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Functional-spatial sustainability potentials of integrated infrastructure planning

Niels Heeres^{a,*}, Taede Tillema^a, Jos Arts^{a,b}

^a *Univeristy of Groningen, Faculty of Spatial Sciences, PO Box 800, 9700 AV Groningen, The Netherlands*

^b *Rijkswaterstaat, Centre for Transport and Navigation, Delft, The Netherlands*

Abstract

In response to societal, political and financial-economic dynamics, a trend towards integration of road infrastructure planning and planning of other land use functions can be observed. Effects of this trend – which is especially visible in the Netherlands, but can also be recognized in other countries – are observable in spatial development plans, designs and projects, as well as the organizational sides of planning. In this paper we take a substantial perspective regarding these innovations; we make a distinction between broadening of the functional scope and the spatial scope of projects. Both deserve careful consideration in the optimization of synergy among planning sectors, which can be seen as a concrete reflection of often abstract sustainability principles. Traditional barriers between spatial policy sectors ('silos') have to be overcome in order to optimize this synergy, while traditional administrative boundaries often hamper the definition of optimal project areas needed for context-specific infrastructure development. This paper aims to analyse the broadening of these scopes from a theoretical and empirical perspective. In order to examine the relationship between planning scopes and sustainability of outcomes we propose an analytical framework based on a review of scientific literature and policy documents. After this we explore the position of these concepts within Dutch road infrastructure planning and build on the experiences gained through our involvement in the development of a planning instrument for sustainable integrated developments. The insights are used to draw conclusions about the relationship between the functional and spatial scope of infrastructure projects and their potential contribution to a more sustainable road infrastructure planning practice, in terms of synergy and spatial quality. Furthermore, possible consequences for the organizational side of infrastructure planning are discussed.

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Keywords: Road infrastructure; infrastructure-land use integration; cross-sectoral planning; functional scope; spatial scope; sustainability; multi-level governance; front-end governance; the Netherlands

* Corresponding author. Tel.: +31 (0)50 363 3880
E-mail address: n.heeres@rug.nl

1. Introduction

Integration of road infrastructure and other land use functions is increasingly promoted as a sustainable alternative to traditional sector planning approaches. Integration attempts (e.g. Transit Oriented Development) often emphasize influencing travel behaviour (mode choice) or reducing mobility demands through influencing accessibility (Cervero 1998, Curtis, Renne 2009, Dittmar, Ohland 2004). These attempts therefore closely appeal to the environmental pillar of sustainability. Much less attention is paid in literature to infrastructure planning concepts that relate to more holistic sustainability aims (e.g. Triple Bottom Line: Elkington 1999) that seem required to make idealistic sustainability objectives work out in an effective manner (Berke 2002, Gunder 2006). These types of infrastructure-land use integration – in the Netherlands often referred to as ‘area-oriented planning’ and mentioned as ‘place-based policy’ by the OECD (2010) – aim to incorporate the needs, demands and opportunities offered by surrounding areas (or ‘places’) into road infrastructure planning in order to solve complex transport issues by searching for solutions within the broader spatial system. Attention to ‘places’ – as nodes in multiple networks – in infrastructure planning carries with it a relational planning approach, challenging the traditional orientation of government on single planning sectors (‘silos’) (Healey 2006, Healey 2007). It appears that the reasons for engaging in such approaches in planning practice are first of all to overcome process-related complexity caused by a highly dynamic context (Heeres, Tillema & Arts 2011). However, since these approaches closely relate to opportunities for synergetic spatial development, also the functional-spatial effects are an interesting topic of research.

