

Article

Towards Local Sustainability of Mega Infrastructure: Reviewing Research on the New Silk Road

Hannes Thees 

Center for Entrepreneurship, Catholic University Eichstaett-Ingolstadt, 85072 Eichstaett, Germany;
hannes.thees@ku.de

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Abstract: The Belt and Road Initiative is the leading project in the regions along the ancient Silk Road. This aims to revive the New Silk Road (NSR) as a transnational space towards an era of new regional integration and globalization. Despite the potential economic effects on a global scale, local sustainability remains questionable. Building upon the central engagement in infrastructure improvements, this article aims to investigate the role of local sustainability in research along the New Silk Road. Starting with 597 scientific articles, this article conducts a systematic literature review on four levels of concretization to characterize the research field of the New Silk Road, and to develop in-depth insights systematically. The results reveal a research focus on economic growth, which is lacking in environmental considerations and especially the socio-cultural dimension of sustainability on a local scale. Future directions in local sustainability should therefore include local stakeholders to build a joint understanding of sustainability by recognizing the characteristics of regionalism upon which manifold local support of mega infrastructure can evolve. Given these findings, the New Silk Road emerges as a field of study that calls for interdisciplinary research on different spatial levels.

Keywords: New Silk Road; local sustainability; mega infrastructure; systematic literature review; Belt and Road; sustainable development; local impact

1. Introduction: The NSR and the Challenge of Sustainability

The “Belt and Road” initiative is the largest development and globalization program worldwide [1]. In 2013, the People’s Republic of China launched the initiative, which includes several overland corridors (Silk Road Economic Belt) and a maritime route (Maritime Silk Road). Connecting with the Ancient Silk Road, the Belt and Road aims to develop trade networks between Asia and Europe, but also towards Southeast Asia, Australia, Africa, and the Middle East. By 2019, 123 countries had officially joined the initiative [2]. Therefore, China promotes investments in different kinds of infrastructure in an export-led growth model, through various financial instruments. The countries or locations that are the focus of the Belt and Road investments are often involved in various global and local initiatives, and thus receive financial support from different countries. Therefore, here I apply the term “New Silk Road” (NSR) as a container for investments and developments in the respective regions that support international trade infrastructure.

Through the years of its operation, the Belt and Road has been subjected to various optimistic scenarios, but also criticism, as nowadays globalization is being challenged. People all over the world are critically assessing globalization because of protectionism, trade wars, or immigration stops, challenging the idea of globalism and a global community. This is combined with a shift in the political world order, wherein China is pursuing more integrated and inclusive globalization [3]. Beyond this, 2020 and the following years will challenge global connectivity and trade within the Belt and Road, as the global slowdown [4] during COVID-19 [5,6] could lead to a renationalization of value chains [7].

The impacts of globalization on local economies and societies are spatially different and influenced by local initiatives [8]. Although countries along the NSR see potential for economic development [9,10], the unclear local effects, a lack of transparency, fears around Chinese dominance, and the role of transit countries offer space for improvement [11–16]. Especially from a European perspective [17], the Chinese role in investments, infrastructure construction, and trade operations could hinder sustainable development. The considerable extent of infrastructure investments raises the complexity of the Belt and Road in the countries along the NSR; a complexity that requires us to steer between the Belt and Road, other international development projects, and local interests. Together with the need to balance infrastructure and its impetus for sustainability, the question arises:

How Has the NSR Been Researched with Special Consideration to Local Sustainability and What Are the Future Directions of Mega Infrastructures in This Context?

Given this question, the NSR serves as an exemplary research field. Regional studies, as well as multi-disciplinary research, should assist in finding pathways towards sustainability. Recent research on the NSR has been influenced greatly by edited volumes, for instance on globalization [18], transformation in Central Asia [19], financial implications [20], and geopolitics [21]. Within the many book publications, there has only been a little research on local or regional matters [22]. With the growing number of journal publications, the NSR is emerging as a diverse field of research.

Given the above local sustainability challenge of the NSR, this study aims to capture current research on the NSR and to gain insight into the discussion of local sustainability (Figure 1). First, the theoretical background addresses the importance of sustainability, within the specialties of mega infrastructure. Second, the methodology of this article is a systematic literature review [23,24], which is then also discussed in light of theoretical considerations. Finally, the study derives research pathways within the NSR to further shape local sustainability.

