Integrating environmental issues into the design of mobility plans: insights from French practices

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Abstract

Local authorities have a strategic role in mitigating the environmental impacts of the transport sector. However, they struggle to integrate environmental issues into their decision-making processes, especially planning. In the European context of the Sustainable Urban Mobility Plan approach and Strategic Environmental Assessments (SEAs), this paper scrutinises three French localities to determine the current best practices and limitations for designing mobility plans and integrating environmental issues. Several limitations are identified: (1) limited expertise in defining and characterising actions and objectives, which complexifies plans' design, understanding, and monitoring; (2) a lack of a framework to conduct long-term quantitative environmental assessments and to use the results to influence decision effectively; and (3) monitoring processes are barely described in the documents, and the planning horizon where objectives are defined is not in sync with the indicators' mandatory evaluation period. This French case study thus reveals that European planning practices must be further analysed and improved to deal with the rising environmental concerns, e.g. through an operational framework to design mobility plans with effective integration of environmental issues.

Key-words

Transportation planning; SUMP; Local authorities; French cities; Strategic decision-making

Highlights

- Planning supports local authorities in moving towards a more sustainable mobility
- There is no robust approach to defining and characterising actions and objectives
- Robust long-term quantitative assessments are lacking to support planning
- Monitoring modalities are scarcely described in plans and SEAs
- Improving planning frameworks would help the integration of environmental issues

1 Introduction

The environment (e.g. ecosystems, species, land, resources, and human health), as defined by Dewulf *et al.* (2015), is constantly threatened by the effects of diverse human activities. These impacts are due to every sector, especially transport, as illustrated by the following statistics from France in 2019. First, transport significantly contributes to climate change as it was the source of 135 Mt CO_2 eq, accounting for 31% of the national internal greenhouse gas (GHG) emissions (CITEPA, 2023). It also worsens air quality as it notably caused 58% of the national NO_x emissions (CITEPA, 2023). Other impacts include noise exposure, land use, water and soil quality, biodiversity, and material consumption (Lesueur *et al.*, 2019).

Hence, public authorities are committed to increasing their mitigation and adaptation efforts to address transport impacts. Societies identified several cross-sector environmental issues to drive the actions carried out by countries and preserve their quality of life in the future. It is notably the role of the international sustainable development goals of the United Nations (2015) and the Swedish environmental quality objectives (Larsson and Hanberger, 2016). Governments also adopted new regulations to promote sustainable mobility practices and improve technologies. For example, since 2009, the French Government (1973, R3261-1 and R3261-3) has compelled employers to pay half the cost of the transport passes of their employees if public transport is used to commute. Also, in 2015, 2019, and 2021, French laws defined minimal shares of low-emission light vehicles and buses that public authorities and companies must buy when renewing their fleets (French Government, 2000, L224-7 to L224-10). Governments also defined frameworks and orientations for mobility planning to push objectives and promote actions that contribute to the mitigation and adaptation efforts at the territorial levels. For example, the European Commission (2013) defined the Sustainable Urban Mobility Plan (SUMP) approach, which aims to foster "a better integration of the different urban mobility modes" and "changes in mobility behaviour" (European Commission, 2013, p. 4). Nowadays, mobility planning brings substantial benefits as cities with a SUMP implement more sustainable mobility actions, conduct participative activities more often, and achieve best results regarding safety and pollutant emissions (Jordová and Brůhová-Foltýnová, 2021; Kiba-Janiak and Witkowski, 2019) and is widespread as the Eltis City database reported 1,320 urban mobility plans across 38 European countries in February 2023 (Eltis, 2023).

Nevertheless, several problems persist despite the involvement of public authorities, and the adverse environmental effects of transport have not been sufficiently reduced. In France, mobility demand is growing, cars and planes remain the dominant modes (Baltazar *et al.*, 2023), and GHG emissions from the transport sector have not decreased between 2009 and 2019 (CITEPA, 2023). We identify diverse reasons for these unsatisfactory outcomes. First, several barriers hinders French local authorities to tackle environmental issues, notably the difficulty in managing conflicting objectives, a limited political willingness, and a lack of methodologies and tools (Baltazar *et al.*, 2023). There is also a gap between the SUMP framework and actual practices, notably regarding cooperation between stakeholders,

strategic ex-ante evaluation, and monitoring (Chakhtoura and Pojani, 2016; Jordová and Brůhová-Foltýnová, 2021; Mozos-Blanco *et al.*, 2018).

These limitations within the decision-making process must be solved as local authorities have a crucial role in shaping the future of mobility and reaching settled environmental objectives. Therefore, our research aims to help planners and local authority representatives design their mobility plans and integrate environmental issues into the process. Planning is an interdisciplinary science, notably linking engineering, economics, politics, and geography, but we analyse it from the specific design engineering and sustainability design perspective. This descriptive study aims to improve the understanding of current planning practices based on the French experience and pave the way to enhancing mobility plan design. Therefore, our paper focuses on the local level of SUMPs and investigates the following research question: *What are the current best practices and limitations for designing mobility plans in France and integrating environmental issues?* The literature review in Section 2 investigates the main benefits and limitations of mobility planning practices and how Strategic Environmental Assessment (SEA) supports such a process. Section 3 defines the methodology used to examine the planning practices in three French localities. Section 4 characterises the French legal context and scrutinises current local practices through an in-depth analysis of three mobility plans and SEAs. Section 5 highlights the best practices and limitations when designing mobility plans, based on the literature and our French case study. Section 6 summarises the findings, states the limitations of the paper, and gives pathways for a future framework to improve planning.

2 Integrating environmental issues into mobility planning

This section investigates to what extent local authorities integrate environmental issues into their strategies, particularly during mobility planning. First, Section 2.1 identifies the barriers to integrating environmental issues into French local authorities' strategies. Then, the review focuses on planning, particularly from the SUMP perspective in Section 2.2 and SEA in Section 2.3. Each process is described, and the benefits and limitations of current practices are dissected. Finally, Section 2.4 details the positioning of our paper regarding the reviewed literature. At the end of the paper, Table 5 summarises some critical shortcomings of mobility planning and SEA (first column) and compares them with the findings from the case studies investigated in this paper.

2.1 Barriers to integrating environmental issues into French local authorities' strategies

Moving towards more sustainable mobility is not trivial, as local authorities meet several barriers to dealing with environmental issues. We define **an environmental issue as what societies seek to reduce, preserve, or improve to protect the environment** (Sauvé *et al.*, 2016), while the environment includes three areas of protection: the natural environment (i.e. ecosystems and species), natural resources (e.g. lands, waters, and minerals), and human health (Dewulf *et al.*, 2015). Some issues can be both environmental and social, notably those related to human health, such as air quality.

Previous studies highlighted that several barriers hinder French local authorities from tackling environmental issues. Baltazar *et al.* (2023) identified the following barriers by analysing French law and conducting interviews in six local authorities. (1) Local authorities face numerous and conflicting objectives defined in the law, so they struggle to manage trade-offs between environmental and other sustainability issues. (2) There are difficulties in organising interactions between local authorities' departments and sectors of activities (e.g. urban and mobility planning). (3) Local authorities may also face a limited political willingness to have ambitious mobility objectives and strategies, so the plans

are not very prescriptive and have a limited long-term impact on decision-making. (4) There is a lack of methodologies and tools to support local authorities' decision-making, notably to help define and monitor objectives and actions. Two studies investigating mobility planning in France complement these findings. First, Buhler and Lethier (2020) applied textometry to 37 plans adopted between 2000 and 2015 and found that the most recent plans are less concrete and precise. It may be symptomatic of the barriers (1) and (3) mentioned above, as abstraction and ambiguity are useful to avoid disagreement between stakeholders and conflicts between objectives. Second, Chakhtoura and Pojani (2016) investigated four transport-related plans from Paris and evaluated on a five-level ranking scale if their objectives have been reached based on three internal evaluation reports and external evaluations (i.e. 67 news articles, academic papers, and online portals). They found that the objectives defined in the plans are broad and subjective. Moreover, they highlighted that the internal evaluations skip some objectives and can be inconsistent with external evaluations. This finding illustrates barrier (4) above effectively.

