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Martin Schmidt, Jochen Monstadt

Infrastructure

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Leibniz Association

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Infrastructure

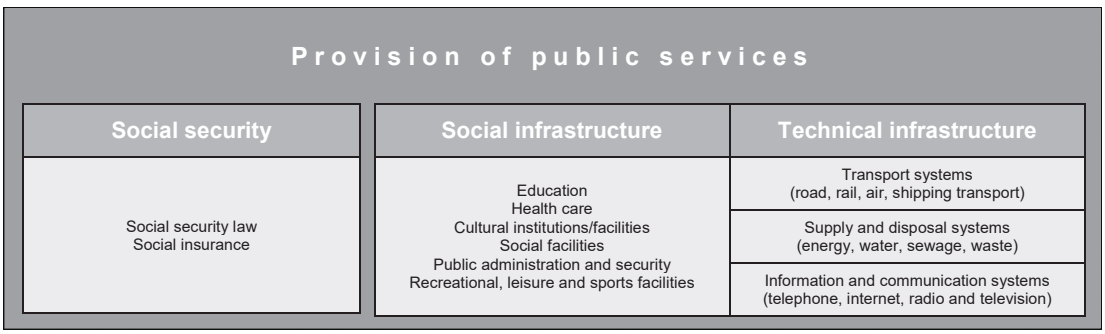
Contents

The German infrastructure debate is shaped by economic perspectives and often neglects the specific features of the two subareas of social infrastructure and technical infrastructure as well as coordination problems both between the various divisions of infrastructure planning and with comprehensive spatial planning. Given the current challenges, the scientific and planning approaches to infrastructure development should be critically examined.

1 Clarification of the term

The term *infrastructure* describes facilities and systems for both individual and collective beneficial use and which influence the economic development, social coexistence and sustainable environmental development of a space. Along with social security, infrastructures make up the key component of the ▷ *Provision of public services* (see Fig. 1). Infrastructure systems are characterised by special economic and/or technical features. In accordance with traditional assumptions, these are difficult to provide via the market and require specific institutional regulations. With ▷ *Social infrastructure* and ▷ *Technical infrastructure*, the umbrella term *Infrastructure* comprises two categories that share a number of fundamental characteristics – e.g. certain essential functions for modern societies and the state's responsibility for guaranteeing and funding them – but otherwise have significant differences. Social infrastructures include education and healthcare, social, cultural, recreational, leisure and sports facilities, public administration and (in quite controversial interpretations) social housing (cf. Zapf 2005; Tsohatzopoulos/Gliwa/Nagl 2011). Technical infrastructure is divided into transport (▷ *Transport infrastructure*), information and communication systems (▷ *Information and communication technology*) and utilities systems (▷ *Utilities*), which in turn includes water supply (▷ *Water management*) and the ▷ *Energy industry* (electricity, gas, district heating, etc.) as well as sewage and waste disposal (▷ *Waste management, recycling*) (cf. Jochimsen 1995; Frey 2005; Tietz 2005).

Figure 1: Infrastructures and provision of public services



Source: The authors

Infrastructure facilities have particular features, entailing special requirements when it comes to provision and maintenance as well as management, oversight and funding (cf. Libbe/Köhler/Beckmann 2010: 50). For example, the provision of infrastructure involves a high level of state regulation, the production of goods and services and, in some cases, public funding. Beyond this however, technical infrastructures differ from social infrastructures in their patterns of development and other features, such as the way in which they are shaped by location-bound technical artefacts and supply networks, their high fixed costs and socio-technical path dependencies.

In terms of function, infrastructures form the foundation for the realisation of basic public service functions for the individual as well as the economic and political activity of communities, i.e. they allow modern societies to function. Infrastructure is a basic indicator of the ▷ *Equivalence*

of living conditions aspired to by the constitution and thus plays a key role in spatial cohesion policies. Traditionally, a major objective of state infrastructure policy has therefore also been to compensate for spatial disparities (▷ *Disparities, spatial*). However, besides structural policy objectives, infrastructures also perform environmental, social, democratic and symbolic functions, as well as functions relating to budgetary policy (cf. Naumann/Moss 2012: 5 et seq.).

In accordance with the guarantee of self-government as per Article 28(2) of the Basic Law *(Grundgesetz, GG*), much of the responsibility falls to local authorities (▷ *Local self-government*). Mandatory local self-government responsibilities include the construction and running of schools as well as waste and sewage disposal, whereas the provision of most cultural and social facilities (e.g. theatre, welfare centres and sport complexes) are voluntary self-government tasks. Responsibilities here are distributed within the municipal territorial authorities (▷ *Territorial authority*) between towns or local authorities (for example water supply and sewage disposal as well as child care facilities) and districts or urban districts (e.g. waste disposal, schools and emergency services).