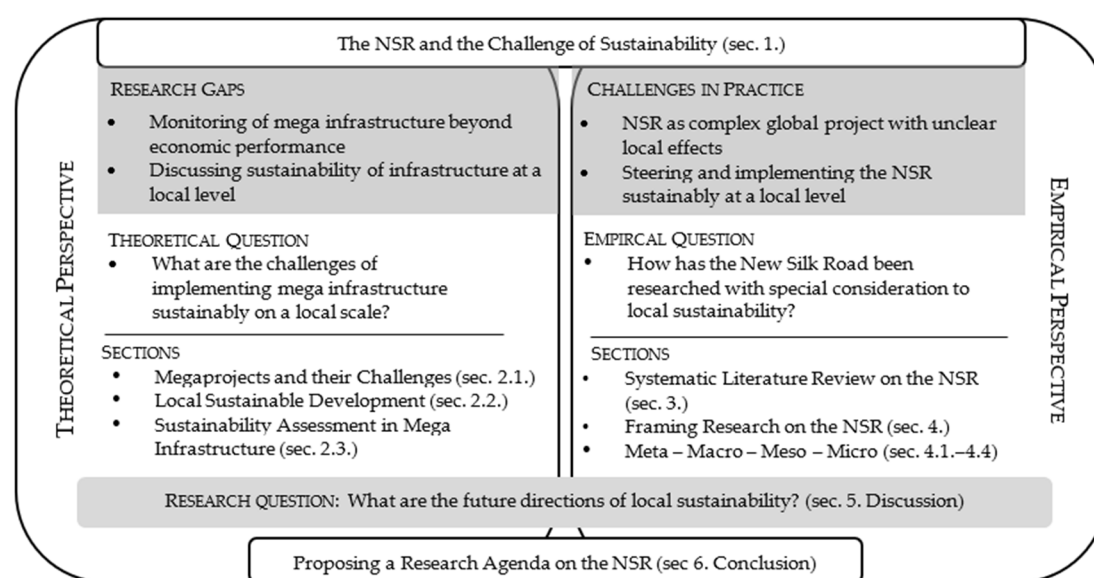


Figure 1. Research framework. Source: Own elaboration.

2. Theoretical Background: Sustainable Implementation of Mega Infrastructure

The conceptual options for the NSR are various. A range of concepts, theories, and disciplines are relevant as the NSR influences nearly all dimensions of life—including technology, economics, the environment, geography, businesses, politics, information and knowledge management, and socio-cultural aspects [1]. Such a holistic understanding meets the principles of sustainable development, even more so when the NSR is viewed from the perspective of the participating countries, exceeding the mere allocation of finance and the promotion of trade. In terms of sustainability,

there are a number of linkages to discuss within the NSR. However, as the research field on the NSR is still emerging, this article concentrates on the fundamental linkage between infrastructure and sustainability, and puts the focus on the local scale. This limitation on a central theoretical linkage opens space for future research to occur in a more integrative manner. However, the spatial focus on the local scale determines the disciplinary positioning of this article in local or development studies. Complementary to this, transport geography is the starting point of the theoretical considerations, as the NSR is dominated by mega infrastructure—especially when recognizing the economic size of the receiving countries. This is all the more relevant as the NSR exceeds the perspective of single national infrastructure projects as it is combining a whole set of transnational mega infrastructures.

2.1. Megaprojects and Their Challenges

Megaprojects are often perceived as drivers for long-term development, as they allocate capital and workforce, but also technological knowledge. Megaprojects are defined by investments of more than one billion USD, and have a long lifetime of about 50 years [25,26]. Further criteria involve high complexity, specified knowledge, widespread impacts, or multi-stakeholder involvement [27]. Megaprojects may include all kind of projects, but are strongly related to physical infrastructure (mega infrastructure), greater industrial production, or resource extraction (see modernization theory, e.g., [28]). Such physical infrastructure is typically a public good, in which governments are highly involved, and ranges from power supply, telecommunications, water and sanitation supply, education and healthcare, to freight and public transport [29–32]. Transport infrastructure particularly includes high costs and a long duration of construction [33]. By taking a historical perspective, researchers have agreed that infrastructure and specific transport infrastructure enhance performance, accumulate capital, support knowledge creation, create opportunities of production and trade, and serve social and economic development [30,34–36]. This relationship is also stressed as an accelerator of growth in developing countries [29,34,37,38].