Despite these barriers to integrating environmental issues into mobility planning, there is a lack of recent papers investigating the French planning practices and effects. We did two searches on Scopus to demonstrate this point. We considered only recent journal papers written in English and published between 2013 and 2023 (the period corresponds to the diffusion of the SUMP framework). First, we searched for papers with "mobility plan", "mobility planning", "Transport plan", "Transport planning", "transportation plan", "transportation planning", or "SUMP" in their titles and "city" or "local" in their titles, abstracts, and keywords. We found 239 results, but only 22 remain after a title and abstract screening to keep only those addressing the process, practices, or effects of local passenger mobility planning in the EU. Among the 22, only two focus on France (namely, the papers of Buhler and Lethier, 2020; Chakhtoura and Pojani, 2016, which have been analysed above), and none address environmental integration in particular. Second, we searched for papers with (1) "Strategic environmental assessment" or "SEA" in their titles and (2) "Strategic environmental assessment" and "mobility plan", "mobility planning", "Transport plan", "Transport planning", "transportation plan", "transportation planning", or "SUMP" in their titles, abstracts, and keywords. We found only two papers focusing on Italy and New Zealand (De Montis *et al.*, 2016; McGimpsey and Morgan, 2013, resp.). As there is a lack of recent studies about SEA application in mobility planning, we extend the temporal boundaries to cover the 2003 to 2023 period (the period corresponds to the application of the EU directive about SEA, cf. Section 2.3) and obtain 15 results. We then exclude one proceeding paper, one paper about the electricity transmission grid, one paper about transport infrastructure investments, and three papers addressing SEA outside the EU (China and New Zealand). None of the nine remaining papers is focused on France.

According to these findings, local authorities encounter several problems at the strategic level, i.e. where objectives and actions are defined and monitored within mobility planning. The strategic level is essential from the territorial perspective as it is where local authorities holistically address mobility and investigate the cumulative effects of their decisions. The strategic level is also where local authorities have the most influence on decisions and can shape the changes in mobility systems, although inhabitants' requirements and national policies influence local authorities' decisions. Our paper therefore investigates mobility planning by focusing on the strategic level.

2.2 Mobility planning practices in the EU: process, benefits, and limitations

Supranational and national guidelines frame mobility planning. The European Commission (2013) pushes the SUMP approach, which considers four steps for planning: preparation and analysis, strategy development, action planning, and implementation and monitoring (Rupprecht *et al.*, 2019).

Governments usually produce complementary national guidance for planning (Mladenovič *et al.*, 2022). Such guidance is flexible, notably to allow municipalities to properly consider their specific local conditions (Klímová and Pinho, 2020). We identified ten papers published between 2013 and 2023 investigating how mobility planning is conducted in the EU and identifying its benefits and limitations. Appendix A lists the reviewed papers and gives the methods they used to collect data and the perimeter of each study. These papers were identified with the screening on Scopus detailed in Section 2.1.

Buhler and Lethier (2020) evaluated that environmental concerns are increasingly integrated into mobility plans and that the role and commitment of local authorities are rising. Jordová and Brůhová-Foltýnová (2021) found that cities with a SUMP implement more sustainable mobility actions, conduct more participative activities, and are better at analysing and evaluating mobility. Kiba-Janiak and Witkowski (2019) consider that cities with a plan consistently collaborate with different stakeholders, implement more sustainable mobility actions, and achieve the best results regarding safety and pollutant emissions. Mozos-Blanco *et al.* (2018) highlight that the stage of preparation and analysis is meticulously done, so it provides a deep knowledge of the initial situation before undertaking a SUMP. They also found that most SUMPs include indicators, a budget, a timeline, and a monitoring programme. Finally, guidance for planning leads to significant positive results when the guidelines are clear about general sustainable mobility principles (Klímová and Pinho, 2020).

However, the literature also reveals a gap between the SUMP framework and current mobility planning practices. First, planning has a low impact when national frameworks are still in the early stages of development (Mladenovič *et al.*, 2022). Also, there are still issues with the process, such as the lack of:

- Ex-ante evaluations of plans, particularly regarding air and noise pollution and long-term impacts (Mozos-Blanco *et al.*, 2018).
- Objectives defined according to the SMART criteria, which require objectives to be specific, measurable, achievable, relevant, and time-bound (Chakhtoura and Pojani, 2016).
- Comprehensive audit, ex-post evaluation, and monitoring systems for plans (Chakhtoura and Pojani, 2016; Jordová and Brůhová-Foltýnová, 2021; Mladenovič *et al.*, 2022).
- Consistent prioritisation of actions that are influenced by numerous short- or long-term conflicting interests (Jordová and Brůhová-Foltýnová, 2021; van der Linde *et al.*, 2021; Sitányiová and Masarovičová, 2017).

The causes of these issues identified in the reviewed papers are the following. First, funding is limited (Jordová and Brůhová-Foltýnová, 2021; Mladenovič *et al.*, 2022; Sitányiová and Masarovičová, 2017). There is a lack of systematic data collection to evaluate plans and actions (Jordová and Brůhová-Foltýnová, 2021). There is a lack of tools and methodologies to facilitate planning (Sitányiová and Masarovičová, 2017) and trained experts to carry out the planning process and conduct high-quality evaluations (Jordová and Brůhová-Foltýnová, 2021). Moreover, planners struggle to define objectives because they may not know how ambitious objectives should be and what resources are available to achieve them (Chakhtoura and Pojani, 2016). Chakhtoura and Pojani (2016) add that current ex-post evaluations are not comprehensive, as all plan objectives are not evaluated. The same authors also suggest that objectives might be voluntarily vague to prevent future ex-post evaluation from revealing that the plan implementation has been unsatisfactory. Buhler and Lethier (2020) also report this trend of designing ambiguous and abstract plans, perhaps to help reach a consensus among stakeholders and avoid court rejection of the plans.

The SUMP framework recommends involving governmental stakeholders, notably to coordinate policies from different sectors and develop cooperation between different governmental layers and

their institutions, as well as non-governmental stakeholders, i.e. citizens, civil society, and private companies (Rupprecht *et al.*, 2019). Buhler and Lethier (2020) consider that stakeholders are increasingly involved in plan design. It is a primary concern for local authorities as involvement increases the trust between stakeholders and their knowledge, creates synergies between sectors, and gives input to decision-making (van der Linde *et al.*, 2021).

However, the reviewed papers also identified limitations regarding stakeholder involvement. There is a lack of communication, cooperation, coordination, and information sharing between stakeholders (e.g. Jordová and Brůhová-Foltýnová, 2021) and a low level of trust and agreement as it is challenging to find solutions satisfying everyone (Jordová and Brůhová-Foltýnová, 2021). Moreover, there is a lack of public involvement in the planning process (Jordová and Brůhová-Foltýnová, 2021; Mozos-Blanco *et al.*, 2018), notably as researchers, consultants, and professional and technical stakeholders are relatively underrepresented (Jordová and Brůhová-Foltýnová, 2021; Michelini *et al.*, 2023). Furthermore, van der Linde *et al.* (2021) emphasise issues with citizen involvement regarding their willingness to participate, representativeness during consultations, and difficulties in making them grasp the stakes related to strategic decision-making as they are more focused on a practical level. They also found that practitioners regret that involving all stakeholders is time-consuming and often delays implemention.

2.3 Strategic Environmental Assessment practices in the EU: principle, benefits, and limitations

Strategic environmental assessment (SEA) aims "to achieve high-level protection of the environment and promote sustainable development by contributing to the integration of environmental considerations into the preparation and adoption of plans and programmes" (European Commission *et al.*, 2019, p. 25). According to the Handbook on Strategic Environmental Assessment (Fischer and González, 2021), SEA is a framework to select the best methods, processes, and strategies to be applied in a specific situation, i.e. sector, territorial level, type of SEA (from the most strategic policy-oriented SEAs to more project-related SEAs). The Handbook thus clearly emphasises that "there is no one-size-fits-all approach to SEA" (p. 6), in accordance with Fischer (2006) and Noble and Nwanekezie (2017). For example, a SEA for a SUMP, which is a local policy-oriented plan, is likely to be very different from a SEA for a national infrastructure plan such as the German federal transport infrastructure plan. This section summarises the EU SEA requirements and then investigates the effectiveness and shortcomings linked to SEAs in the EU, primarily focusing on transport applications.

SEAs are prescribed by the European Directive 2001/42/CE (European Parliament, 2001), which notably requires making, at the end of the planning process, a SEA report to present the final environmental evaluation of the plan. It must include (a) the objectives of the plan and links with other plans, (b) a description of the initial state of the environment regarding relevant issues and its likely evolution without the implementation of the plan, (c) the likely significant effects of the plan on the environment and population, notably on biodiversity, human health, soil, water, air, climatic factors, material assets, cultural heritage, and landscape, (d) the measures envisaged to prevent, reduce, and offset any significant adverse effects, (e) reasonable alternatives for the plan and the reasons for selecting the alternative dealt with, (f) a description of the assessment of the plan undertaken, and (g) a description of the measures envisaged concerning monitoring, notably to identify unexpected impacts and define corrective actions (European Parliament, 2001, annex 1 and art. 9 to 10).