In this paper we aim to further explore the substantial side of road infrastructure-land use integration as a means to promote sustainability in road infrastructure planning. For this purpose we distinguish between the functional scope and the spatial scope of road infrastructure planning. In section two we commence with a conceptual review in which we consider the relationship between road infrastructure planning and planning for further land uses from a functional and a spatial perspective. We propose a theoretical framework for the exploration of recent developments regarding these planning scopes. Our theoretical perspective is based on (a) conceptual thoughts about synergetic effects that may emerge from the intensified combination or coordination of different land use types and (b) conceptual ideas on optimization of area- and scope-definition against contemporary political and societal developments. In section 3 we take an empirical focus on the integration of road infrastructure and land use functions. Therefore, we explore the introduction and first application of a practical instrument for the promotion of sustainable integration in road infrastructure planning. Here we make use of practical experiences, gained through the participation of the authors in these practical initiatives as a strategic advisor and participating observant, in the establishment of these initiatives (for specific considerations on participant observation see Hennink, Hutter & Bailey 2011). The application of the instruments is illustrated by description of two infrastructure projects. Subsequently in section 4 we analyse the extent to which the establishment of practical instruments relates to our theoretical framework. Finally, the paper concludes with recommendations for road infrastructure planning practice that we derive from our analysis.

2. Changing functional and spatial scopes

The paradigm change in Dutch infrastructure planning – from traditional approaches, based on instrumental rationality, towards more integration of road infrastructure planning and other land use functions (Priemus 2007) – can be observed in different manners. A specific way to analyse these changes is the policy arrangements approach, which distinguishes between a substantial perspective and an organizational perspective on policy arrangements (Arts, Leroy & van Tatenhove 2006, Tatenhove, Arts & Leroy 2000, Arts, Tatenhove 2004). This approach allows for analysis of the interaction between

substance and *organization* of policy arrangements, as well understanding the development of policy arrangements. From an organisational perspective its focus is on *policy coalitions*, *power and resources*, and the *rules of the game*. Considering the current developments in Dutch road infrastructure planning from this organizational perspective, new demands for inter-actor collaboration become clear (Healey 2006, Teisman, Klijn 2002). In line with general trends in planning, away from central and top-down government, a movement towards network governance (Nooteboom 2006, Torfing 2005) is increasingly relevant in road infrastructure planning. Furthermore, in order to accommodate efficiently for such a change the current set of planning instruments and procedures – that provide incentives, manage conflicts and cooperation and reduce uncertainty in planning (Edquist 1997) – may require modification. However, in this paper we approach the changes primarily from a substantial perspective, dealing with “the way [...] problems are redefined socially and politically”, which is done through discourse: the dynamic ensemble of concepts, principles, objectives, etc. (Tatenhove, Arts & Leroy 2000).

In this paper we explore what the implications of the described changes are for the content of plans and designs. For this purpose, our substantial perspective consists of a functional scope and a spatial scope, which are first of all explored separately. First of all, the *functional scope* of road infrastructure planning issues changes (Priemus 2007, see also Visser 2011, Evenhuis et al. 2010). Traditionally, the regulation of land use in the Netherlands has been a sectoral affair with individual policy sectors defining their own sectoral spatial policy, including sectoral procedures, instruments and funding. However, within the complex context of planning in the Netherlands, working in policy ‘silos’ leads to inter-sectoral conflicts and overruns in costs and time. Integration of different functions in policy and comprehensive plans is expected to overcome these problems through the different synergetic benefits it has to offer. The concept of synergy relates to the idea that the coordination of activities creates additional – financial or non-financial – value for the individual activities and a higher overall outcome that would not have been created without coordination. Synergy can be understood as the effect of collaboration leading to “added-value [or collaborative advantage (Huxham 1996)] to the actors involved or the increased coherence between the node and place characteristics of the location, in its turn resulting from their collaboration” (Peek, Louw 2008). Founded on Van der Heijden’s theory on the combination of societal functions, three concrete principles for functional integration, leading to synergy, can be distinguished (Van der Heijden 2010).

- Parallel integration: doing activities that can be done at the same time simultaneously. In planning for land use this implies allowing for simultaneous emergence of different land use functions in comprehensive developments;
- Serial integration: doing activities in a logical order to get the most out of it. In spatial planning this stands for a reconsideration of the order or position of process elements within a planning process in order to optimize these processes;
- Simultaneous integration: sharing resource streams and integrated budgeting in order to keep the costs of planning, realization and management down through increasing the efficiency of investments.