Nevertheless, the ongoing hunger to increase economic growth calls for even more massive infrastructure investments, causing significant challenges, leading to questions regarding the overall performance of megaprojects [39]. The risks of megaprojects include cost, demand, the financial market, and political risks [25]. Flyvbjerg [26] extended this categorization by claiming ten challenges, including also conditions such as a high number of participants, multi-nationality, diverging interests, increasing costs over time, and changing regularities. Further, he mentioned weak project leadership, knowledge integration, cultural differences, extraordinary technology implementation, difficulty in performance evaluation and planning, and the occurrence of an external and unplanned crisis. All in all, megaprojects face divergence of desired and realized outcomes, as they are often promoted in an over-optimistic way as political symbols [25,26,39]. This is also reflected by current infrastructure projects that have received criticism, such as the Nord Stream 2 pipeline, the Stuttgart 21 railway station, the Grand Ethiopian Renaissance Dam, the Fehmarnbelt crossing between Hamburg and Copenhagen and Desertec in the Sahara region.

From a theoretical perspective, researchers tend to focus on understanding the dynamics of megaprojects, and are thus addressing multi-disciplinary research agendas “including management and organisation studies, but also history, anthropology, sociology, urban studies, engineering, and economic geography” [39]. From the perspective of development studies, new international economics, according to Krugman [40], are suitable for mega infrastructure. In particular, transaction costs, capability, social conflict theory, handling of the interface, cost theories, power, and innovation theories are addressed [32,39]. Against the background of the high complexity, Söderlund [39] called for increased research on the management and functioning of cooperation and coordination [39]. Although the challenges and the cooperative nature of megaprojects are obvious, research on multi-country cooperation and on interests of private and public actors is limited, with the exception of research from Kardes et al. [32]. For the economic growth of a respective country, foreign aid or development assistance is not a necessary condition, according to several theories. Besides theories

of endogenous growth, development cooperation is connectable to several concepts and theories, such as modernization, Foreign Direct Investments, the reduction of disparities, multiplier and accelerator effects, and Rostow's growth model. Research might still be in the phase of giving economic reasons for megaprojects, which is visible in multiple research works on non-megaprojects and their impact assessment [34,36,41,42], productivity [35], trade relations [43], and performance [31]. However, research has lately engaged more in sustainability [29,44–46] in order to take responsibility for sustainably designing projects that can impact millions of people [26]. Recognizing this need, Söderlund [39] called for the need to rethink why megaprojects exist, and to include also a discussion of their soft effects [39].

2.2. Framing Sustainable Development from a Local Perspective

Local development can call on various research agendas and theoretical streams [47,48]. As regional studies are highly context-specific, they vary in terms of their sustainability-definition, which has recently been shaped by questions around inclusive development [49], sustainable development [50,51], and the transition towards sustainability in regions [52]. The manifold conceptual differences in sustainability can follow Sturup [53]: Sustainability is “*the property (a species, a process, a culture, a society etc.) or quality of being able to be sustained*”, which also implies a normative perspective. Sustainability includes a systemic perspective, including environmental, socio-cultural, and economic principles [54]. The term ‘sustainable’ is the “*measure of the degree to which something can be sustained*” [53,55]. Sustainable development follows the Brundtland definition of meeting the “*needs of the present without compromising the ability of future generations to meet their own needs*” [56] (p. 43), which is also based on the scarcity of resources [57,58].

Through its multiple perspectives and disciplines [59], the targets of sustainable development are wide-ranging, starting with environmental protection in the 1990s and moving towards increasing quality of life in the 2000s [60]. Further criteria of sustainable development are justice and equity in terms of recognition, process, procedure, and outcome, as well as respecting the limits of the ecosystem and promoting cultural identities [61]. This is supported by the concept of the triple bottom line, which calls for the harmonization of the environmental, social, and economic perspectives. Although sustainability has been frequently discussed in scientific discourse [54,62,63], it is still contested in its demarcation from sustainable development [50]. This article tries to follow the clear idea that sustainability is the goal in a system integrating economic, social, cultural, political, and ecological factors, and sustainable development is the implementation of measures from a long-term and multi-scale perspective. Practically, this means that local sustainability in mega infrastructure is the quality or goal to be achieved, supported by various development pathways that especially rely on sustaining local interests in a global system.