Since 2001, SEAs have successfully contributed to integrating environmental issues into plans to some extent. The European Commission *et al.* (2019) conducted a review, a questionnaire consultation, interviews, and a workshop to evaluate SEAs. They found that SEAs successfully provide a systematic

framework to address environmental issues in any plan, lead to more transparent and participatory planning processes, influence planning and decision-making processes, and raise environmental awareness among decision-makers. Their study also highlighted that stakeholders evaluate that the costs of SEA implementation are not excessive and are proportionate to the benefits regarding environmental issues integration and stakeholder involvement in planning. Moreover, they found that the consistency of the SEA framework and legislation among EU member states helps consider transboundary issues and share good practices and knowledge. De Montis *et al.* (2016) analysed the SEA reports of eight transport-related plans. They evaluated the aspects relative to the diagnosis, SEA integration, identification of the primary issues and options, and monitoring information as being satisfactory.

However, some evidence shows that SEA is hindered in achieving its goal, notably because the quality of SEA reports is limited and SEAs have a low influence on the plan content. The European Commission *et al.* (2019) highlighted that, although environmental issues like biodiversity, water, fauna, flora, and landscape and cultural heritage are effectively considered in SEAs, there are difficulties in tackling issues such as climate change, ecosystem services, and natural capital. They also identify several problems related to (1) timing (i.e. initiating SEA too late in the planning process), (2) the understanding of SEAs (e.g. uncertainty about when SEA must be carried out and ambiguous interaction with project-level environmental assessments), (3) inadequate consideration of alternatives (i.e. too late consideration or unfeasibility of proposed options), (4) lack of guidance on how to conduct SEA in specific sectors (including transport), (5) poor environmental monitoring, and (6) the need to update the implementation guidance for the SEA directive. Moreover, they found a tendency to produce overly long and detailed environmental reports, notably to avoid non-compliance, and to assess concrete and specific impacts rather than analysing impacts at the strategic level. De Montis *et al.* (2016) evaluated that the quality of SEA reports is unsatisfactory regarding impact significance determination, consultation, presentation of information and results, and recommendations on preferred options. The aspect "determination of impact significance" got the worst results even though defining, assessing, and measuring the significance of the environmental impacts generated by the plan is a core step of SEA. Fischer and He (2009) surveyed 51 UK and 20 China SEA experts to identify the main SEA shortcomings. UK experts highlighted that there is (1) too much-unused baseline data and a lack of relevant baseline data, (2) too much useless collation of supposedly different documents, (3) a lack of good practice cases, (4) a will to make SEA a more rigorous and structured process, and (5) a lack of real influence of SEAs. Hildén *et al.* (2004) examined SEA effectiveness in transport planning in eleven European countries. They highlighted the difficulties in integrating environmental and social issues into planning, notably due to barriers to quantifying impacts and synthesising assessment information. Fischer (2005) examined documents and conducted interviews to analyse transport-related SEA based on four case studies from the Netherlands, Finland, Germany, and the UK. They identified several context elements influencing SEA effectiveness, such as the lack of SEA requirements and political willingness, negative attitudes of actors involved in SEA, and a lack of time and funding. Wende *et al.* (2004) analysed the German transport infrastructure plan and found that (1) environmental information should be available earlier in the process, (2) the plan does not provide clear and applicable objectives, (3) SEA is focused on project assessment and focus on one transport mode, (4) SEA lacks a comprehensive analysis of all environmental impacts (e.g. CO2 emission forecasts), and (5) the extent to which the plan complies with the environmental objectives is unclear. Rehhausen *et al.* (2018) analysed SEA-related documents about German national plans, notably the federal transport infrastructure plan, and organised focus group discussions with planners. They found that (1) transport goals are prioritised and overrode environmental objectives, (2) alternatives are assessed too late (i.e. when the preferred alternatives are already set) and overlook

some alternatives, and (3) SEAs are siloed between agencies, so it prevents common inter-plan cumulative effect assessments and monitoring for different sectors.

2.4 Research gap

The literature review highlighted that French local authorities face several barriers to integrating environmental issues into mobility planning practices. Although several journal papers address mobility planning practices, we found a lack of recent studies focusing on environmental issues or addressing the French context. Moreover, no paper investigates how SEA of mobility plans is conducted in France.

Moreover, among ten archetypal papers dealing with mobility planning practices in the EU, most are based on analysing a large sample of plans or interviews and surveys of numerous stakeholders. Differently, Klímová and Pinho (2020) performed a content analysis of two plans from two distinct countries, and Chakhtoura and Pojani (2016) analysed the internal and external ex-post evaluation documents related to four transport-related plans from Paris. Focusing on a few documents allowed them to investigate a precise aspect of planning thoroughly. Klímová and Pinho (2020) examined the adherence or divergence of the plans with their respective national guidelines and the SUMP framework. Chakhtoura and Pojani (2016) evaluated the effectiveness of the plans, i.e. the extent to which sustainable mobility targets have been achieved, and whether the existing evaluations are adequate. Therefore, we propose to analyse environmental integration into planning by adopting a similar approach: an in-depth analysis of a few mobility plan documents to get precise insights about this specific aspect of planning in France.

Furthermore, the screening of transport-related SEA journal papers presented in Section 2.1 revealed a lack of recent studies. Among the nine papers identified between 2003 and 2023, only three address transport planning in a single country, focusing on eight Italian transport-related plans (De Montis *et al.*, 2016), the 2003 German federal transport infrastructure plan (Wende *et al.*, 2004), and the 2004 Athens Olympic Games' transport plan (Zagorianakos, 2004). Further research is thus required to analyse the application of transport-related SEAs in a country, especially at the local level and in the context of SUMPs.

Our study therefore aims to detail the specificities of the planning legal requirements and describe current practices in France. It focuses on the local level, i.e. the level where mobility plans are defined in the SUMP framework. Conversely, according to French law, transport planning at the regional level is primarily about infrastructure planning and coordination between local authorities, so it differs from the principle of SUMPs.

3 Research method applied to mobility planning in France

3.1 Positioning in the overall research framework

This study is based on the French context and addresses the research question from Section 1: *What are the current best practices and limitations for designing mobility plans in France and integrating environmental issues?* Our paper is a part of our broader research framework and is thus complemented by other studies that contribute to helping planners and local authority representatives design their mobility plans. First, we have investigated the barriers met by French local authorities to design more sustainable mobility systems (Baltazar *et al.*, 2023). The local authorities' representatives in charge of transport were interviewed to do so, and we found that political, organisational, and knowledge factors hindered the integration of environmental issues into strategic decisions. As we

identified that mobility planning (and SUMP in particular) could help handle these environmental issues, we aim to diagnose current mobility planning practices and provide guidance to improve them effectively.

Our paper thus provides insights into the French mobility planning context by investigating the specificities of the national policy context, the current approaches to designing mobility plans, and the role of SEAs by analysing the mobility plans and environmental reports from three French local authorities. In other studies (not yet published), we have scrutinised the strategic quantitative environmental assessment models applied in 29 French mobility plans to focus on the issues met when defining the plan strategy. We have also developed a mobility planning framework that primarily addresses plan design (including objective and action definition), strategy definition and validation, and plan monitoring. We have then designed a strategic quantitative environmental assessment model to help local authorities conduct environmental diagnosis and long-term evaluations using generic open-access data and, when available, local authorities' data. We applied this model to the contexts of nine local authorities and compared the results to prove the interest in harmonising modelling approaches.

3.2 Research method

First, we characterise the French policy requirements that influence the design of mobility plans by analysing the up-to-date French law. Such analysis aims to identify the national specificities within the European context detailed in Sections 2.2 and 2.3 and then to compare legal requirements to actual practices. We scrutinise 77 law articles to identify the requirements for mobility planning according to the Transport Code (French Government, 2010, L1214-1 to L1214-38 and R1214-1 to R1214-12) and SEA according to the Environmental Code (French Government, 2000, L122-4 to L122-11 and R122-17 to R122-23).

Then, we perform an in-depth content analysis of some mobility plans and SEA reports to get insights into local authorities' current mobility planning practices. We conduct a multiple case study analysis, as case study research can provide an in-depth understanding of complex processes by thoroughly examining the process and its outcomes through observation, reconstruction, and analysis of a minimal number of elements (Zainal, 2007). She emphasises that investigating multiple case studies raises the robustness of the approach and help generalise conclusions.

Our case study focuses on public establishments for inter-municipal cooperation (EPCIs) because EPCIs are the French administrative structures where municipalities are grouped to share some competencies. In particular, EPCIs or their groupings are the mobility organising authorities (AOMs, in French) within their areas and are responsible for local transport (French Government, 2010, L1231-1).