2 Development of the infrastructure debate in Germany

The scientific debate on infrastructure has in many ways reflected the political and societal developments of each decade (for a full account c.f. Schmidt 2013). Although infrastructure has always been closely linked to societal development, the term 'infrastructure' in Germany was first extricated from its purely military usage in the 1960s, when economic research started to work with the term.

2.1 Descriptions of the term and function of infrastructure in the 1960s and 1970s

The view of Jochimsen (1966), who provided the explanatory model for the functioning of a market economy in the mid-1960s, is seminal: Jochimsen defined infrastructure as 'all of the material, institutional and human capital facilities and circumstances available to an economy based on the division of labour […] which thus [constitute] the basic functions of an economy necessary for growth, integration and utilities' (Jochimsen 1995: 490). Material infrastructure means physical/built structures and resources (cf. Jochimsen 1966: 103-133), whereas institutional infrastructure refers to standards, facilities and policies, and human resources infrastructure refers to human capital. This economic origin of infrastructure as 'the foundation of a political economy which is the premise for the creation, distribution and use of goods and services' (Frey 2005: 469), as well as the different types of infrastructure outlined above, have frequently been cited and expanded upon (cf. e.g. Buhr 2003), shaping the debate in the long term. Even at an international level, infrastructure has hitherto been considered the foundation of economic activity (cf. Smith 2011) or at least it is assumed that there is a close correlation between infrastructure and the level of economic activity (cf. Good-man/Hastak 2006: 1.10).

Stohler (1965: 281) goes on to describe further important features of infrastructures of a technical (long life, indivisible and location-bound systems, etc.), economic (high investment and fixed costs, long payback periods, economies of scale and scope, etc.) and institutional nature

(very close to the state). While it is true that these features primarily apply to the traditional configurations of technical infrastructures, a coherent role of the state was derived from this with regard to the social and technical infrastructure areas when social planning was professionalised in the mid-20th century, with the state taking on an official planning and governing function. Due to an imputed market failure, only the state can be responsible for the planning and financing as well as the construction and operation of infrastructures (cf. Schmidt-Relenberg 1968: 43).

State investment in infrastructure policy was deemed necessary in the 1970s (e.g. expansion of universities and sewage systems). Thus 'infrastructure policy [was considered to be] growth policy' (Vosgerau 1970: 29) and infrastructure measures were seen as 'the main instruments of public planning for managing spatial development' (Wegener 1980: 35). Developing social and technical infrastructure was considered the guiding principle of social policy (cf. Bode 2013: 32) and as a means of steering spatial planning to compensate for regional disparities (▷ *Spatial planning (Raumplanung)*). Guideline values and schemes for planning and operating infrastructures directed the strategic organisational procedure both for technical infrastructure systems and public social amenities – for example by determining land requirements, accessibility and percentage shares of the urban land area (cf. Frey 1972; Borchard 1983). Increasingly, infrastructure was considered not just important for the ▷ *Choice of location* on the part of businesses, but also for the location preference of households, and a distinction was made between enterprise-oriented (productive) and household-oriented (consumptive) infrastructure (cf. Frey 1979: 20 et seq.).

2.2 The changing, broadening discourse in the 1980s and 1990s

While these types of approach can be interpreted as a differentiation of existing debates, the discourse fundamentally changed in the 1980s. Firstly, the focus shifted to the boundaries of integrated planning, which in practice had always had to give way to a 'juxtaposition of departmental planning on the one hand and the planning at federal levels on the other' (Pfaff/Asam/Behnken et al. 1980: 12). Secondly, the negative external effects of technical infrastructures and the resulting environmental crises became the focal point of a growing protest movement. There was a departure from pure infrastructure development as the focus shifted to the management, preservation and the adaptation of existing infrastructures (cf. Beckmann 1988: 67, 71). Obviously flawed dimensioning and possible adaptions were discussed (cf. Henckel 1985), with civil and planning engineers adding to the economic debate to a growing extent.