A significant challenge of sustainable development is its implementation [64]. Although initiatives such as the UN Sustainable Development Goals (SDG) seem to be broadly accepted and widely used, a conflict of interests exists for instance between economic sectors or regions. There are increasing calls for a discussion on regional sustainability, which connects global, regional, and local efforts [50,65] and asks the questions “*what is to be sustained, by whom, for whom*” [61]. Consensus exists about the need to have sustainability strategies at all spatial scales (principle of subsidiarity), and thus they have been implemented in nearly all policy documents [60], but broad stakeholder involvement is still needed in the end. A unique role obtained by residents is civic engagement, and bottom-up processes are central to starting and successfully implementing more sustainable initiatives [66,67]. Such initiatives also relate strongly to the concept of community development and endogenous growth in order to enhance the local culture and environment through sustainable production and consumption, with the target of improving quality of life, which is also accompanied by the empowerment of residents and local decision-making [68,69]. Recognizing the complexity and the multi-level and -disciplinary nature of sustainability, it has become a global focus and requires the joint action of the world community. However, the interventional nature of the concept of ‘global development’ is vivid: local development

itself is embedded in regional, national, or even global factors, and thus relies on joint infrastructure projects, trade, cultural exchange, diplomacy, and cooperation.

2.3. Local Sustainability Assessment in Mega Infrastructure

Against the background of increasing spending on megaprojects—specifically mega infrastructure—in order to keep the pace of economic development, solutions need to be found to assess such projects by a number of different dimensions [29,46]. Taking the local scale into focus, mega infrastructure and its impacts need to be evaluated frequently in terms of their local sustainability, and thus the value they bring to society [34], by asking “Are megaprojects the right solution?” [39]. This needs to be embedded in different political and developmental approaches; for example, the European nations consider the balance between development models (e.g., modernization or export-based development) more than Asian nations.

In practice, the attitude towards megaprojects is unclear. It remains uncertain, however, to which extent and how infrastructure investments create jobs, generate income, foster economic sectors, and facilitate local development, or even if social exclusion is increased or decreased [70,71]. Reflecting upon and researching the criteria of local, sustainable implementation of mega infrastructure leads towards an endless collection of intervening and loose criteria, of which each has been tested and applied only seldom in practice.

Practical evidence can be found through several infrastructure projects that affect all dimensions of sustainability. For example, there exists valuable international discourse and research on the environmental impact of the Channel Tunnel [72], the climate’s long-term impact on New Zealand infrastructure [73], the impact of the Grand Ethiopian Renaissance Dam on water resources [74], port connectivity between Burgas (Bulgaria) and Alexandroupolis (Greece) [34], land use in the Polavaram River project (India) [75], international security linkages over Turkey’s Ilisu Dam [76], the re-settlement of China’s Three Gorges Dam [77], and the UN on Infrastructure and Human Rights [78]. Some of these projects have been highly criticized for their environmental or social impact. Although the Belt and Road projects are still under construction, criticism can evolve in some projects, leading to calls for learning from previous infrastructure projects and their sustainability assessments.

Central to assessing infrastructure is the analysis of its performance. The performance of mega infrastructure is highly shaped by complexity, time-duration, or its extensive impact on communities or ecosystems on several spatial scales [32,39]. Even during the planning phase, it causes high uncertainties in terms of forecasting potential effects [25]. Approaches to measure those effects have been provided by Dimitriou et al. [34], Fedderke and Bogetic [35], and Shen et al. [29], with special consideration around comparing the invested capital (private and public) and the economic performance. These assessments are in line with theoretical streams, such as modernization or dependences, and a number of theories and concepts that contribute to explaining certain elements of the complex relationships, such as spillover [79], productivity [35], regional cooperation [80], firm births [81], spatial distribution [82], competitiveness [83], local entrepreneurship [84], global production networks [85,86] or knowledge networks [86], and diversification or cluster management [38].

Calls are also increasing to include sustainability considerations in all phases of infrastructure planning, construction, and operation. The responsible parties need to decide how an infrastructure project assists in solving the issues of sustainable development in their related ecosystems [29,53,87]. In general sustainability studies, researchers have engaged in developing indicators, scenarios, and measurements of sustainability, but are still struggling with the availability, evaluation, and aggregation of data in a multi-dimensionality and interdisciplinary setting. Besides macroeconomic analysis, qualitative approaches also try to describe the behavior of actors in their surrounding socio-economic systems [65]. By applying complex measurements, sustainability can be broken up into a number of indicators, which cannot be assessed in their holistic surroundings [53]. In terms of the sustainability of mega infrastructure, evidence from research is fragmented or often missing altogether. An important step to address this was the launch of the Journal of Mega Infrastructure and