We sample three AOMs using the following approach, which is also fully described in the Supplementary Material. We use a database that lists the 739 AOMs (Cerema, 2023). First, we exclude the AOMs encompassing less than 100k inhabitants as they are not compelled to execute the complete mobility plan process as defined by law (French Government, 2010, L1214-3). Next, from the 98 remaining AOMs, five are excluded as they are specific French territories, i.e. the capital region, which has one unique AOM for the whole region, or French overseas areas. Then, only recent plans (2013-2023) are considered, excluding voluntary plans and those that the court rejected. There are 38 plans left in the sample. Finally, we exclude ten plans for which there is no available environmental report and five more that have no quantitative evaluation, as they do not comply with the law and would limit the content analysis to qualitative aspects.

Among the 23 remaining plans that we can analyse with content analysis, we select three of them to make a heterogeneous sample to highlight differences in the design of the plans. Note that this sample is necessarily not representative of all French (or EU) mobility planning practices, as it is a limit of the case study approach. First, we select *Communauté urbaine du Grand Reims* (abbr. Grand Reims) and *Angers Loire Métropole* (ALM), as they have about the same population (318k vs 309k), which is close to the average population of the 93 initially sampled AOMs (270k). However, they are interesting cases to compare as Grand Reims adopted a mobility plan, whereas ALM adopted an urban plan that included a specific part about mobility. Grand Reims and ALM are also different as they contain 143 vs 29 municipalities and have 217 vs 441 inhabitants/km² density. Second, we choose a third AOM that differs from Grand Reims and ALM by picking a vast metropolis: the *Métropole Aix-Marseille-Provence* (AMP) that includes 92 municipalities, 1,9 M inhabitants, and 578 inhabitants/km². The three AOMs are from different French administrative regions: Grand Est, Pays de la Loire, and Provence-Alpes-Côte d'Azur for Reims, Angers, and Marseille, respectively.

Through this process, we constitute our sample with the *Communauté urbaine du Grand Reims* (abbr. Grand Reims), the *Angers Loire Métropole* (ALM), and the *Métropole Aix-Marseille-Provence* (AMP). Their main characteristics and locations are presented in Table 1 and Figure 1. The complementary study mentioned in Section 3.1 complements the analysis of these three AOMs by investigating 29 mobility plan environmental reports to focus on the quantitative environmental assessment methodology.

Table 1: Presentation of the three local authorities that are included in the case study (data from 2019)

Perimeter of the local authority (ranked in increasing number of inhabitants)	Number of inhabitants	Area (km²)	Number of municipalities	Date of approval of the plan	Planning horizon
Grand Reims	318k	1,465	143	2016	2026
ALM	309k	702	29	2021	2027
AMP	1,9M	3,256	92	2021	2030

Note: The ALM mobility plan is included in an urban land-use plan, so it has some specificities, especially considering that there is only one common SEA for both urbanism and mobility aspects.

Figure 1: Location of the three local authorities that are included in the case study

We characterise current French mobility planning practices by conducting an in-depth content analysis of the mobility plans and SEA reports from the three EPCIs mentioned above. Content analysis is a method where inferences and conclusions are drawn from the analysis of the content of communications (Prasad, 2008), which are planning documents in our case study. The steps followed to extract, process, and analyse the data are presented in Figure 2. To analyse the three mobility plans, we systematically extract each plan's actions, objectives, and indicators, excluding duplicates and distinguishing objectives and actions according to whether they are associated with quantified target values. We keep the hierarchy used to structure the plans, notably specifying when planners sorted actions, objectives, and indicators in categories (i.e. axes, themes, stakes, and action levers). We can then conduct a qualitative analysis of the structure and vocabulary used in the plan and a quantitative comparative analysis of the number of actions, objectives, and indicators in the plans. Data in Supplementary materials provide additional information about the content of the plans and how we examined them. Then, the three SEA reports of the three plans are investigated. We focus on the four main steps of these reports that aim to (1) present the initial state of the environment by focusing on several issues that are relevant in the local context of the plan, (2) determine the likely impacts of the plan through qualitative and quantitative assessments, (3) verify if the plan is consistent with other plans, i.e. environmental and sectorial plans, and (4) provide monitoring information.

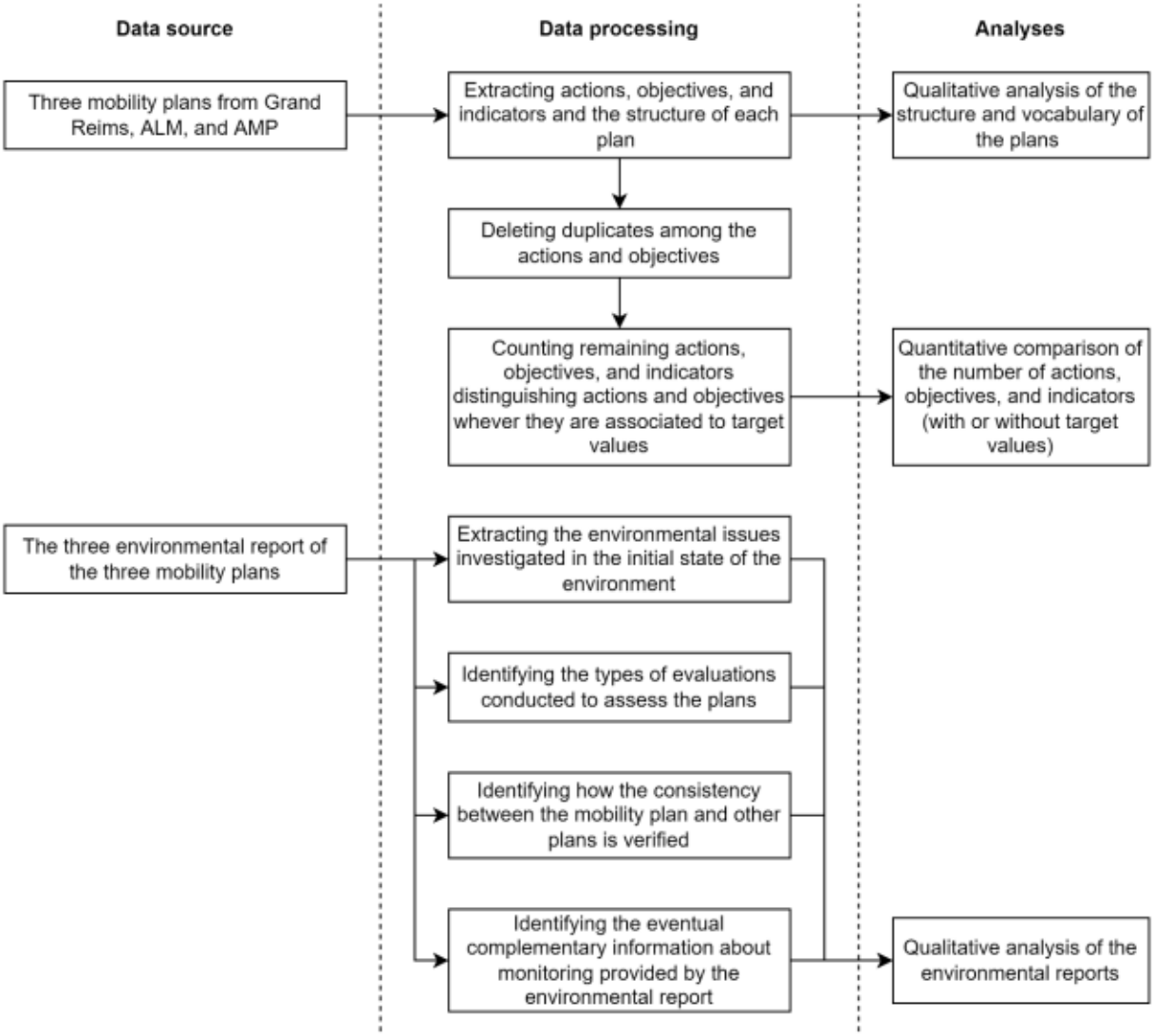

Figure 2: Description of the steps to analyse the mobility plans and environmental reports from Grand Reims, ALM, and AMP

4 Results from the analysis of mobility planning in France

This section describes the specificities of the French legal requirements and investigates three mobility plans and three SEA reports. The methodological barriers to integrating environmental issues into planning are highlighted, and the compliance between the national requirements and local practices is examined.

4.1 Legal requirements influencing planning practices

The foremost local authorities dealing with local mobility in France are municipalities through EPCIs (defined in Section 0). Their strategies are usually defined throughout the mobility planning process; therefore, we investigate what is required by law for mobility planning. First, mobility plans are compulsory for AOMs with more than 100k inhabitants (French Government, 2010, L1214-3). In those cases, AOMs must satisfy the mobility planning requirements defined by law (French Government, 2010, L1214-1 to L1214-38) and perform a SEA (French Government, 2000, R122-17). The content of mobility plans must be aligned with the national objectives: for example, mobility plans must contribute to reducing GHG and local pollutant emissions, reducing noise, and improving access to mobility services in low-density areas and priority neighbourhoods (French Government, 2010, L1214-1 and L1214-2). Mobility plans must also be consistent with regional and other local plans (French Government, 2010, L1214-7), notably by complying with their objectives. In particular, environmental objectives are given by three environmental plans (French Government, 2010, L222-1, L229-26, and L222-4).