The debate of the 1990s was characterised by a greater distinction between social and technical infrastructures. In the area of social infrastructures, priorities appeared to shift towards human-capital-based infrastructure (education and training and knowledge transfer facilities) (cf. e.g. Klemmer 1993: 985), and the extent to which disparities in the provision of social infrastructure adversely affect individual population groups was examined (cf. Schön 1990) (▷ *Social infrastructure*). Even though typical models of an investment-based, supply-side infrastructure policy initially experienced a renaissance in the early 1990s due to '*Aufbau Ost*' – the German 'reconstruction of the East', mainly in the area of technical infrastructure – there were also signs of moderate change. Firstly, demands for a departure from spatial equalisation and distribution policies towards the promotion of regional growth centres became louder. Secondly, the debate around sustainability in technical infrastructures in particular put the processes of commercialisation, ecological renewal and technical innovation as well as options for adapting to changed spatial framework conditions on the agenda. Furthermore, the ▷ *European Union*

adopted initiatives as part of its domestic market policy to deregulate the telecommunications, electricity, gas, rail and postal markets, with the legal, policy and planning sciences increasingly scrutinising the form and scope of the state's responsibility for guaranteeing the provision of these services (cf. Hermes 1998; Grande/Eberlein 2000; Monstadt 2004). For example, the creation of infrastructure services by the state and local authorities was challenged and a shift from the state as provider to the state as guarantor was later identified. In addition to the German concept of ▷ *Provision of public services (Daseinsvorsorge),* the terms 'services of general/general economic interest' appeared in Green and White Papers by the European Commission in the context of safeguarding social and environmental standards on deregulated markets (cf. Krautscheid 2009).

2.3 Changing conditions and use of term from the 2000s

Alongside further discussion of growing EU influence (cf. entries in *Schader-Stiftung* 2001), three trends have set the course for the development of infrastructure since the 2000s. Firstly, the increasing financial constraints of public budgets and the corresponding fiscal reforms have become apparent (cf. Bogumil 2011: 65). Given rising social benefits, the economising of public administrations and the expansion of municipal responsibilities, local authorities in particular have had to cut back on voluntary social infrastructure services (cf. Holtkamp 2011: 16). While the education sector continues to be dominated by the state, the healthcare sector has seen a growing share of private hospital operators entering the market alongside public and charitable providers (cf. Libbe/Köhler/Beckmann 2010: 59 et seq.). Secondly, the environmental modernisation of technical infrastructures, in particular in relation to ▷ *Climate protection*, has become a field of action for local authorities and regions (▷ *Region*). Thirdly, demographic changes (▷ *Demographic change*) have brought about new demands with regard to the funding, accessibility and technical implementation of infrastructure services in both social and technical infrastructure (cf. Koziol 2004; Kloß/Bieber 2008). These developments have shaped the infrastructure debate in the first instance by making a greater distinction between real-capital-based (transport networks, public utilities, etc.), human-capital-based (training capacities, knowledge transfer facilities, etc.) and budget-based infrastructures (social and cultural facilities), with social infrastructure in particular being deemed to be of 'fundamental significance' in the competition between locations alongside transport (cf. Federal Office for Building and Regional Planning *[BBR]* 2005: 109).

Technical infrastructures have increasingly been discussed as agents of ecological material flows (cf. Monstadt 2009), but also in terms of their role in adapting to climate change (▷ *Climate, climate change*). At the same time, attention has increasingly turned to users in their role as customers with choice and potentially co-producers. In addition, the discussion has shifted from regarding infrastructures as an instrument of regional structural funding to their competitive and political restructuring and the associated spatial effects (cf. Graham/Marvin 2001). From the point of view of infrastructure planning, aspects of the protection of critical infrastructures (cf. e.g. Lauwe/Riegel 2008) (▷ *Resilience/robustness*; ▷ *Vulnerability*) have become an issue, as well as the management of major infrastructure projects, which goes hand in hand with a changed understanding of planning (participation-based instead of top-down planning) and a new role for the players in infrastructure planning (cf. Flyvbjerg 2007).

In recent years, the theory and practice of planning has once again linked the term 'infrastructure' with a more pronounced social understanding of public service provision (cf. Libbe 2009; Neu 2009). Despite this broadening of the discussion, economic perspectives

in the sense of the 1960s understanding of infrastructure as a foundation of modern national economies continues to dominate the German infrastructure debate. This has predetermined the views of other disciplines – for example, its introduction into the debates on social planning and the welfare state (cf. Bode 2013: 31) – and has placed the focus on the economic effects of infrastructure investments (cf. Moss 2011: 76) to the detriment of social, ecological and cultural effects. The fact that social and technical infrastructures are two areas that are subsumed under one umbrella term should be assessed critically: while it is true that they are together significant for growth and cohesion policies, and are often organised in proximity to the state, this does not sufficiently take into account important differences between the infrastructure sectors with regard to their institutional (and technical) characteristics, their patterns of development and innovation, their cultures of provision and how the state performs which duties.