Sustainable Development in 2019 to fill this gap. Research from the Journal of Sustainable and Resilient Infrastructure is valuable, as well, but rather specific. On a practical level, institutions are engaged in deriving practical guidelines for project implementation. This practical collection of determinants to promote a more sustainable implementation of mega infrastructure stresses the role of planning and monitoring. The central determinants are:

1. Purpose: Beyond the aim of economic growth, there are many sub-goals to be defined focused around the benefits for local communities at different spatial scales [46,88].
2. Stakeholders: The definition of who is a relevant stakeholder has traditionally been limited to elites that are directly associated with the allocation of capital and power [32,89]. In this vein, Gellert and Lynch [89] explored power issues in displacements and called for the involvement of local communities as key stakeholders, given they are strongly affected by infrastructure but widely excluded in the planning of megaprojects [67].
3. Time and processes: As mega infrastructure tends to have an enormous time horizon, the dynamics of change require a sustainability assessment at all stages of the life cycle [39], starting with pre-evaluation, feasibility, and monitoring [34,65], though it will still be subject to uncertainties [90].
4. Surroundings and extensions: Infrastructure-supportive aspects need to be taken into accounts, such as the construction-environment, including housing or corridors for material transport or all kinds of human activity on and around the project. In addition, megaprojects often involve multiple different sectors, such as railroads and power plants, and lines to support an industrial cluster [53,89].
5. Spatial level and cooperation: In general, sustainability assessment is mostly conducted at the national scale, but for implementing and monitoring specific initiatives, more advanced levels of assessment are needed [59,66]. For example, successful transport corridors call for the harmonization of national systems to provide fast transit systems, but also rely on local gateways, hubs or markets [91]. On the local level, Sturup and Low [53] and the OECD [71] stress the comparison of project goals and local policy, and put local authorities and the representation of their residents into positions of responsibility.

In sum, the above argument follows the idea that mega infrastructure accelerates economic development, which needs to be transformed towards the goals and principles of local, sustainable development. Figure 2, therefore, serves as an exemplary discussion-grid that addresses the specialties of mega infrastructure in terms of sustainability dimensions, context, type of infrastructure, and supplementary determinants.

Type of Infrastructure	Sustainability dimensions					Context	
	Society	Environment	Economy	Politics	Complexity, Risk, Uncertainty		
	Transport	• Accessibility and mobility	• Displacement and land use	• Trade			• Trans-regional cooperation
	Health	• Power supply	• Air and water quality, emissions	• Services			• Transparency
	Education	• Living standards	• biodiversity	• Business opportunities			• Governance model
Sanitation	• Involvement of periphery	• Resource allocation	• Cost savings in transport	• Territory			
Industry	• Technical progress	• Regulations for constructions	• Market access	• Coordination			
	• Service standards		• Technology usage	• Involvement,			
	• health		• construction	• Power relations			
	• Employment		• Sector-shift				
			• Local sourcing				
Purpose Stakeholders Time Surrounding and extend Spatial Level and cooperation							
Determinants							

Figure 2. Dimensions of local infrastructure assessment. Source: Own elaboration, derived from Shen et al. [29], Ward et al. [92], the OECD [71], and Haughton and Counsell [60].

Reflecting upon the theoretical roots in regional studies, sustainability and transport geography, the assessment of the impacts of mega infrastructure on different local dimensions remains fragmented.

There exist practical discourse and research that certainly assist in the planning of mega infrastructure, including within the NSR. Universally valid learnings are hard to find, as all projects are embedded in a unique local setting and are often stuck in a specific sustainability dimension. Future research at this interface of infrastructure and sustainability thus could engage in both integrated development approaches and tools for flexible sustainable planning.

3. Methodology: Systematic Literature Review on the NSR

Catching up the challenges of the NSR in its local implementation, research and practice need to develop an understanding of what sustainability along the NSR means, before developing guidelines or monitoring. With the aim of discussing local sustainability within research on the NSR, this systematic literature review (SLR) identifies research articles in a systematic and reproducible way. Consequently, specific search processes and search criteria were implemented (Figure 3, Table 1) and assisted in framing the research field [23,93–99]. Compared to a traditional narrative review, an SLR is less rigid and seeks to answer a specific research question [96,100,101]. There is manifold theoretical support for SLRs; scholars like Cooper [102] and Petticrew and Roberts [95] have explored the conceptual foundation, and Denyer and Tanfield [96] and Kitchenham [23] have provided detailed guidelines for conducting an SLR. There exist different types of systematic reviews [101], which range from explorative to confirming, as well as qualitative and quantitative approaches [103,104]. Qualitative SLRs often use qualitative content analysis for a guided exploration of the literature. In opposition, quantitative SLRs apply statistical methods, namely meta-analysis or bibliometric analysis, to evaluate the structures of a research field [99,101,103].

