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Fauna-sensitive road design: Transitioning from best practice to standard practice

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1. Rationale

Although sustainability has become an important topic in transport policy, it focuses primarily on human-centered issues, such as electric vehicles, mobility, and greenhouse gas emissions (Hassouna & Al-Sahili, 2020; Thaller *et al.*, 2021; Axsen, 2022; Cavallaro & Nocera, 2022; Żochowska *et al.*, 2022). The negative externalities associated with ***Linear Transport Infrastructure*** (LTI), such as wildlife mortality from collisions with vehicles and restricted animal movements, are often overlooked (Johnson *et al.*, 2022, Papp *et al.*, 2022).

Road ecology is a newly emerged field that examines the various components of roads, including vehicles, soil, water, air, plants, and wildlife, to minimise the negative impacts of LTI on wildlife (Jones and Pickvance, 2013, van der Ree *et al.*, 2015). The implementation of road ecology principles, such as green networks, wildlife corridors, defragmentation programs, and ***fauna-sensitive road design*** (FSRD), preserves wildlife and enhances the economic and social benefits of LTI. FSRD, especially, allows wildlife to safely move between forest patches while reducing the risk of wildlife-traffic collisions and the associated costs borne by road managers and users (Smith *et al.*, 2015). This, however, requires a robust regulatory framework, as has been demonstrated in European Union member states like Belgium, Denmark, Norway, and Sweden (Damarad and Bekker, 2003, Wilson *et al.*, 2007, Jones and Bond, 2010). In Australia, FSRD is voluntary and only recognised, at least publicly, by transport sectors in two states: Queensland (TMR, 2010) and Victoria (VicRoads, 2012).

Our recent systematic review found that although FSRD guidelines have been in place in Australia, at the State-level, for over a decade, both road ecology and FSRD are not widely acknowledged or considered in road transport infrastructure planning (Johnson *et al.*, in submission). Indeed, discussion of FSRD within peer-reviewed transport research, in Australia, is entirely absent. This is concerning, as an acknowledgment of the environmental impacts of roads, especially on wildlife, in peer-reviewed literature has greatly improved their consideration in road transport planning, especially in the EU (Damarad and Bekker, 2003; Johnson *et al.* 2022b). Where this has occurred, FSRD has been developed to be an essential part of transportation planning that provides a framework for ecological planning, engineering, and mitigation in road transport projects (van der Ree, Smith, and Grilo, 2015).

While still at a nascent stage of implementation, there is substantial potential for the inclusion of FSRD in road transport projects to be further enhanced. This, however, will require both supportive policies and practical user experiences, both of which are poorly understood at present. In this abridged paper, we will explain our methodological approach to filling this important gap. In doing so, we hope to help other researchers and practitioners to better understand the approach taken, its advantages (and disadvantages), and where it may be helpful if used in other parts of the field.

2. Preliminary methodology

The assessment of FSRD policies will employ a combination of methodologies, blending theoretical frameworks with practical applications. This methodology mirrors the approach taken by Clement *et al.* (2015), involving the analysis of policy documents using the Institutional Grammar Tool (IGT), a linguistic analytical tool developed by Crawford and Ostrom. The IGT structures individual statements in tabular form, facilitating qualitative analysis across varying scales - individual, comprehensive, or grouped. This structured approach aids in comprehending policy constraints, opportunities, and intended objectives (Siddiki *et al.,* 2010, 2011, 2012). In this context, the IGT will identify permissible, obligatory, and prohibited actions, allocate responsibilities to stakeholders, and outline temporal, spatial, and non-compliance parameters linked to FSRD.

The IGT will be employed on three transport guidelines used in regional planning and decision-making (Table 1). Implementation follows the empirical guidelines outlined in Siddiki *et al.* (2010; 2011). Document selection involved consultations with informed individuals familiar with regional transport planning.

Table 1: Key policy documents for IGT analysis

Policy document	Study area	Lead agency	Statutory/Non-statutory	Purpose of policy
Environmental Processes Manual	Queensland	TMR	Statutory	Offers the framework for overseeing environmental assessment and management of TMR's road transport projects.
Fauna Sensitive Road Design Volume 2 Chapters 3-7	Queensland	TMR	Non-statutory	Offers guidelines for best practices to mitigate the impact of road infrastructure on wildlife.
Fauna Sensitive Road Design Guidelines	Victoria	VicRoads	Non-statutory	Presents a framework for implementing FSRD in road projects.

Institutional statements will be categorised into five subcomponents based on the ADICO grammatical syntax (Table 2).

Table 2: Subcomponents of the IGT syntax including the modifications applied in this study

Subcomponent	Description
Attribute	Individual/organisation to which it applies
Deontic	What is permitted, obliged, or forbidden (e.g., must, may, shall, shall not, will, etc.)
aIm	Goal or action to which D refers
Condition	When, where, how, or why the aim applies
Or else	Punitive action if a rule is not adhered to (e.g., fine)
oBject	Inanimate or animate part of a statement that receives the action (e.g., plan or policy)

An ***Attribute*** denotes an active agent carrying out an action, often involving characteristics like age, gender, or role for individuals and size for organisations (Siddiki *et al.*, 2011). These attributes can be explicit or implied in statements, requiring cautious coding, especially when implicit (Siddiki *et al.*, 2011). This is crucial when dealing with multiple agents in larger entities, where only the primary agent is named. In such cases, secondary agents need inference. For example, an individual (primary agent) acting for a company/organisation (secondary agent). Identifying the statement's aim helps identify the Attribute, as the two are closely linked (Siddiki *et al.*, 2011).