Relating these theoretical principles for integration specifically to the focus of the paper, a distinction can be made on the purposes of the principles. The first two principles may create additional value to actors involved in planning processes: the outcomes of the planning process may have a higher value to actors involved due to enhanced coordination of the specific functions involved. The third principle is primarily aimed at saving costs for the actors involved. Ideally, achieved additional financial values “are not taken out of a project but are reinvested to enhance the quality of the plan” (Priemus 2007, Smolka, Furtado 2002). Societal functions that are considered suitable for integration with road

infrastructure objectives are for example housing, business, energy, public transport, water, nature, recreation and agriculture.

Regarding the *spatial scope* of infrastructure developments changes can also be observed. Within a regulation-guided and engineering-oriented planning system, planning of roads traditionally took place within narrow corridors, requiring compensation and mitigation measures to allow developments to proceed. The definition of planning areas of contemporary integrated infrastructure and spatial development issues increasingly conflicts with traditional administrative borders (Bertolini 2009). A narrow scope may not only add to the complexity of the planning process, it also implies that opportunities for making road infrastructure development more sustainable, from the perspective of holistic development (covering environmental, economic and social aspects), are missed. Allmendinger et al. have argued for a more flexible spatial development perspective that allows for developments to take account of these ‘soft spaces’ and ‘fuzzy boundaries’ caused by the demands of our highly dynamic society (Tewdwr-Jones, Allmendinger 2006, Houghton, Allmendinger & Vigar 2010). This flexibility allows for the ability to make policy and plans interacting between different political and administrative levels: multi-level governance (Bertolini 2009, Hooghe, Marks 2003, Salet, Thornley 2007). In infrastructure planning practice, approaching planning issues in an area-oriented manner links in with this as it implies giving regard to the embedding of an infrastructural issues in diffuse relational systems (such as the local context of place and the wider context of the road network). Furthermore it allows for local stakeholders to participate on a relevant level of scale in accordance with specific local interests and discussions (Heeres, Tillema & Arts 2011). In doing so, area-oriented planning offers an opportunity to overcome the problems related to suboptimal area definition. Figure 1 is a visualization of the described expansion regarding functional and spatial scope of road infrastructure projects.

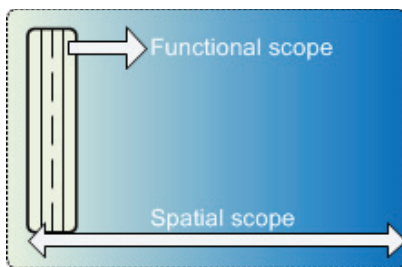


Fig. 1. Development of functional and spatial scope of road infrastructure projects in the transformation from traditional approaches to integrated approaches

In relation to a more sustainable perspective on road infrastructure planning the described changes – expansion of the functional and spatial scope – are promising in the sense that they seem to link up to contemporary holistic perspectives on sustainability, such as the Triple Bottom Line. Various authors consider such holistic visions on sustainability a crucial factor in the challenging fundamental transformation towards a sustainable spatial planning practice and avoiding the use of the concept as a fuzzy “catchall term” without any operational merit (Gunder 2006, Healey 2007). However, as Triple Bottom Line was merely intended as a way of thinking or a philosophy (Vanclay 2004), further operationalization of this interpretation of sustainability into concrete interpretations is required. The establishment of area-oriented planning approaches in the Netherlands can be regarded as such an attempt.

In order to optimize the effects of infrastructure-land use integration, the focus of the integrated planning processes is first of all on the early stages. Samset (Williams, Samset & Sunnevåg 2009) refers to these stages as front-end governance in projects, when degrees of freedom are large and allow for

strategic and conceptual choices to be made. The front-end phase – between initial idea and the final decision to finance the project – allows for conceptual thinking in which “the focus is on economic and social aspects, rather than technical aspects” and where “the anticipated effects of a perceived project” can be leading “rather than the present undesired situation” (Williams, Samset 2010).