3 Infrastructure and spatial planning

In accordance with the close reciprocal supply relationship between infrastructure and the respective ▷ *Space*, expectations of infrastructures in managing the desired ▷ *Spatial development* are traditionally high, as are the demands on ▷ *Spatial planning (Raumplanung)* for the across-the-board coordination of infrastructures.

3.1 Infrastructure planning

As with 'infrastructure', there is no standard definition of the term 'infrastructure planning'. In reference to technical infrastructure, it includes heterogenous planning activities (cf. Moss 2011: 77): (1) measures by various state levels within the framework of regional economic policy in particular to promote structurally weak areas (▷ *Regional economic policy*); (2) sectoral planning by local and national authorities (for example the creation and implementation of sectoral plans and strategies and their coordination with spatial planning; ▷ *Spatially-relevant sectoral planning*); (3) internal plans by utility companies (as advance provision for the aforementioned municipal/national plans and as strategic plans (▷ *Strategic planning*) in the sense of corporate objectives). Following on from Becker and Wendt (1977), Moss (2011: 79) describes the duties of infrastructure planning as the technical and social ▷ *Provision of local public infrastructure* to territories, which should enable the best possible use of space to ensure the access of all users (households, businesses, public institutions, etc.) to reliable, comprehensive, affordable and sustainable infrastructure services. According to Beckmann (1988: 78), infrastructure planning has four objectives: (1) the development of land for anthropogenic uses, (2) the management of functional and spatial differentiations, (3) the safeguarding of participation options (specific to both sub-regions and players) as well as (4) the management of anthropogenic environmental uses.

The ▷ *Planning* of infrastructures is highly fragmented within the technical and social categories and is very diversely organised according to sector. Overall, sectoral infrastructure planning is not standardised and takes place on the basis of sectoral duties and measures (cf. Reitzig 2011: 387). It has been described as highly fragmented from as far back as the 1970s (cf. Zohlnhöfer 1970: 705). As early as 1983, Kühn (1983: 434) criticised the lack of qualified staff, far-sighted strategies and the relevant capacities in urban administrations for the planning of social

infrastructures. Huge differences can be seen in sectoral infrastructure planning in terms of both the responsibilities and the extent to which they are rooted in institutions, as well as in the huge diversity of players. Some infrastructure planning makes use of formalised procedures (such as in ▷ *Planning approval*), but for many (e.g. hospital requirements planning) neither the procedure nor its conclusive form (e.g. administrative act) is regulated. Even though local authorities may be responsible for an infrastructure service, sectoral planning can take place at state level, as is the case with sewage or even hospital plans (cf. Libbe/Köhler/Beckmann 2010: 92). Furthermore, planning within each sector varies immensely across social and technical infrastructures: the sectoral planning of social infrastructure is often characterised by the fact that it does not include any separate stipulations relating to land law (▷ *Land law*).

3.2 Infrastructural coordination through spatial planning

While it is true that early initiatives and large-scale urban planning (reconstruction) projects were rooted in the planning of infrastructures, and that technical infrastructure in particular was a point of reference for further ▷ *Urban development* and a structural basis for ▷ *Urban design* thanks to its networks and facilities (cf. Neuman/Smith 2010), sectoral infrastructure planning is nowadays not only discretely organised, but also often takes the form of downstream, reactive departmental planning. Consequently, such interests are only taken into account in spatial development planning at a late stage (cf. Moss 2011: 73 et seq.; Hühner 2011: 231 et seq.; Schiller/Siedentop 2005; Neuman/Smith 2010). However, spatial planning has the formal responsibility of coordinating how space is used by the individual areas of infrastructure and their interaction. In this respect, ▷ *Spatial planning (Raumordnung)* not only takes infrastructure issues into account, but also uses them in its strategies. Thus, social and technical infrastructures are an important aspect in the central-place theory (▷ *Central place*) as well as in point-axial development strategies. At the same time, however, spatial planning also finds itself in an inter-sectoral position to ensure cross-sectoral coordination of sectoral infrastructure planning (Einig 2011: 96). Spatially-coordinating comprehensive planning is expected to optimise the overall systems and the subsystems according to the ▷ *Settlement structure* (Tietz 2005: 1244) in order to achieve a spatial burden sharing and coordination of competing uses (cf. Tietz 2007).