The increasing interest in SLR studies has promoted the establishment of the SLR as a research method. In terms of sustainability, various SLRs have been conducted; for example, on climate change adaption [104], behavioral patterns in climate change mitigation [105], sustainable tourism [94], sustainability transition [106] and performance [107], sustainable supply chain management [108], local sustainability assessment in forestry [109], green infrastructure [110], city logistics [111], and governance of smart cities [112]. While the SLR is widely accepted in research articles, different steps of analysis are predominant. Figure 3 provides a collection of operation steps that serve a qualitative SLR in a more holistic way, which also include pre- and post-considerations in the analysis [95,99,102,104].

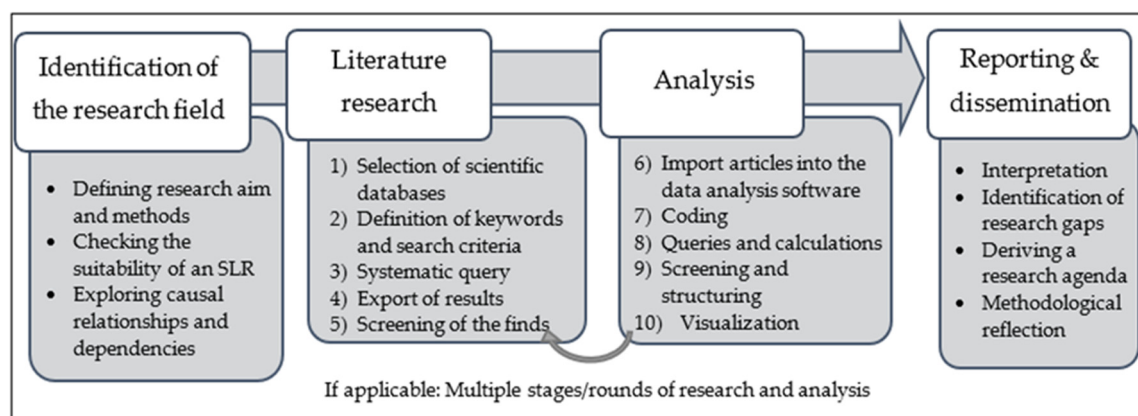


Figure 3. The procedure of the qualitative Systematic Literature Review (SLR). Source: Own elaboration as an extension to Snyder [101], O'Neill et al. [24], O'Neill and Booth [113] and Tranfield et al. [99].

This article processes a SLR through NVIVO™ according to the provided steps in Figure 3. NVIVO™ is a software used for the qualitative analysis of data, which supports semi-automated as well as manual coding. Its specialty is the processing of multiple rounds of research and analysis, which is also reflected by different literature samples and levels. Therefore, this SLR begins with the meta-level and then continues to develop deeper insights into the lower levels of analysis (Table 1).

This is why analysis on the micro- and meso-level applies a qualitative exploration of characteristics and sustainability dimensions. The general search criteria are: publications in scientific journals listed in World of Knowledge (WoK) and Science Direct (SD), publication date from 2013 (official start of the Belt and Road), and publication language English.

Table 1. Screening stages.

Stage	Starting Point	Analysis	Sec.	Question	n
Meta: Field description	Search query in WoK, SD on titles including 'BRI', 'Belt and Road', 'New Silk Road', 'One Belt One Road', 'OBOR'	Bibliometric: Titles, Keywords, Abstracts	Section 4.1.	Is sustainability of relevance in the research field?	597
Macro: Sustainability clusters	Search query with sub-keywords in titles and article-keywords: 'Sustainability', 'Development', 'Region', 'Local', 'Impact'	Clustering of full texts, Counting	Section 4.2.	Which thematic clusters evolve in sustainability?	162
Meso: Research characteristics	Selection of relevant clusters	Manual coding and queries	Section 4.3.	How is sustainability researched (scales, concepts, methods)?	58
Micro: Local sustainability	Search queries in the set on the linkage between spatial scales and sustainability	Codings and cross tables	Section 4.4.	How is sustainability handled and defined in the local context?	42

Source: Own elaboration.