The ***Deontic*** signifies permissions, requirements, or prohibitions (Siddiki *et al.*, 2011). Commonly conveyed through terms like 'may,' 'must,' and 'should' (Siddiki *et al.*, 2011). deontics indicate the strength of a statement; 'must' > 'should' (Siddiki *et al.*, 2011). While most statements state deontics explicitly, they can be implicit, like 'required' or 'must', or carried from prior statements (Siddiki *et al.*, 2011). The study acknowledges qualitative differences in 'must' and 'will' (Clement *et al.*, 2015), where the former implies a strong obligation and the latter a weaker stance. The ***aIm*** aligns with the deontic, explaining a policy's goal or action (Clement *et al.*, 2015). Interpreting the aim clarifies a statement's attribute and ***oBject*** (Clement *et al.*, 2015), addressing ambiguity in the deontic (Siddiki *et al.*, 2011). The ***Condition*** establishes time and space requirements of the aim, explicit or implicit, with the potential for multiple conditions.

For systematic coding, Siddiki *et al.* (2011) recommend: Deontic, aIm, oBject, Condition, and Or Else/Attribute. This deconstruction unveils shared strategies, norms, and rules within policies, unveiling how institutions guide behavior (Clement *et al.,* 2015) (Table 3). An example application of the IGT for analysis of policy statements, as well as the final analysis of the outputs, are provided in Tables 4 and 5.

Table 3: Description of institutional statements

Type of statement	Description	Sub-components
Shared strategies	Statements for mutual understanding to guide behaviour, effective with stable actor preferences and their active pursuit and optimisation.	AIC/ABIC
Norms	Statements that rely on collective perceptions of appropriate behaviour in each context. They work best when individuals act in alignment with their beliefs, values, and identity.	ADIC/ABDIC
Rules	Statements and actions contradicting these standards become ineffective or may face sanctions from authorised actors.	ADICO/ABDICO

Source: Clement *et al.* (2015)

Table 4: Illustrative IGT application of the IGT on policy statements

	Statement	Subcomponent	Attribute	aIm	Deontic
1	"For existing roads, the principles can be adopted during repair and/or maintenance."	ADIC	Project Manager (implied)	Adopt	'can'
2	"Connectivity between habitats at a regional scale (at the minimum) should be considered, with particular regard for transport infrastructure, distribution of habitats and other potential barriers such as built-up areas."	ADIC	Project Manager (implied)	Consider	'should'

3	At a regional scale, fauna mitigation structures are required to maintain necessary contact within and between populations of animals (permeability concept).	ADIC	DTMR	Maintain	'must' (implied)

Table 5: Illustrative exemplar of analysis of the outputs of the IGT

Component	Policy Document #1	Policy Document #2	Etc.
No. Shared Strategies	-	-	-
No. Shared Norms	-	-	-
No. Rules	-	-	-
Total statements	-	-	-

Organizing the results of the IGT in this structure enables the assessment of the fundamental intent and objective of the policy documents. For instance, a document exhibiting a greater prevalence of shared norms statements, primarily featuring deontics like 'should', 'might', and 'consider', would indicate an inclination toward a norms-centered approach, characterized by a softer stance on policy implementation (Clement *et al.*, 2015). Conversely, an increased occurrence of rules, coupled with deontics such as 'must' and 'need', would suggest an orientation toward a rules-based approach (Clement *et al.*, 2015).

Nevertheless, the IGT is not without limitations, particularly in capturing the complete context. Verbal expressions may not consistently align with practitioner awareness and execution, and they might fail to encompass deeply ingrained institutional behaviours (Siddiki *et al.*, 2011). To bridge this methodological gap, semi-structured interviews will be employed. These interviews have demonstrated effectiveness in assessing transportation and biodiversity policies in previous studies that employed the IGT (Clement *et al.*, 2015; Siddiki *et al.*, 2010). Through the involvement of practitioners with varying experiences and responsibilities, these interviews will leverage insights from the IGT outcomes and delve into the real-world adoption and implementation of FSRD.

3. Expected outcomes

In essence, the combined results of the IGT analysis and semi-structured interviews will jointly assess the overall effectiveness of FSRD. This collaborative approach bridges the gap between theoretical foundations and practical implementation, thereby shedding light on challenges faced and potential solutions. By merging these two methodologies, our objective is to develop a deeper understanding of the intended goals within the existing institutional frameworks that govern FSRD. This understanding encompasses how practitioners translate these aspirations into tangible actions in the real world. The overarching goal is to provide valuable and strategic recommendations for enhancing current environmental protection and conservation policies within governmental organisations and institutions. Simultaneously, this integration aims to advance the ecological, economic, and social sustainability of the road transport network. A comprehensive presentation of the findings is slated for the upcoming ATRF conference.

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