The law pushes several orientations to precise how local authorities should satisfy these objectives, e.g. by developing "public transport and less-polluting low energy consumption modes such as cycling and walking" and "shared use of vehicles" (French Government, 2010, L1214-2). The law directly influences mobility systems and local decisions to execute these orientations, notably by providing incentives for electric vehicles (French Government, 2011, D251-1) or making the creation of low-emission zones compulsory in EPCIs with more than 150k inhabitants (French Government, 1996, L2213-4-1). The law also gives AOMs several competencies to let them organise mobility within their boundaries, notably regarding parking organisation and road management (French Government, 2010, L1214-2).

Moreover, the law imposes some requirements for mobility plans. First, to elaborate or revise a plan, AOMs must rely on governmental stakeholders, e.g. from the national and regional levels, local elected representatives, and infrastructure operators (French Government, 2010, L1214-14 and L1214-15). They must also involve non-governmental stakeholders (e.g. users, representatives of professions, reduced mobility people associations, and environmental associations), notably relying on coordination committees, which are composed of representatives from companies and user associations and some inhabitants randomly chosen (French Government, 2010, L1214-14, L1214-16, and L1231-5). Then, mobility plans must detail the funding for their execution and deal with accessibility for people with reduced mobility (French Government, 2010, R1214-1), monitor road accidents (French Government, 2010, R1214-3), and assess the current and future GHG and atmospheric pollutant emissions caused by transport inside their boundaries (French Government, 2010, R1214-1). Finally, a mobility plan must be evaluated every five years and, if necessary, revised (French Government, 2010, L1214-8).

When a mobility plan is required by law, it must be linked to a SEA (French Government, 2000, R122-17). It implies "elaborating a report about environmental impacts, involving stakeholders, taking into account the results of the report and the consultation during decision-making, and communicating

about the decisions" (French Government, 2000, L122-4). SEA also requires monitoring to verify if the plan's effects on the environment have been correctly forecasted and provide corrective measures if necessary (French Government, 2000, R122-20). The law defines the content of SEA reports in line with the EU requirements detailed in Section 2.3 (French Government, 2000, L122-6 and R122-20). Especially for the monitoring process, the French law specifies that SEAs must define criteria, indicators, and modalities (including the timeline) to verify the actual effects of the implemented plan and be able to undertake remedial actions (French Government, 2000, R122-20).

4.2 Definitions of objectives, actions, and indicators in mobility plans

We analyse how actions, objectives, and indicators are defined in the mobility plans of Grand Reims, AMP, and ALM. We do not focus on the phases that aim to define and compare plan alternatives as there is little information about them in the three plans, contrary to what the law requires (cf. Section 2.2). Data in Supplementary materials provide additional information about each plan and how we executed the methodology.

Figure 3 gives an overview of the structure of the three mobility plans, with examples focused on active modes and cycling for each element. Different groups (axes, themes, stakes, or action levers) are defined to gather the actions, objectives, and indicators that address the same issue or the same transport mode. Some groups are specific to a transport mode, e.g. "transfer transit traffic towards the ring roads" or "develop the cycling network" (themes from Grand Reims), while some others are broader, e.g. "combat noise and air pollution". We may consider these groups as the orientations of the plans, which are expected to be consistent with those defined by law (French Government, 2010, L1214-2).

Analysing actions and objectives is complex as the plans do not explicitly define these terms. From what we observed, we may define an **action** as what the local authority will concretely perform, e.g. "implement a touristic and patrimonial signage aiming to encourage pedestrian trips" (Grand Reims). In contrast, an **objective** corresponds to what must be achieved through the authority's actions. Some include target values, e.g. "reach a 30% modal share for walking in the EPCI" (ALM). However, the actions and objectives of the plans do not always match those definitions. Indeed, there are some vague actions without linked objectives, so they do not indicate what the local authority should do, such as "functional and available delivery areas" (AMP). Such action could have been more explicit, e.g. by naming it "make delivery areas more functional and available" and specifying some objectives to detail what is expected and to enable monitoring. We also find actions that could be objectives with target values, such as "500 km of structuring cycling axes" (AMP). According to the definition above, this would have been an objective associated with the action aiming to "create cycling lanes". Inversely, some objectives could be actions. For example, "improve the parking offer for bikes" (ALM) could be an action associated with some objectives to enable its monitoring. The fact that the vocabulary is not defined and harmonised between plans makes the characterisation of actions more difficult for the planners, complicates the understanding of the plan, and is a barrier to performing efficient monitoring.

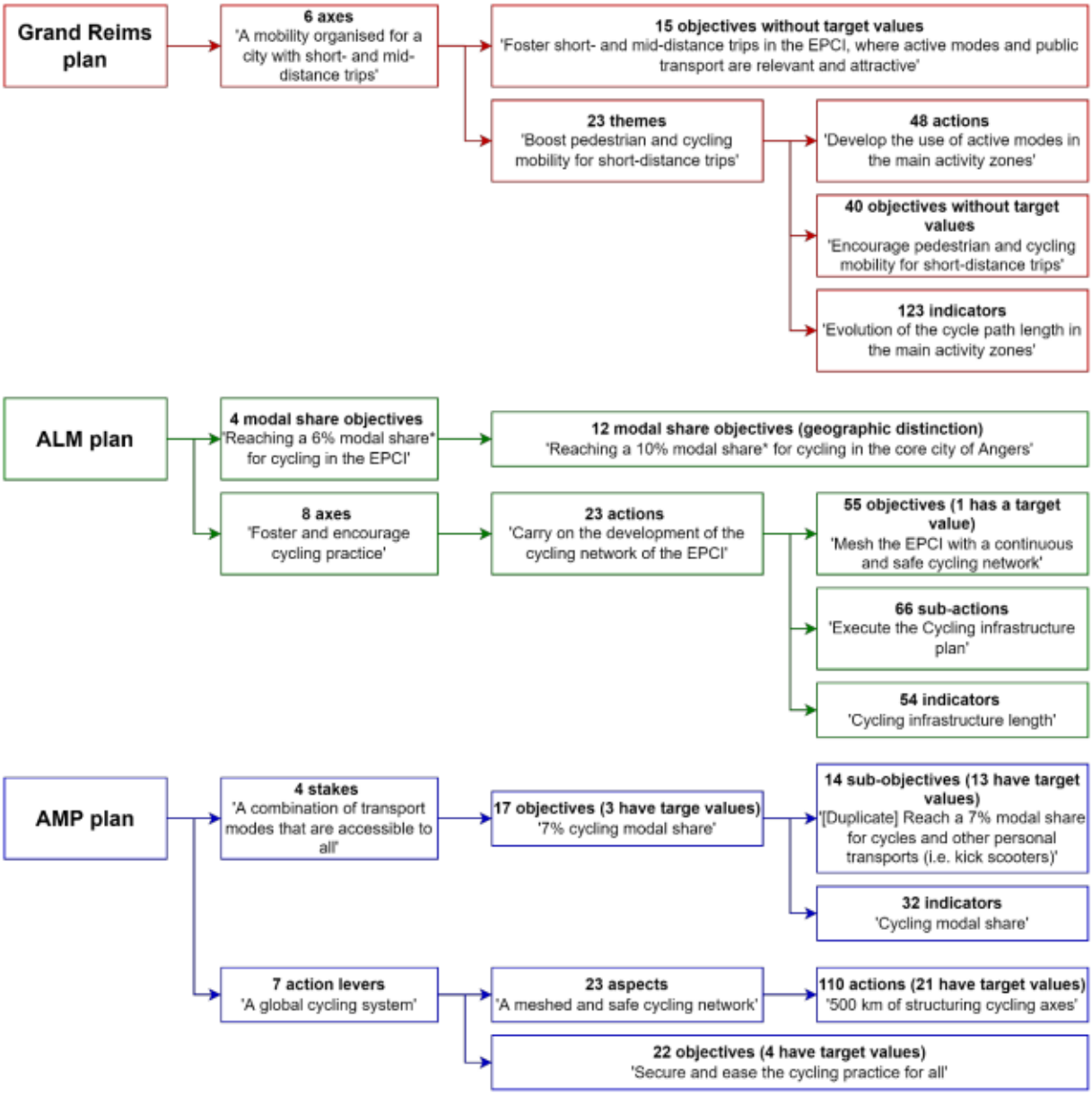

Figure 3: Structure of the three mobility plans regarding objectives, actions, and indicators definition

Table 2 summarises the number of objectives, actions, and indicators in each plan. It details if target values are associated with objectives and actions or not, i.e. “reach a 6% modal share for cycling” (ALM) vs “encourage and facilitate cycling practice” (ALM). However, in some cases, it is difficult to determine if a target value is defined, as it is sometimes difficult to associate a measurable indicator to a given objective and as some objectives are not reachable. For example, we consider "0 vehicles on pavements, pedestrian crossing, cycle lanes, or bus lanes" (AMP) to be an objective associated with a target value, although it is nearly impossible to reach; technically, it is more an orientation or a perspective than a rational objective with a reachable target. Table 2 shows that 79% and 91% of the objectives and actions are defined with target values, respectively. Many objectives have no target values, making it challenging to monitor objectives as there is no way to determine whether they are satisfied and corrective actions should be planned. An inadequate formulation of an objective, i.e. when an objective could be an action, leads to difficulties in setting target values.