3. Planning practice: tools and projects

In the Netherlands the responsibility for transport policy and planning of main roads is with the Ministry of Infrastructure and the Environment, who has delegated the operational tasks to its executive agency, the Department of Transport, Public Works and Water Management (Rijkswaterstaat). In order to operationalize the earlier described transformation towards a sustainable road infrastructure planning practice Rijkswaterstaat, who is responsible for planning and realization of both road and water infrastructure, has identified *sustainable area development* surrounding its road infrastructure network as one of the core themes in its sustainability strategy. For this purpose several developments are taking place within Rijkswaterstaat. The following sections use the establishment of a specific instrument for sustainable area development in two ways for illustration and analysis of these developments. In section 3.1 the focus is on the establishment of this instrument for sustainable area development in road infrastructure planning. In section 3.2 the described instrument is applied for the analysis of developments regarding the functional and spatial scope in a case study of two large infrastructure planning projects.

3.1. ‘Omgevingswijzer’: the development of a sustainability instrument

In order to understand how an infrastructural issue is embedded in a broader functional-spatial context and what the potential is for integrated area-development, a specific sustainability appraisal instrument is currently under development in the Netherlands. The purpose of this instrument – ‘Omgevingswijzer’: an integrated assessment tool for sustainability potentials of planning initiatives – is to gain concrete insights into the potentials for sustainable area developments around road infrastructure issues. Therefore the instrument explicitly considers (a) what potential for infrastructure-land use integration exist and may lead to the creation of additional value, (b) which actors would be involved in these processes of integration and (c) what the role of Rijkswaterstaat would be to allow for such integration. For this purpose the instrument consists of two main elements: firstly, a tool that visualizes spatial-functional effects and potentials for synergy in sustainable area developments and, secondly, a linkage between project organization and the relevant stakeholder environment of the integrated project. Relating to the aim of this paper, our primary focus is first of all on the first element. The Omgevingswijzer works by comparing different project development alternatives on 12 different indicators of sustainability. The main purpose is not to provide quantitative insights, but rather to start a discussion on the potential infrastructure-land use integration. Therefore, the indicators represent a broad perspective on sustainable development that originate from the three pillars of the triple bottom line. Furthermore, by comparing early strategic principles and aims with concrete development proposals the instruments also allows for a consistency check on projects as they progress towards establishment of final proposals. In practice, project alternatives are rated on sustainability characteristics by means of available policy and project documentation and by using standardized interviews questions. An overview of the indicators used can be found in figure two.

The outcomes of this examination are visualized in a ‘synergy wheel’. This is not unique, it seems to resemble other recent initiatives regarding the assessment of sustainability effects. The use of a wheel (figure 2) allows for an accessible and comprehensive overview of sustainability effects and provides

insight into the relative positive and negative effects of different alternatives (see also the development of the Adaptive Capacity Wheel: Gupta et al. 2010).

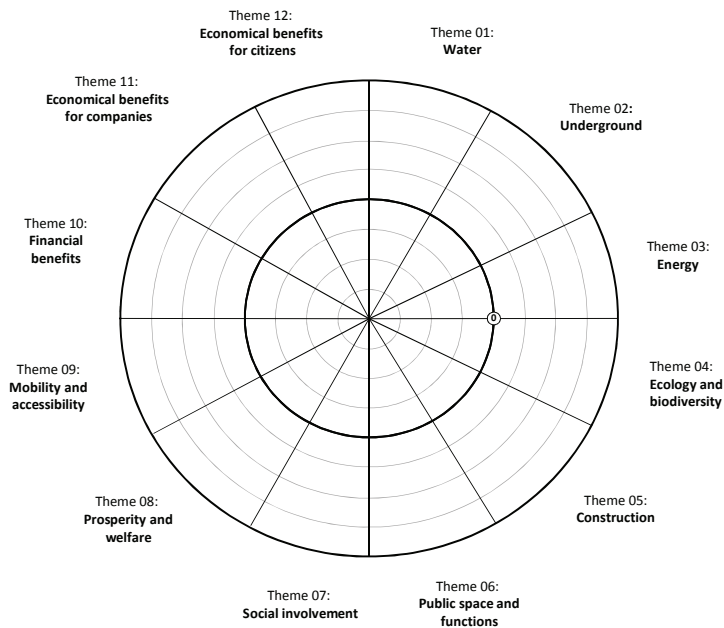


Fig. 2. The 'synergy wheel' with 12 indicators of sustainability (translated from RWS 2011)

