ICAT)

6. Conclusions

As infrastructure projects become more complex and more interdependent, collaboration across various infrastructure organizations is essential. Infrastructure owners with different backgrounds, skills, cultures, and perspectives increasingly have to collaborate to realize a project. To facilitate such a collaboration, assessing the status of IOC and identifying the potential issues during collaboration are all critical steps. This paper aims to identify IOC assessment criteria in infrastructure construction projects aiding to develop collaboration and design of an inter-organizational collaboration assessment tool (ICAT) to facilitate the collaboration process and its evaluation. The assessment tool was developed in two stages. The criteria from the literature were identified and classified into three categories: individual collaborative capacity, relational collaborative capacity, and organizational collaborative capacity.

In the second stage, in-depth interviews were performed to learn the practitioner's perspectives on assessing the status of collaboration between different infrastructure owners. Based on interviews, two sub-criteria from the literature were modified and four more criteria were identified to assess IOC. However, only two criteria were added to the assessment tool as sub-criteria since the other two are outcome-oriented criteria and can only be used as control questions for the assessment of IOC.

The ICAT introduced in this study offers a valuable means to evaluate inter-organizational collaboration within collaborative projects. It serves as a foundation for practitioners to score and design collaboration (*ex ante*) and assess the collaboration status during a collaborative project and in hindsight (*ex post*), encompassing multiple dimensions and enabling the identification and analysis of underlying issues. Moreover, conducting follow-up interviews allows for a more in-depth analysis, facilitating active improvements in collaboration and providing decision-makers with targeted insights to enhance specific aspects of IOC. These interviews can include control questions to gather comprehensive opinions from involved practitioners and foster detailed discussions about their current collaboration in interconnected infrastructure projects.

The utilization of ICAT creates a robust platform for collaborative parties to engage in assessment discussions, fostering increased interaction, mutual understanding, and openness among practitioners involved in IOC. Regular assessments using ICAT actively contribute to enhancing the quality of collaboration and improving IOC outcomes.

From a scientific perspective, this research makes a significant contribution by identifying the key criteria for inter-organizational collaboration. The developed tool encompasses a total of 12 criteria and 36 sub-criteria, classified into three distinct categories. This comprehensive framework enables infrastructure owners to gain a clear understanding of IOC and evaluate collaboration status, identifying both strengths and weaknesses. By raising awareness of these identified points and collaboration issues, the tool empowers practitioners to comprehensively assess their current collaboration and take targeted actions to enhance IOC in practice, addressing the root causes of identified issues.

Given the unique nature of each infrastructure project and its various phases, the relative importance of each criterion in the assessment process may vary. As a recommendation for further research, it would be beneficial to explore the impact and weighting of each criterion when assessing IOC, considering the size and specific circumstances of each project. Additionally, future studies could investigate the optimal frequency of using ICAT throughout a project's lifecycle, taking into account project characteristics. Furthermore, expanding the application of ICAT to a wider range of inter-organizational collaborations would provide valuable insights and further enhance its practical use.