Table 2: Quantitative summary of the number of objectives, actions, and indicators in each of the sample plans

Plans	Nb. of objectives			Nb. of actions			Nb. of indicators
	Without target values	With target values	Total	Without target values	With target values	Total	
Grand Reims	55 (100%)	0 (0%)	**55**	48 (100%)	0 (0%)	**48**	**123**
ALM	54 (76%)	17 (24%)	**71**	66 (100%)	0 (0%)	**66**	**54**
AMP	33 (62%)	20 (38%)	**53**	89 (81%)	21 (19%)	**110**	**32**
Total	**142 (79%)**	**37 (21%)**	**179**	**203 (91%)**	**21 (9%)**	**224**	**209**

Objectives are defined at different levels in the three plans (cf. Figure 3) and target different scopes: the whole plan, a group of actions, or a single action. However, they all are indiscriminately named objectives, and the reason for this hierarchy is neither explicit nor clear. In particular, we highlight the numerous duplicates within objectives and actions in the plans. We found and excluded 55 duplicates among ALM's objectives, 7 among AMP's objectives, and 2 among AMP's actions. For example, in AMP's plan, the "7% cycling modal share" objective is repeated at the three levels of objectives defined at the bottom of Figure 3. Similarly, in ALM's plan, "foster and encourage the practice of cycling" is an axis, while "encourage and facilitate cycling practice" is also an objective that is duplicated for each action of this axis. Thus, the structure used for the hierarchy of these plans is not always relevant, as these duplicated objectives should have been defined at a higher level to cover the different actions that influence this objective. It reveals that objectives cover different scopes, but they are not sorted accordingly. It is a barrier to planning as the methods to define and monitor objectives depend on their scopes.

A mobility plan must be evaluated every five years (French Government, 2010, L1214-8). However, the objectives have been defined for periods that are longer than five years. Indeed, there is a ten-, six-, and nine-year gap between the adoption and the planning horizon of the plans from Grand Reims, ALM, and AMP, respectively. It is therefore unclear how monitoring can be conducted, as the timing to evaluate indicators is not synchronised with the planning horizon where objectives are defined.

According to Table 2, indicators are insufficient to ensure efficient monitoring as every objective and action is not associated with an indicator. For example, AMP's plan only has 32 high-level indicators for 53 objectives and 110 actions (cf. Figure 3). Furthermore, there is little information about indicators, notably regarding how they will be measured and whether such measures are feasible. The meaning of some indicators is unclear, e.g. "offer and evolutions on the national and regional railway lines" (ALM) can lead to different interpretations of what should be measured and monitored. These findings reveal that objectives and actions are not systematically defined with related indicators and lack preciseness. It can be a barrier to monitoring.

4.3 Integration of environmental issues into planning through SEA

This section investigates the SEA reports of these three mobility plans. The focus is on four main aspects of these reports: (1) which environmental issues are analysed, (2) how the likely impacts of the plans are assessed, (3) how the consistency between plans is verified, (4) and which information is provided regarding monitoring.

4.3.1 Description of the sampled SEAs

The SEAs focus on several environmental issues relevant in the local plan's context. They are investigated during the environmental diagnosis at the beginning of the planning process and are used to assess the plan's actions. The issues from the three SEAs are presented in Table 3. Despite some

naming, prioritisation, and grouping changes, every document focuses on the same issues. Nevertheless, there is confusion regarding some issues. For example, Grand Reims encompassed GHG emissions in the analysis of the effects of their plan on air quality, although GHGs are not significant atmospheric pollutants. Also, the environmental diagnosis of the AMP confuses climate change mitigation with adaptation; indeed, it mentions "find alternatives to gasoline and diesel vehicles" and "create low-emission zones" as levers to tackle the issues of "vulnerability to the effects of climate change", although they are related to mitigation.

Table 3: Comparison of the environmental issues identified in the SEAs and used for the diagnoses and assessments of the plans

<table>
<tr><th>Grand Reims</th><th colspan="2">AMP</th><th>ALM</th></tr>
<tr><th>For the diagnosis and the assessment of actions*</th><th>For the diagnosis</th><th>For the assessment of actions</th><th>For the assessment of actions**</th></tr>
<tr><td>Air quality and health damage[1]</td><td>Air quality[1]</td><td>Air quality[1]</td><td rowspan="3">Air quality, GHG emissions, and energy consumption</td></tr>
<tr><td>GHG emissions[1]</td><td rowspan="2">Vulnerability to climate change effects (GHG, energy consumption, climate change effects) [3]</td><td>GHG emissions[1]</td></tr>
<tr><td>Renewable and non-renewable energy consumption[1]</td><td>Energy transition[1]</td></tr>
<tr><td>Land-use[2]</td><td>Land-use[1]</td><td>Land-use[1]</td><td rowspan="3">Biodiversity, natural areas, and land-use</td></tr>
<tr><td rowspan="2">Biodiversity and natural areas</td><td rowspan="2">Natural areas[1]</td><td>Natural area quality[1]</td></tr>
<tr><td>Natural habitat fragmentation[1]</td></tr>
<tr><td>Water[3]</td><td>Natural resources (water and soils) [3]</td><td>Water and soil quality[3]</td><td rowspan="2">Water and waste management</td></tr>
<tr><td></td><td>Waste management[3]</td><td></td></tr>
<tr><td>Landscape, heritage, and living environment[3]</td><td>Landscape and heritage[3]</td><td>Landscape and heritage[3]</td><td>Landscape and heritage</td></tr>
<tr><td>Noise[1]</td><td>Noise[2]</td><td>Noise[2]</td><td rowspan="3">Vulnerability to risks and nuisances</td></tr>
<tr><td rowspan="2">Natural and technological risks[3]</td><td>Natural risks[3]</td><td rowspan="2">Resilience regarding natural and technological risks[3]</td></tr>
<tr><td>Technological risks[3]</td></tr>
<tr><td></td><td></td><td>Well-being and physical activity[1]</td><td></td></tr>
<tr><td colspan="4">Legend: Level of importance of the issues according to the SEAs</td></tr>
<tr><td>High[1]</td><td>Moderate[2]</td><td>Low[3]</td><td>Undefined</td></tr>
<tr><td colspan="4">*For Grand Reims, the same issues have been identified in the diagnosis and used to assess the actions, except for GHG emissions and energy consumption, which have been assessed together.
**Because ALM's plan combines an urban land-use plan and a mobility plan, the issues for the environmental diagnosis are not presented in this table as it targets both aspects.</td></tr>
</table>

Regarding assessment, there are two approaches to evaluating the impact of the plans regarding the issues: qualitative and quantitative evaluations. The three SEAs include **qualitative evaluations**. For each environmental issue, Grand Reims analysed groups of similar actions and assessed each action on a five-level ranking scale. In contrast, the AMP assesses the plan at two levels, considering each issue individually. First, the impact of each "action lever" is discussed, evaluated with a five-level ranking scale, and specified according to whether the impact is proved or potential, direct or indirect, and permanent or temporary. Then, the cumulative effects of the whole plan are analysed for each issue. The ALM assesses the plan in three steps, considering the five environmental issues associated with 41 qualitative environmental objectives. As a first step, the plan is discussed regarding each issue, and a qualitative score is given for each environmental objective based on a three-level rating scale. Next, for each issue, the plan's content is assessed by answering key questions such as "Does the plan ensure the development of active modes?", and another qualitative score is given for each environmental objective. Finally, for each of the 66 actions regarding mobility, their potential effect

on energy consumption and pollutant emissions are analysed and assessed through a four-level ranking scale.

