The focus of this manuscript.	
Comment	It is recommended that the author revise the title. In the current title, the two contents do not seem to be closely related, causing trouble for readers to obtain the information of this manuscript in the first time.
Reply	The focus and the title of this study should be redefined. Thus, the topic of the study has been corrected as follows: Critical Infrastructures Resilience: A Guide for Building Indicator Systems. The focus of this study is to develop a guide, which enables Critical Infrastructures stakeholders to build their specific indicator systems. This guide should provide practical steps on criteria setting, indicator setting, and data collection. The relevant detailed revision can be found in the attached document.
Revision **Section 1: Introduction**	**1 Introduction** The research for Critical Infrastructures (CIs) goes across disciplines, sectors, and scales, as the disruption or destruction of CIs would have a significant cross-border impact on human society. However, CIs are vulnerable to natural and technological hazards worldwide. The concept of "Resilience", presented as an inherent attribute of a system addressing external hazards, has developed rapidly recently in the field of CIs management. Meanwhile, resilience assessments have become an important aspect for CIs management. An efficient resilience assessment could integrate a set of key concepts and provide alternative ways of thinking about and practicing resource management (Resilience Alliance). Moreover, the assessment of CIs resilience is frequently based on indicators (Hosseini et al., 2016; Mebarki, 2017; Cantelmi et al., 2021). Indicator-based resilience assessment could be simply summarised as a process consisting of three factors and two phases, as shown in Fig. 1 (Yang et al., 2023, a): - Resilience assessment: a process in which resilience values are obtained by usable indicators; - Indicator assessment: a process in which indicator values are obtained by reliable data. The principle of indicator-based assessment is transforming from data, to indicators, and from indicators to knowledge or goal. Available methods for both resilience and indicators assessments are diverse and multidisciplinary and could be quantitative, qualitative, and semi-quantitative (Hosseini et al., 2016; Mebarki, 2017; Yang et al., 2023, a).  **Fig. 1. Indicator-based Resilience Assessment, source: Yang et al. (2023, a).** A single indicator can rarely provide useful information. To generate increasingly precise information on conditions, the assessment designed for a complex system could rely on indicator systems (Shavelson et al., 1990). An indicator system should contain numerous specific indicators that are associated with concrete conditions, requirements, or situations. These specific indicators could not be set without consideration of the realities of each particular studied case. Thus, it necessitates practical tools that enable CIs managers to set their specific indicator system for their particular studied case, without providing directly pre-defined indicators. As argued by Shavelson et al. (1991) "no indicator system could accommodate all of the potential indicators identified by a comprehensive process and remain manageable". A desirable hazard-related indicators tool should be simple and flexible, adapting itself to different case studies and different kinds of users (Barroca et al. 2006). Even though existing CIs resilience assessments by indicators are diverse and multidisciplinary, few tools exist for guiding CIs managers build specific indicator systems in

	regarding realities. For example, Yang et al. (2023, a) review 68 scientific papers relating to indictors-based assessments for CIs resilience. Several papers reviewed by Yang et al. (2023, a) present assessments based on a large number of systemic indicators: Fisher et al. (2010), Hromada and Lukas (2012), Petit et al. (2013), Bialas (2016), Upadhyaya et al. (2018), De Vivo et al. (2022). However, all these papers directly show the suggested indicators without describing the detailed steps to set them. Therefore, the main objective of this study is to provide a guide for CIs managers to enable them to build specific indicator systems for their particular studied cases. Indicator systems building involves criteria setting. Criteria serve as characters or signs making a judgment of appreciation. From an operational perspective, multi-criteria analysis allows CIs managers to keep holistic thinking that balances the various advantages and disadvantages (Yang et al., 2023, b). However, many studies about CIs resilience criteria setting have focused on abstract capabilities related to resilience, but have overlooked the fact: the benefits, costs or impacts of implementable actions for every CIs manager are critical. The lack of discussion about the effects of implementable actions causes the application difficulties of CIs resilience assessment in practical management. Therefore, the developed guide for building indicator systems should consider a criteria-setting framework involving implementable actions. The ways for multi-criteria setting involving implementable actions should be added in the objective guide of this present study.