The first screening stage identified 966 articles on the NSR (Table 2). A correction followed this query to eliminate duplexes, unwanted types of publication (abstracts, editorials, conference proceedings) or thematic misdirection. This correction led to a final meta-sample of 597 articles (Table 3), which represents the starting point for further analysis. The timely distribution of the articles shows the increasing interest in research on the NSR since its announcement (Table 3).

Table 2. Search results.

Search Criteria	Belt and Road	BRI	New Silk Road	One Belt One Road	OBOR	n
Science Direct	135	4	7	11	1	158
Web of Knowledge	612	36	52	91	17	808
Sum	747	40	59	102	18	966

Source: Own elaboration.

Table 3. Publication dates.

Year	2013	2014	2015	2016	2017	2018	2019	2020	Sum
Number of publications	1	2	9	18	37	67	251	212	597

Source: Own elaboration.

4. Results: Framing Research on the NSR

The SLR had multiple rounds, which represented four levels of concretization. Equally, the presentation of the results starts with the meta-level and continues to explore detailed insights at the micro-level.

4.1. Meta-Level: Is Sustainability of Relevance in the Research Field?

The meta-level reflects a quantitative description of the research field by broadly including all journal publications in the keywords (Table 1). This chapter aims to evaluate the relevance of sustainability in the broad research field by referring to article keywords and abstracts.

The article keywords allowed to obtain a rough overview of thematic focuses. Based on the word stem, the following keywords were used frequently by authors (Table 4). Obvious keywords, such as Belt and Road, were excluded. Consequently, the keywords represent a lively mixture, including terms like *infrastructure* and *investment*, *regional scales* and *cooperation*, but also *sustainability* and *politics*. Nevertheless, the perception of the NSR as an economic development initiative introduced by China prevails.

Table 4. Article keywords.

Word	Amount	Word	Amount	Word	Amount	Word	Amount
china	156	internationality	49	global	33	policy	24
development	99	environmental	48	regional	32	corridor	23
economic	86	transport	48	fdi	31	emission	23
trade	71	sustainable	40	countries	30	power	23
model	60	investment	38	relations	28	spatial	23
analysis	56	network	36	risk	26	chinese	22
infrastructure	52	asia	35	carbon	25	factors	21
energy	50	cooperation	35	financial	24	growth	20

Source: Own elaboration, articles = 597, keywords = 997.

Abstracts provide the space to formulate problem statements and research methodology, as well as to indicate the main results of the research. Based on word stems a word cloud was processed (Figure 4). In opposition to the keywords, the abstracts reveal that research on the NSR is often driven by the perspective of the countries along several corridors. *Belt and Road regions* or *Belt and Road countries* are terms which are often used in this regard. Although the term *Asia* is widely used, it is hard to identify a regional focus in these NSR studies. The thematic focus is equal to that of the article keywords: *Development*, as well as *economics*, *trade* and *investment*, play a crucial role. The role of a monitoring or impact assessment of the NSR cannot be neglected, as the keywords *effects* and *impacts* reveal. An additional keyword which is visible in the abstracts is *sustainable*, highlighting that a number of research articles have been concentrated on sustainability lately.



Figure 4. Word cloud based on abstracts. Source: Own elaboration, articles = 597, words = 1000.

A large share of journals, such as Sustainability and the Journal of Cleaner Production, also confirm the sustainability orientation. Moreover, the journals reveal a possible focus on Eurasia (Eurasian Geography and Economics), Asia (Asian Education and Development Studies), in the Pacific (Pacific Economic Review), or more generally, emerging markets (Emerging Markets Finance and Trade).

In sum, the meta-analysis confirms the intense focus of the NSR on economic development, along with the countries of the respective infrastructure and trade corridors. The sustainability discussion around the NSR has gained increased attention through impact assessment. Beyond that, the NSR is presented as a project with different spatial layers and a need for international networks, relationships, or cooperation.

4.2. Macro-Level: Which Thematic Clusters Evolve in Sustainability?

The second level of analysis is the macro-level, which should explore clusters in sustainability discussions around the NSR. Therefore, a query with additional keywords (Table 1) represents the thematic focus of this study, and forms a new set of articles.

In general, the keywords of the full texts at the macro-level reveal that *institutions*, *banks*, *finance*, and *world* play a much more dominant role compared to at the meta-level. In more detail, a cluster analysis based on the Pearson Correlation for measuring the word distance in the full texts was conducted (Figure 5).