A filled in wheel show on which pillar of sustainable development the focus in the explored integrated development alternatives is and which pillars may require attention. Green shading on a theme means that this theme is positively influenced by the examined alternative; red shading on the other hand indicates that there are possible negative influences. Scores are accumulations of potential positive and negative influences identified through the interview questions on certain themes. To prevent loss of nuance, the wheel allows for showing positive and negative influences simultaneously on either side of the zero line. The scores in the wheels indicate which themes are strong point and for what themes advancements can still be achieved. Scores are not intended for interpretation in absolute sense, but rather comparison between development alternatives and to check consistency of early strategic plan and later proposals. Finally, the wheels are also helpful in identifying what stakeholders should be involved in the integrated process of infrastructure and other land use development aims.

3.2. Case studies: two major infrastructure projects

To assess and improve the application of the developed instrument, the 'Omgevingswijzer' is currently being tested in pilot projects, relating to both road infrastructure and water infrastructure. To show the results and potential of the instrument two preliminary pilot projects are selected for presentation here: one that combines road infrastructure with opportunities for spatial development and one co-development

project of a canal, nature and recreation. In this paper these pilot projects serve as an illustration of the potential broadening of the scope of infrastructure projects.

First of all, the A1-zone program aims to enlarge the capacity of one of the major highways in the Netherlands on stretch 70km in the eastern part of the country. It is an important connection between the Randstad-area and Germany. The aim of the program is to utilize opportunities for the region that originate from the capacity enlargement of the road. Regional opportunities that have been identified are the enhancement of spatial quality and sustainability, as well as better exploitation of the region economic potential, from which ten core issues have been identified. The spatial definition of the area that is involved seems to be first of all dependent on the administrative territories of the municipalities that are cooperating within the program.

Secondly, the Zuid-Willemsvaart project comprehends the realization of a new waterway (7 km) to replace an older canal with a new section that is suitable for larger ships. This project is part of a larger waterway project that aims to increase the capacity of waterway system in the south of the Netherlands. Where the new section of waterway passes between the city of 's Hertogenbosch and the town of Rosmalen required construction works are expanded by the local municipalities with the development of an ecological zone, including nature and recreational facilities. The construction of a piece of national infrastructure is seized to provide for a local desire.

Table 1. Infrastructure-land use integration projects compared

Project	A1-zone	Zuid-Willemsvaart
Infrastructure type	Highway	Waterway
Current phase	Explorative studies (front-end governance)	Realization
Objectives	Combination of infrastructure and spatial objectives on a regional level of scale to enhance spatial quality, sustainability and economic potentials	Construction of a new waterway in combination with the creation of an ecological zone, including nature and recreation facilities
Direct reason of planning proposal	Capacity increase	Capacity increase
Functional scope	A bundling of existing projects on infrastructure, housing, business, water and recreation	Water infrastructure, nature, recreation
Spatial scope	Zone around highway A1 between Apeldoorn and the border with Germany (ca. 70km x 5km)	A 7 km stretch of new waterway and the area between the city of 's Hertogenbosch and the town of Rosmalen (ca. 7km x 1km)
More information	http://www.a1-zone.nl	http://www.rijkswaterstaat.nl/

The results of the explorations for these integrated infrastructural developments are visualized in figures 3a and 3b. The initiative for the A1-zone shows a general improvement on all themes, with strong emphasis on economic improvements. This seems to be in line with the intention of the program to stimulate the economic position of the region, accompanied by spatial quality and sustainability. Regarding the Zuid-Willemsvaart, also a broad distribution of positive effects is observable. This implies that the realization of the new waterway is a drive for the quality of the area as a whole.