Discussion	
Comment	The discussion part is weak, does not grasp the focus of this manuscript's work, and does not incorporate enough previous work.
Reply	We have optimised the discussion section regarding the use of the developed guide and its limitations, to better relate the discussion to the objectives of the study. Additionally, the demonstration of resilience assessment has been moved to the discussion section and appendixes, as it is not the primary focus of this study. The Emphasis of this study has been placed on designing practical steps for criteria setting, indicator setting, and data collection. The relevant detailed revision can be found in the attached document.
Revision **Section 5: Discussion**	**5. Discussion** **5.1 A practical guide for building indicator systems** The developed guide requires a multi-criteria analysis, a setting of numerous indicators and an investigation of available data. The built indicator systems may be considered complex with a large number of contents, and it may increase the application complexity of indicator systems to a certain extent. Nevertheless, there is no doubt that CIs resilience is a complex object, but not a complicated one. A complicated object, i.e. one with a certain amount of disorder, can be simplified, whereas a complex object should not be simplified. “Complexity varies according to a number of parameters, including the multiple uses to which it is put, the number of participants involved, its geographical dispersion, and the spatial and temporal scales considered” (Barroca et al., 2016). Since CIs resilience is a complex object, complex indicator systems seems inevitable for CIs resilience assessment. The more complex an indicators system, the more it requires detailed knowledge of local realities in diverse dimensions (geographies, socio-economic, environmental, technic, etc.). At the same time, the higher the need to increase the autonomy of local managers, which the developed guide in this study provides.

A consideration of the local realities of each case may be one key for advancing CIs resilience application. The realities bring the uniqueness of each case that could be realised by the specificity of sub-criteria and indicators. Just as teaching a man to fish, rather than simply giving him fish. Rather than predefining sub-criteria or indicators for all potential resilience scenarios of CIs resilience, the guide for building indicator systems developed in this study enables CIs to set specific sub-criteria and indicators based on concrete situations. This guide is a tool flexible, adapting itself to different case studies and different kinds of CIs. The developed guide provides a wide margin of autonomy for CIs managers or stakeholders who need support and guidance to build indicator systems. The autonomy also brings the possibility of continuous updating or optimising of building indicator systems. Changes in the external environment may lead to changes in the setting and weighting of criteria, and indicators. For example, the sub-criteria of "Environmental damage" and the indicator of "Additional CO^2 emission" has become important in recent years because of the development of environmental concern. In addition, the criteria and indicators relating to implementable actions are another key for advancing the application of CIs resilience assessment. Even though many existing theories or models for CIs resilience assessment are valuable, the discussion about the effects of implementable actions is not sufficient in current studies. The present study insists that, for advancing CIs resilience application, it is necessary to consider the cost-effectiveness and side effects of implementable actions.

Meanwhile, the autonomy of this guide can also be interpreted as a weakness. Managers' experience or knowledge may be so limited that they overlook invisible factors. From a holistic perspective, a collaborative exchange between different stakeholders can reduce this shortcoming. The examples in this study demonstrate exactly the kind of cooperation between local operators, university scientists, and local researchers. Whereas a significant investment in human resources at the same time may reduce the cost-benefit of collaborative management. Research in the field of management is therefore needed for better use of built indicator systems.

In addition, the developed guide that promotes the practical use of resilience indicators could further contribute to the application of CIs resilience. The current studies of the CIs resilience aim to develop more effective and sustainable infrastructure management strategies for CIs through the concept of "resilience". In other words, one of the desired developments in resilience research is to put resilience-based theories, tools, and models into practice. Thus, CIs resilience studies need to consider the application of the concept of "resilience" in practical risk management. According to Cambridge Dictionary, an application is a way in which something can be used for a particular purpose. A practical application of CIs resilience is therefore a way in which CIs resilience can be used for real risk management. Although CIs resilience has gained considerable attention in the research literature during the last decade, there remain relatively few resilience studies with application in real-life infrastructure (Hosseini; 2016; Meerow et al., 2016; Hernantes et al., 2019; Heinzlef et al., 2022; Esmalian et al., 2022; de Magalhães et al., 2022; Barroca et al, 2023; Rød, 2020). The obstacle to applying the CIs resilience concerns two major limitations: 1) the absence of applied tools; 2) the lack of an organisational aspect (Weichselgartner and Kelman, 2015; Hernantes et al., 2019 ;Heinzlef et al., 2022; Rød et al., 2020; Yang et al., 2023, b). The guide developed in the present study is firstly a practical tool that can be applied in concrete scenarios, as demonstrated by the example case presented. The fact that the criteria setting is based on organisational perspectives has been also emphasised. The developed guide could contribute to transforming the concept of "resilience" into an object of practical value, in the broader sense of 'use'.

5.2 Assessment demonstration

This study aims furthermore to discuss the possibility of assessing CIs resilience by the built indicator system in section 4 (Fig.12). As shown in Fig. 1, resilience could be assessed based on indicators, and indicators could be assessed based on reliable data. The resilience assessment process based on this built indicator system, for the studied scenarios (Fig.11) focusing on Nantes Ring Road, includes potentially 4 phases (Fig. 12):

- Indicators assessment based on collected data;
- Assessment of the level of sub-criteria based on indicators;
- Assessment of the level of criteria based on the level of sub-criteria;
- Resilience assessment based on the level of criteria.