These same SEAs also include **quantitative assessments**. Grand Reims SEA describes a simulation model to compare two scenarios depending on whether the plan is executed. This model is then used to estimate the evolution of the distance travelled and pollutant emissions (CO_2, hydrocarbon, NO_x, and PM) for 2025. The traffic emission estimation is based on the HBEFA 3.2 European database. A similar approach has been conducted by the AMP, where two scenarios are compared depending on whether the plan is executed. Simulations rely on a four-step model (McNally, 2007) and a French freight transport simulation tool called FRETURB. For 2030, they notably forecast the evolution of the distance travelled, economic costs, geographic accessibility to public transport, energy consumption, and pollutant emissions (GHG, NO_x, PM, and non-methane volatile organic compounds). It considers the likely evolution of the population, changes in the transport network, evolutions of the freight transport flows, occupancy rates, teleworking, and vehicle emissions according to the European standard calculator COPERT v5. The ALM SEA proposes a calculation of future pollutant emissions (GHG, NO_x, and PM) based on the modal shares expected for 2027. It considers the possible evolution of population, mobility demand, occupancy rates, and vehicle fleets. Only the daily trips of inhabitants inside the ALM boundaries are considered, and freight transport is excluded.

The three SEAs verify that their mobility plans are consistent with other plans, which are either regional or local and transversal or sectoral. The plans concern territorial development, water management, waste, climate change, air quality, energy, health, flood risks, and landscapes. The analyses of the consistencies between different plans are mostly done through qualitative considerations. This is the case for 10 plans out of 12 in AMP SEA, 10 out of 11 in Grand Reims SEA, and 15 out of 15 in ALM SEA. The AMP SEA is the only document that consistently compares the expected impacts of the plan determined by the simulation model with the objectives defined in the mobility plan and two transversal plans. Table 4 synthesises this comparison. For example, the objective of the mobility plan is to reach a 29% reduction in primary energy consumption compared to 2012. It is more ambitious than the objectives fixed in the regional territorial development plan, aiming for -15% from all sectors, and in the local environmental plan, aiming for -29% from the transport sector and -25% from all sectors. However, the simulation of the AMP predicts a reduction of 20% only; thus, the objective may not be reached.

Table 4: Comparison of the objectives of the AMP defined in the environmental plans and the mobility plan with the expected results by 2030

2030 objectives for the AMP (reference 2012 when required)	Regional territorial development plan (2019)		Local environmental plan (2021)		Mobility plan (2021)	
	Transport sector	All sector	Transport sector	All sector	Objectives	Simulation
Final energy consumption		-15 %	-29 %	-25 %	-29 %	-20 %
GHG emissions	-35 %	-27 %	-26 %	-21 %	-28 %	-28 %
$PM_{2.5}$ emissions		-55 %		-25 %	-55 %	-67 %
PM_{10} emissions		-47 %		-40 %	-47 %	-56 %
NO_x emissions		-58 %		-37 %	-75 %	-67 %
NMVOC emissions		-37 %		-14 %	-37 %	-71 %
Car modal share reduction (reference 2017)	-15 pts				-15 pts	-13 pts
Bike modal share	12,5 %				7 %	7 %
Legend: In red are the objectives for which the objectives of the plan or its simulation results to do not comply with.						

The objective or the simulation results:		
Satisfy the objectives from all plans	Satisfy the local objectives from the mobility plan and the environmental plan, but some of the others are not reached	Do not satisfy the local objectives set in the mobility plan or the environmental plan

The SEA reports propose additional information relative to the monitoring process detailed in the mobility plans, such as methodological proposals or complementary indicators regarding environmental issues. The AMP's SEA proposes to distinguish two types of indicators. On the one hand, there are indicators to measure mobility changes in AMP, such as modal shares or the number of kilometres travelled. Such indicators can then monitor health and air quality, geographical accessibility, GHG emissions, and energy consumption evolutions. On the other hand, there are contextual indicators to evaluate the effect of the actions on natural areas, land consumption, landscape and heritage, water and soils, and risk exposure.

4.3.2 Analysis of the sampled SEAs

The three French SEAs address several environmental issues, according to Table 3. These lists of issues show that the plans' effects on biodiversity, population, human health, soil, water, air, climatic factors, material assets, cultural heritage, and landscape are investigated to some extent. Therefore, the multi-criteria aspect of the SEA is aligned with the European Directive requirements (cf. Section 2.3). However, their analysis sometimes revealed confusion regarding issues, especially between atmospheric pollution, climate change mitigation, and climate change adaptation.

The three SEAs include a qualitative assessment of the actions, and every AOM used a simulation model to quantify the current and future GHG and local pollutant emissions caused by transport inside their boundaries, as required by law (French Government, 2010, R1214-1). In the case of ALM and Grand Reims, they used their models to test if the objectives were sufficiently ambitious to satisfy the environmental objectives. In AMP SEA, they used a four-step simulation model to assess the effect of some actions defined in the plan to predict future performances and environmental consequences. The first finding is that the approaches of the three AOMs to designing their models are not transparent. For example, in the case of Grand Reims, there is barely any detailed hypothesis, e.g. regarding future demographic evolution or modal shares, and some hypotheses are not justified, e.g. traffic evolution. Moreover, the simulation models have significant limitations. First, they only assess exhaust pipe emissions and in-use vehicle consumption and thus do not consider life cycle impacts. This is a significant bias, notably regarding GHG emissions that cause the same effects on climate independently from the location of the emission. Although it prevents double counting of impacts across sectors, the risk is neglecting trade-offs and then making flawed decisions. For example, the GHG emissions from electric, hydrogen, or autonomous vehicles are underestimated if fabrication, energy supply, or infrastructure impacts are not considered. Second, the simulations' perimeters are limited, leading to incomplete results regarding environmental effects. Freight, transit trips, and vacation mobility are not always included in the models; simulations thus do not give complete information on the future impacts of the transport sector.

Our literature review highlighted a lack of interaction between the different plans. In theory, French mobility plans must be consistent with other plans (French Government, 2010, L1214-7), but this interaction is primarily qualitative in practice. This issue is perhaps due to the plans' different planning horizons and timing, the qualitative nature of some issues (e.g. "Landscape and heritage"), and the inconsistent frameworks used to define objectives and assess impacts. Furthermore, even when the approach to testing the consistency between plans is quantitative and based on a simulation model, it seems that the objectives of a plan are not systematically modified when it appears that they are not

in line with those defined in other plans. For example, in AMP's plan, estimating the effects of the actions showed that some objectives were not likely to be reached; nevertheless, the plan has not been modified. Perhaps the results were deliberately not considered by stakeholders, or stakeholders did not give much credit to the model and its results.

Finally, a SEA is supposed to help define the best alternative for a plan. However, the reports have no actual definition of alternatives or comparative assessments. SEA appears to be an iterative process that incrementally integrates environmental issues throughout planning rather than a final decision-making methodology to select an alternative.

5 Best practices and potential issues when designing mobility plans

The literature review about mobility plans and SEAs in the EU and our French case study highlighted several limitations and best practices when designing mobility plans. These findings are summarised in Table 5 and aim to help planners and local authority representatives design their plans and effectively integrate environmental issues into this process.

Table 5: Limitations and best practices when designing mobility plans according to our literature review and our French case study

Limits identified in the EU literature in Section 2	**Findings from the French case study**	
	Limitations in current French practices	**Best practices and pathways to improve the plan design**
The planning process lacks public involvement (De Montis *et al.*, 2016; Jordová and Brůhová-Foltýnová, 2021; Mozos-Blanco *et al.*, 2018). Citizens have difficulties grasping the stakes of strategic decision-making (van der Linde *et al.*, 2021).	Reading plans and environmental reports gives scarce information about stakeholders' involvement in the design process. Therefore, we do not highlight any limitation linked to this aspect due to our methodology.	To elaborate or revise a plan, AOMs should rely on governmental and non-governmental stakeholders to elaborate or revise a plan, as recommended by the SUMP framework (Rupprecht *et al.*, 2019) and required by law (French Government, 2010, L1214-14, L1214-15, and L1214-16).
Some environmental issues are not fully addressed in SEAs, notably climate change (European Commission *et al.*, 2019)	There is confusion among atmospheric pollution, climate change mitigation, and climate change adaptation issues.	The environmental reports should address various environmental issues, covering the requirements of the European Directive. Planners should clearly distinguish between atmospheric pollution, climate change mitigation, and climate change adaptation issues.
There is a lack of specific, measurable, achievable, relevant, and time-bound objectives in the plans and a lack of methods to define them (Baltazar *et al.*, 2023; Chakhtoura and Pojani, 2016; Wende *et al.*, 2004).	There is a lack of expertise and willingness to precisely define and characterise actions and objectives. It complexifies planning, the understanding of the plan, and monitoring.	Planners should share the planning vocabulary and a methodology to help characterise actions and objectives. Objectives should be defined with satisfaction criteria and measurable indicators.
N/A	Objectives are defined at different levels, but the hierarchy is unclear.	Three levels of objectives should be clearly defined to distinguish between strategic objectives (e.g. reducing GHG emissions), performance objectives (e.g. increasing bike modal share), and tactical objectives (e.g. installing new bike parking sports) to help set and monitor actions.
There is a lack of ex-ante evaluations of plans (De Montis *et al.*, 2016; Hildén *et al.*, 2004; Mozos-Blanco *et al.*, 2018; Wende *et al.*, 2004)	The three plans include both qualitative and quantitative evaluations. However, quantitative assessments are sometimes lacking in French environmental reports (as	Each plan should be based on both qualitative and quantitative ex-ante evaluations. It should include an assessment of the current and future pollutant emissions caused by transport, as