There are various formal regulations here, which provide for a ▷ *Weighing of interests* and weighting of sectoral infrastructural issues for ▷ *Urban land-use planning*. Section 4 of the Federal Spatial Planning Act *(Raumordnungsgesetz, ROG)* and the spatial planning clauses in the individual sectoral laws ensure the implementation of spatial planning stipulations in the sector-specific infrastructure planning for supra-local spatial planning. However, coordination deficits in planning practice continue to arise. For example, in spite of its higher ranking authority, spatial planning is not usually actively involved in strategy, but rather often adopts existing sectoral infrastructural aspects by way of information only. Conversely, the provision of infrastructure is often criticised for being reactive 'containment planning' following behind settlement planning (cf. Schiller/Siedentop 2005: 83) without formulating its own spatial planning objectives. Overall, coordination between the infrastructure systems and with settlement development is made much more difficult by sectoral planning, which is highly sector-based and primarily geared towards business economics (cf. Tietz 2011: 6). Furthermore, 'diverging interests between planners and (private) infrastructure operators' are often reflected in a deficient 'information policy' (Moss 2011: 84). In particular given current challenges such as ▷ *Shrinking cities* and urban redevelopment,

however, long-term 'considerations on infrastructure and urban development in the context of city-wide strategies' (Libbe 2009: 31) are eclipsing the project-based cooperation of the past.

4 Outlook: trends and challenges

Considering current trends, social discussions and political objectives, the priority tasks in future will vary between and within the social and technical areas of infrastructure (as well as the coordination requirements between these). On the one hand social infrastructure facilities (such as child care) continue to shape the level of the small-scale locational advantage of municipalities. Furthermore, it is expected that the significance of social infrastructure services will grow in Germany as a result of global challenges such as crises and climate refugees, demographic change or immigration on the labour market. On the other hand, environmental objectives, resource conflicts, global environmental changes and aspects of the security of supply are turning attention back to technical infrastructure issues.

Current infrastructure planning has to grapple with the changes to demographic, financial and climatic conditions which are very specific at a sub-regional level. This requires individually and locally adapted infrastructural solutions and a 'paradigm shift in infrastructure provision' (Winkel 2008: 41). In particular the debates around demographic change, together with changed household structures, socio-spatial polarisation and changes in societal values (cf. Libbe/Köhler/Beckmann 2010: 199 et seq.), and the debate around spatially equivalent infrastructure across different regions will continue. In the case of social infrastructure, questions about the sustainability and (close-to-home) accessibility as well as the shift of services between the age-specific user groups must be resolved (cf. Schmidt 2010; Federal Institute for Research on Building, Urban Affairs and Spatial Development *(Bundesinstitut für Bau-, Stadt-und Raumforschung, BBSR)* 2012: 36-52). In the area of technical infrastructures, the viability, financial feasibility and (ecological) follow-up costs of the infrastructure which has, in most cases, been in place for a long time, must be examined. In the meantime, the wide range of innovative technologies which are ready for use and the market offer new possibilities for spatially adapted and environmentally-friendly supply solutions. All areas of infrastructure are faced with further financial challenges at an operational level as reinvestment and modernisation requirements rise (cf. Schneider 2009). Obstacles include the limited fiscal margins of the federal states (▷ *State finances*) and the local authorities (▷ *Municipal finances*), as well as the altered return expectations of private commercial and competitive infrastructure providers. Admittedly, the ▷ *Privatisation* of infrastructure provision has slowed down considerably in past years and the first infrastructure companies have recently been remunicipalised (cf. Becker/Beveridge/Naumann 2015). However, the trend towards the deregulation of infrastructure provision and the expansion of European domestic markets for infrastructure services continues. In the case of technical infrastructures in particular, the influence of the European Union on the market design, environmental re-regulation and the expansion of trans-European networks is likely to increase in future.

In this respect, the content and forms of national and subnational infrastructure policy and planning must be critically examined. At the same time, intersectoral coordination of the individual branches of infrastructure will have to take on a central role to enable sustainable spatial development objectives (▷ *Sustainability*), as well as a system transformation including

the entire energy, material, financial and human-capital potential. This means that strategic municipal infrastructure management and integrated spatial planning and coordination will become more important. This applies first and foremost within the technical infrastructures, but is also very relevant across all sectors, as is becoming clear from the dovetailing of public transport with changed health care and school locations (cf. Winkel 2009: 121).

Given the wide-ranging changes in the infrastructure sector, both the past relationships between the key players (state and local authorities, traditional and new infrastructure providers, users) as well as traditional service standards and solutions for towns and rural areas (▷ *Rural areas*) must be critically examined (cf. Moss 2010: 224). Not only will this present new challenges for infrastructure policy and planning, it will also put classic infrastructure theory to the test in terms of its traditional basic assumptions, categories and patterns of thinking. Future research and the players within politics an planning who are responsible for solving these challenges will have to pay particular attention to the heterogenous developments and characteristics of social and technical infrastructures.

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