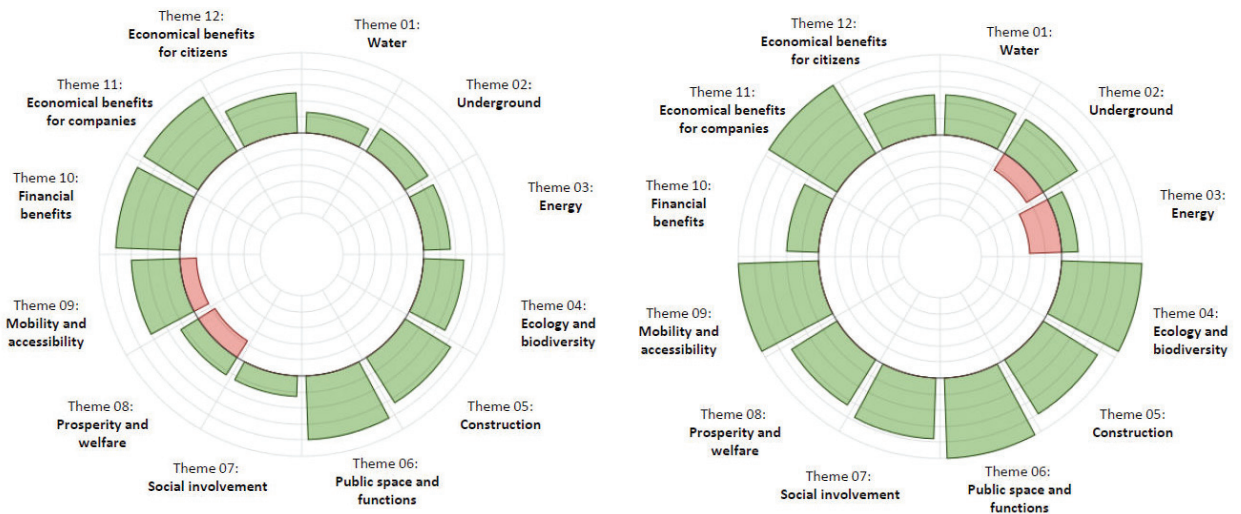


Fig. 3. The 'synergy wheel' for the explored developments: (a) A1-zone & (b) Zuid-Willemsvaart

4. Analysis/discussion

The application of the instrument 'Omgevingswijzer' may increase the insight into opportunities for integrated and synergetic development. It is a very visually oriented tool that provides a clear insight into the sectoral strengths and weaknesses of different development alternatives.

4.1. Functional scope

With regard to the changing scopes of proposed developments, the benefits of implementation of the instrument seem to be first of all adhering to the functional scope. The instrument clearly recognizes the significance of this dimension of infrastructure-land use integration. First of all, the choice of the indicators seems to provide a first insight into the possible synergies of combining policy sectors. Linking back to the proposed framework with different types of integration, the application of the instrument, with its ability to point out possible sectoral combinations, seems to closely adhere on the principle of parallel integration. It remains however difficult to determine the influence of variation in individual sector developments on the integrated effects of a specific proposal. Therefore it remains hard to define in what way individual themes strengthen each other and determine synergetic effects that give regard to the relational dynamics that are connected to a location.

Secondly, when the wheels are connected to other tools that can relate the outcomes to stakeholder management, there also seem to be opportunities for simultaneous integration. In order to achieve this relevant actors need to be involved to create a system of shared budgets, resources and task allocation in relation to opportunities for integrated functional development.

Finally, the opportunities for serial integration in the process of realization seem to be less distinct, since the instrument does not explicitly relate consecutive realization phases. The instrument is first of all focused on developments in the early – front-end – planning phases.

4.2. Spatial scope

Regarding the spatial scope of developments the instrument does not provide a profound insight since it does not contain any provisions for the spatial definition of the area. As a consequence, the instrument appears to be rather vulnerable to variations in spatial scope. Infrastructure planning has a typical line-oriented nature, while planning for other land-use functions is typically place-bound. Consequently, the effects experienced on different themes may be recognized on different levels of scale: e.g. economic or transport effects often have a spatially larger impact than social or environmental effects, which are experienced more locally. An issue that needs to be explored therefore, is whether the spatial scope of a project or program follows from rigid administrative jurisdictions or tries to link up with an optimized functional scope. Regarding this issue it seems advisable to take into account considerations of authors such as Healey (2006) on the theme of relational dynamics and complexity, or Brenner (2004) on the theme of new levels for planning interaction. It seems important to define the spatial scope in relation to the context of every specific case, as scale of development may otherwise turn out suboptimal. This implies that planning intervention takes place from a dynamic multilevel perspective.