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Appendix

Inter-organizational Collaboration Assessment Tool (ICAT)		
Please rate the following criteria by assigning a score of 1 = Strongly disagree, 2 = Disagree, 3 =Neither agree nor disagree, 4 = Agree, 5 = Strongly agree		
#	Criteria	Scores
(ICC). Individual collaborative Capacity		
i.1	**Attitudes and motivations**	
i.1.1	The project team members are committed to devoting skills, knowledge and resources to the collaboration.	1 2 3 4 5
i.1.2	The project team is willing to work with each other.	1 2 3 4 5
i.2	**Attitudes about other project participants**	
i.2.1	The organizations and team members in our project have a collaborative culture rather than a competitive culture.	1 2 3 4 5
i.2.2	Project team members trust the other (subproject) team members	1 2 3 4 5
i.3	**Ability to work with others**	
i.3.1	The project team member can constructively deal with the conflicts associated with other subproject teams	1 2 3 4 5
(RCC). Relational Collaborative Capacity		
r.1	**Working climate**	
r.1.1	There is cohesion between the different (sub) project teams and we work together as a unit.	1 2 3 4 5
r.1.2	The relevant members are involved in our collaborative project.	1 2 3 4 5
r.1.3	In our project, we recognize the benefit of working together with other subproject teams.	1 2 3 4 5
r.1.4	There is mutual trust between the organizations.	1 2 3 4 5
r.1.5	In our project, there are no hidden agendas among (sub) project teams.	1 2 3 4 5
r.1.6	We support the coordinators of our collaborative project.	1 2 3 4 5
r.1.7	In our project, we support and help each other to achieve common goals.	1 2 3 4 5
r.1.8	In our project, we collaboratively adapt ourselves to unforeseen incidents/changes.	1 2 3 4 5
r.1.9	We appreciatively welcome new information and innovative ideas.	1 2 3 4 5
r.2	**Shared vision**	
r.2.1	In our project, we have a mutual understanding of the goals, related activities and interdependencies between the activities.	1 2 3 4 5
r.2.2	In our project, we have a common mission and vision established between the different (sub)project teams.	1 2 3 4 5
r.2.3	In our project, we have joint working processes (such as jointly reviewing plans and the requirements, performing, monitoring, controlling and reporting together, and joint decision making).	1 2 3 4 5

r.2.4	Contributions from different (sub)project teams are aligned and their work meets the expectations.	1 2 3 4 5
r.3	**Knowledge sharing**	
r.3.1	In our project, we motivate knowledge collection and distribution with other subproject teams.	1 2 3 4 5
r.3.2	In our project, we are able to transfer explicit and tacit knowledge with other subproject teams.	1 2 3 4 5
r.3.3	In our project, we have gained and applied new knowledge from the representatives of other organizations.	1 2 3 4 5
r.4	**Relationship continuity**	
r.4.1	In our project, we feel that our organizations are sufficiently involved (engaged) in various steps of the project.	1 2 3 4 5
r.4.2	Beyond this project, we are willing to work with each other in future.	1 2 3 4 5
r.5	**Value diversity**	
r.5.1	The project team understands and examines the perspectives of team members from other organizations in the project.	1 2 3 4 5
r.5.2	Cultural differences of organizations are appreciated by the project team.	1 2 3 4 5
(OCC) Organizational Collaborative Capacity		
o.1	**Leadership**	
o.1.1	Senior management connects the members to the network and is driving the relationship to achieve outcomes.	1 2 3 4 5
o.1.2	Senior management is committed to providing necessary resources and supporting the collaboration.	1 2 3 4 5
o.1.3	Senior management of both organizations actively works together to resolve potential conflicts when needed.	1 2 3 4 5
o.2	**Communication**	
o.2.1	We have a free flow of communication between all members of the project team; all members can access all information.	1 2 3 4 5
o.2.2	In our project, we have a system able to facilitate high volumes of information sharing.	1 2 3 4 5
o.2.3	In our project, we are able to share our ideas openly with team members from other organizations.	1 2 3 4 5
o.2.4	In our project, we communicate regularly with team members from other organizations.	1 2 3 4 5
o.3	**Formalized procedures**	
o.3.1	In our project, the roles and responsibilities of team members are clarified.	1 2 3 4 5
o.3.2	In our project, there are clear procedures and guidelines for all of the processes involved in collaborative work (e.g. interagency agreements, decision-making, conflict resolution).	1 2 3 4 5
o.3.3	In our project, there are clear values, norms and rules that establish/determine the collaboration and interaction between the organizations (e.g. Collective approach, no blame culture, win-win, communication with openness).	1 2 3 4 5
o.4	**Improved orientation**	
o.4.1	In our project, our actions, needs and resources are regularly monitored to meet common goals.	1 2 3 4 5

Source(s): Authors own work