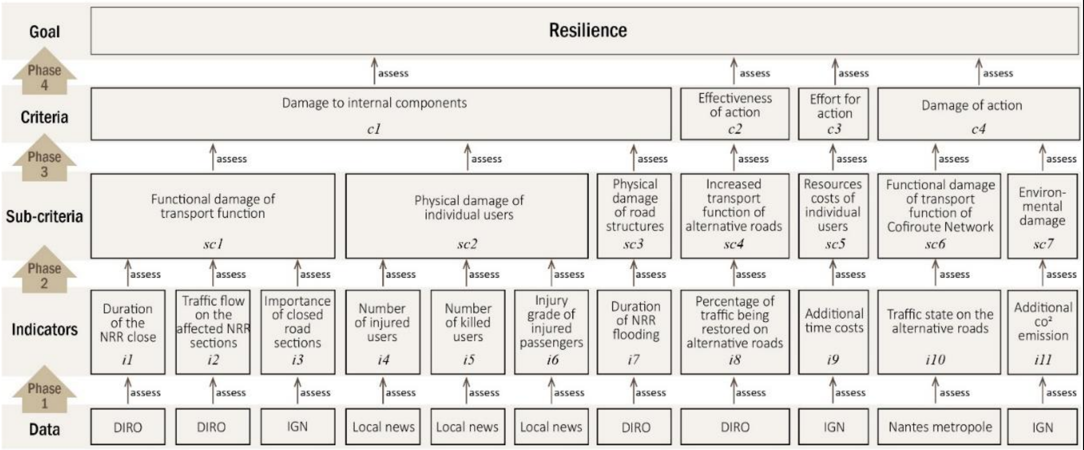

Fig 12. Assessment process of Nantes Ring Road resilience based on the indicators systems developed in present study.

It necessities in addition to determining assessment methods and weighting methods. As numerous methods are deployable, this example shows only some of them that are considered applicable and suitable for the built indicator system.

5.2.1 Criteria & Indicators weighting

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5.2.2 Assessment methods and results

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5.3 Limitation

The assessment framework replied to the method presented in this study aims precisely at assessing the resilience of a studied CI associated to defined scenarios (Fig.11). This approach, based on a scenario, considering both consequences and implementable actions, allows studying a CI facing a hazard with a global perspective. The objects of the presented example, both the hazard and infrastructure, remain unchanged. The values of resilience, criteria levels, and indicators change, if suggested alternative roads change. Thus, the scenarios with different alternative roads could be compared to find the better one. However, under other implementable actions, for example “creating dams”, the sub-criteria and indicators relating to “action” should be modified. The problem then arises that the values of resilience and general criteria, assessed by different indicators and sub-criteria, could not be compared. It results in the meaningless of the values of resilience and general criteria in the indicators-based assessment suggested in this study.

	On the other hand, in practice, the value of resilience and general criteria, while important, is not the only significant part of the decision-making process, because resilience and general criteria are too abstract and do not contain concrete information. Only with sub-criteria and indicators in place, managers enable to understand the content of each scenario in its entirety. We can imagine now that two implementable actions are available, "Creating dams" (A), and "Suggesting alternative roads" (B). Option A has a much higher resilience value than B, since in the scenario where A is implemented, there is no significant "damage to internal components". And the "effectiveness of action" is high even though the "effort for actions" and "damage of action are both high". Based on this information, the choice of A is highly probable. But a further analysis of the sub-criteria and indicators values shows that the resource costs of action A is much higher than the city of Nantes can sustain. Action B becomes therefore more implementable. The set of specific sub-criteria and indicators could play a key role in practice management. Another limitation of this guide refers to the suggested method for data collection. As it is based on existing available resources, for instance in the presented example, many pre-set indicators are rejected due to le lack of appreciable references or local data. Road infrastructures require the management of a large quantity of varied data (topographical, geospatial, geometric, etc.), which is often available in heterogeneous formats. Intelligent digital systems can improve data collection and integration. However, the construction and maintenance of digital data of road infrastructure in Europe are not enough due to an insufficient level of cooperation, inadequate information management and limited investment in research, technology and development (UNECE, 2021). Without true data, professional and particular simulation models, for example by digital twin, would be acceptable. A specific model targeting given scenarios may enable producing useful data resources for practice management. But it has large time-consuming and high investment and is instead less effectivity and cost-efficient. Potential challenges relate to effective and convenient ways of data collection. On the other hand, for data managers, data resource building could take place from possible indicators. For serving the important indicators without available data, creating useful data resources presents a key task for local data institutions for the purpose of a continuous assessment.