4.3. Front-end governance

Finally, anticipating on the discussion regarding optimization of sustainable area development, we find that the ‘Omgevingswijzer’ is in line with theoretical thoughts on front-end governance. The instrument focuses on the early planning phases – i.e. on the agenda setting, before the official start of the planning process, and on the subsequent explorative studies, before the preferred alternative decision and complementary budgetary allocations (see also figure 4). Implementation of the instrument in these phases allows for the necessary strategic freedom to seriously consider different conceptual solutions. Furthermore, by distinguishing between different early phases – pre and post start decision – the ‘Omgevingswijzer’ allows for monitoring of consistency of early plans – agenda setting – and later proposals, such as the preferential solution. Early strategic choices, often on regional development directions, are made in the agenda setting phase and are desirably leading for later proposals. The ‘Omgevingswijzer’ has the capability of monitoring this consistency.

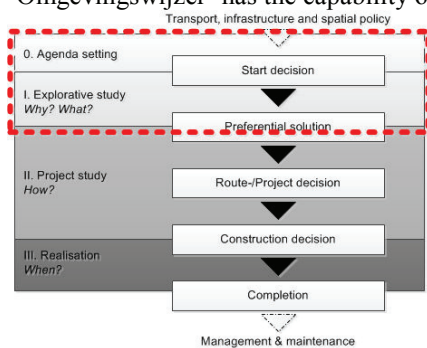


Fig. 4. The Dutch infrastructure planning process, with the early stages outlined

5. Conclusion

In order to promote sustainable road infrastructure planning, Dutch planning practice increasingly aims to create and exploit the links between road infrastructure planning and further spatial developments. By betting on what is often referred to as area-oriented planning or area development, road infrastructure-land use integration is becoming a core theme in the sustainable planning debate (Heeres, Tillema & Arts

2011) and links to more holistic thoughts on sustainable development. In this paper we have explored the functional-spatial dimensions of road infrastructure-land use integration as a means to promote sustainability in road infrastructure planning. In order to do so, we have used experiences gained from planning practice, by focusing on a newly developed sustainability instrument called ‘Omgevingswijzer’.

It appears that with respect to the substance of plans and designs especially broadening of the functional scope of projects can be observed. There is a growing awareness that synergy through the combination of different planning sectors can lead to additional value. However, planning practice does not seem to be completely adhering to the differences between various types of integration as defined in our theoretical framework. Taking into account the difference between types of integration may improve the merit of synergy-thinking in infrastructure and land use planning. Furthermore, it remains very hard to engage in quantification of the value of these synergetic effects. Current identification of possible synergies remains on the level of identifying opportunities, which is already a first leap forward.

Due to the emphasis on functional scope, planning practice seems to be less focused on the spatial scope. Although the application of the ‘Omgevingswijzer’ has shown us that definition of the spatial scope is an influential aspect in integrated approaches, this issue does not take an important place in the planning debate. This may imply that spatial scoping is not seen as problematic. However, such conclusion would be premature; it is at least something to examine more specifically. From a theoretical point of view, with a lack of consideration regarding the spatial scope, the results of planning and specific instruments, such as the “Omgevingswijzer”, may become rather unclear and may be less valuable to the planning process.

It appears that closely related to the functional-spatial side of integration between road infrastructure and other land use functions are processes of inter-actor collaboration. The application of instruments such as the ‘Omgevingswijzer’ provides an excellent opportunity to bring relevant stakeholders together by making a connection between substantial and organizational considerations. Consequently, these stakeholders must be induced to actively involve themselves in integrated planning processes. This requires the creation of incentives and efficient systems of collaboration, especially when the overall integrated benefits are clear but benefits of integration for individual stakeholders remain disputable. Therefore the organizational side of the integration of infrastructure and land use policy arrangement is an challenging direction for further research in sustainable road infrastructure planning.

Finally, with respect to the implementation of sustainable developments in the planning process, the focus of infrastructure-land use integration is currently in the early stages of the planning process. Being in line with our theoretical framework, this should – if applied well-considered of the importance of front-end governance – provide fruitful opportunities for co-development of sustainable integrated development concepts.

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