	highlighted during case study selection in Section 3.2). The quantitative assessments in the three scrutinised plans have significant methodological limitations.	required by law (French Government, 2010, R1214-1). Planners should share a methodology to help conduct these strategic quantitative environmental assessments.
Mobility plans and SEAs lack interaction with other sectoral documents (Baltazar *et al.*, 2023; Rehhausen *et al.*, 2018).	The consistency between plans is mostly checked through qualitative assessment. When the assessment of a plan reveals that the environmental objectives may not be reached, modifying the plan is not systematic.	The consistency between mobility plans and other plans is required by law (French Government, 2010, L1214-7). However, the nature of this interaction should be further specified. Planners should share a method to define and validate objectives.
SEA fails to generate plan alternatives and justify why a given alternative is selected (De Montis *et al.*, 2016; European Commission *et al.*, 2019; Rehhausen *et al.*, 2018).	The plans and SEA reports do not define and compare plan alternatives.	Mobility planning could be considered an iterative process that incrementally builds a final strategy and action program rather than a process that defines alternatives and determines the best one.
Ex-post evaluations are not comprehensive, and there is a lack of methodologies to monitor objectives (Baltazar *et al.*, 2023; Chakhtoura and Pojani, 2016; European Commission *et al.*, 2019; Jordová and Brůhová-Foltýnová, 2021; Mladenovič *et al.*, 2022)	The monitoring process is insufficiently defined in the plans. However, reading plans and environmental reports gives little information about monitoring, so our study is insufficient to characterise and analyse this aspect of planning. The planning horizon where objectives are defined is not in sync with the indicators' mandatory evaluation period.	A mobility plan must be evaluated and revised every five years, and the environmental report must define monitoring modalities (French Government, 2000, R122-20, 2010, L1214-8). The planning horizon should be synced with the mandatory evaluation period.

6 Conclusion

Local authorities are responsible for improving transport sustainability by adopting ambitious strategies and relevant action programs. However, there are barriers to integrating environmental issues into mobility planning and a need for recent papers investigating French planning practices.

Our paper fills this gap by analysing the current best practices and limitations for designing mobility plans in France and integrating environmental issues. To do so, it thoroughly scrutinised the national regulatory context, three mobility plans, and their corresponding SEA reports. We compared the shortcomings identified in the EU literature and legal requirements with actual French practices. We highlight the following findings. First, the three case studies include several good practices that are compliant with the SUMP and SEA frameworks and national law: (1) numerous actions, objectives, and indicators are set for different orientations that are defined in the law framing mobility plans, (2) a large spectrum of environmental issues is addressed in the environmental reports, which generally follow the steps defined in the SEA directive, (3) the qualitative environmental ex-ante evaluations are complemented by quantitative assessments for the climate change and air quality issues in compliance with French law. However, the effectiveness of the plans is hindered by several shortcomings that were also highlighted by our EU literature review: (a) there is no robust approach to defining and characterising actions and objectives as the differences between actions and objectives are unclear, and objectives lack satisfaction criteria, (b) several methodological issues limit the quantitative assessments as all hypotheses are not (or insufficiently) detailed and discussed and the perimeter of evaluation is limited, (c) monitoring modalities are scarcely described in plans and SEAs as only few indicators are defined without always being measurable, no process to implement corrective actions is mentioned, and the ex-post evaluation timing is not synced with the planning horizon where objectives are set.

As our study revealed mixed findings about planning practices, an operational framework should be defined to help design mobility plans with an effective integration of environmental issues. According to the three above shortcomings, it could include (a) a method to define actions and specific, measurable, achievable, relevant, and time-bound objectives, considering environmental objectives as the foremost strategic objectives that influence the choice of lower-level objectives, (b) a method to validate objectives, notably by using a strategic quantitative environmental assessment model that should be shared between local authorities to help those with fewer resources and enable comparability, and (c) a monitoring process that would include preparing and negotiating potential corrective actions before the implementation of the plan actions in case they lead to outcomes below the objectives.

We identified some good practices and shortcomings in French mobility plan design and suggested some recommendations. As they can help improve the design process of any plan, such findings can be acknowledged by all planners – wherever their location or sector. However, the limitations of our approach are to be underlined. Content-based analyses are fundamental to acquiring an in-depth understanding of a process (here, mobility plan design), but they prevent the coverage of a large data sample. Although our approach has been applied to three French local authorities, the shortcomings we identified are consistent with our EU literature review, and our approach could be further used in other contexts to extend the validity of our findings or identify other specific critical issues that need to be addressed. Moreover, planning practices depend on local authorities' resources (experts, prior experience, funding), context, and stakeholders' engagement. Hence, current planning practices need further investigation to potentially generalise our findings to other local French (or EU) authorities. Our work could thus be complemented by other quantitative (e.g. meta-analyses) and qualitative approaches (e.g. interviews, surveys) to enhance the representativeness of our results. Moreover, our study focused on the plan design and thus put aside other aspects of planning, such as stakeholder involvement, planning governance, timing, SEA influence on decisions, objectives monitoring, and plan effectiveness, but complementary studies based on alternative methods and materials (e.g. interviews, content analyses of ex-post evaluation reports) are required to investigate these aspects. Indeed, our results did not concern these aspects, as they are barely described in planning documents, so we highly recommend future studies to investigate how these aspects are addressed as they can significantly affect the quality and effectiveness of the plan.

Finally, more research is needed to support local authorities through consistent methods and tools to move towards more sustainable mobility. Our paper paves the way for improving planning and effectively integrating environmental issues into the process.

Glossary

SUMP	Sustainable urban mobility plan
SEA	Strategic environmental assessment
GHG	Greenhouse gas
CO_2	Carbon dioxyde
NO_x	Nitrogen oxydes
PM	Particulate matter
Grand Reims	*Communauté urbaine du Grand Reims*
ALM	*Angers Loire Métropole*
AMP	*Métropole Aix-Marseille-Provence*
AOM	Mobility organising authority (in French, *autorités organisatrices de la mobilité*)
EPCI	Public establishments for inter-municipal cooperation (in French, *établissement public de coopération intercommunale*). Grand Reims, ALM, and AMP are EPCIs.

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Appendix

Appendix A: Sample of journal papers analysing the mobility planning process at the local level in the EU

Paper	Method	Perimeter
Jordová and Brůhová-Foltýnová (2021)	Performed 45 interviews and conducted an online questionnaire survey answered by 76 city representatives	Czechia
Mozos-Blanco *et al.* (2018)	Analysed 38 SUMPs	Spain
Sitányiová and Masarovičová (2017)	Interviewed 55 stakeholders, including decision-makers, policy influencers, practitioners, and academics.	Slovakia
Klímová and Pinho (2020)	Analysed and compared two mobility plans and the role of corresponding national guidelines	Municipalities of Olomouc (Czech Republic) and Matosinhos (Portugal)
Mladenovič *et al.* (2022)	Surveyed 14 experts from academia, the transport planning industry and the national organisation for SUMP and performed four interviews	European economic area
Michelini *et al.* (2023)	Analysed 67 planning documents	Germany
Kiba-Janiak and Witkowski (2019)	Surveyed 15 local authorities, including representatives and transport planning experts, and analysed their transport plans	15 capital cities in the EU
Van der Linde *et al.* (2021)	Conducted 21 semi-structured interviews with professionals working in the traffic departments and involved in the SUMP process.	Cities of Malmö (Sweden) and Utrecht (Netherlands)
Chakhtoura and Pojani (2016)	Evaluating on a five-level ranking scale if the goals and objectives from 4 transport-related plans have been reached based on three plan evaluation reports, 67 news articles, academic papers, and online portals	Paris
Buhler and Lethier (2020)	Applied textometry on 37 planning documents adopted between 2000 and 2015	France

Supplementary materials

Additional data is available to get more information about the three plans investigated in our paper and how we executed our methodology.

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