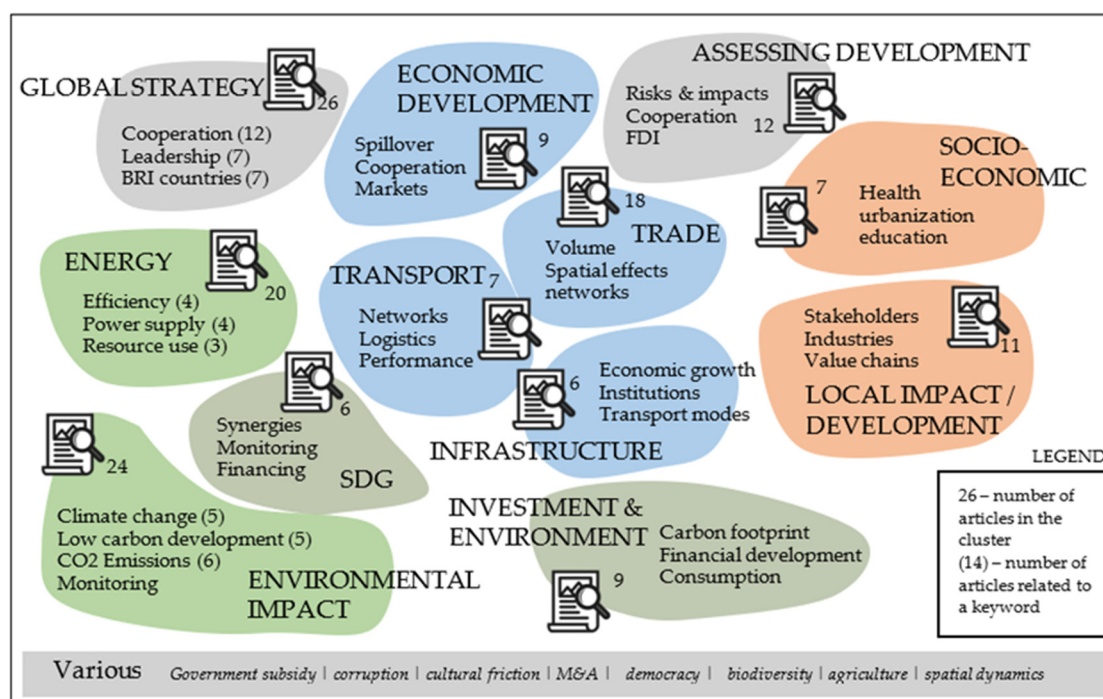


Figure 5. Clustering of articles and issues. Source: Own elaboration, articles = 162.

Tian et al. [114] and Wang et al. [115] discuss the effects of infrastructure investments in close relation to economic growth or development. A significant number of studies estimate the trade effects of the NSR, often in a quantitative manner, such as those by Chen et al. [116] or Baniya et al. [117]. Though it is frequently criticized as not being environmentally friendly, research on the NSR shows several approaches to environmental sustainability. Worth mentioning is the relation of *investments and environment*, calls to analyze the carbon footprint, and the effects of financial instruments following the central question: “Does finance affect environmental degradation?” [118]. In addition to this question, researchers are strongly focusing on the cluster *energy*, which handles fundamental questions of energy

supply in rural areas, but also the implementation of green energy projects [119]. Besides discussions on the *environmental impact*, including monitoring or climate change, several authors have addressed the *SDG* at the interface of the three sustainability dimensions [120–122]. Still, sustainability challenges the *assessment of development* in general, but also at the local scale. Reflecting the macro-literature set, the spatial concept “local” is seldom applied [123–126]. Another literature gap exists in the exploration of socio-cultural and even socio-economic effects. Issues of health [127] and education [128] are discussed, but a comprehensive understanding of residents and their socio-economic surroundings is largely missing. From a more strategic and political perspective, the cluster on *global strategy* indicates several pain points of the NSR around geopolitical relations. In this vain, cooperation was analyzed between China and regions along the corridors [10,129,130], as well as the approach of global leadership.

A further indication is provided by analyzing the three sustainability dimensions. Figure 6 presents the number of coding references according to the most frequently used keywords in the macro-set that directly include the terms: economic, social (and cultural), and environment. Deriving from the concept of strong sustainability, the economy is at the center, followed by society and the environment. In addition to the cluster analysis, this net graph reveals a research focus on *economic cooperation* and the *development of corridors*, as well as *environmental degradation, quality and pollution*. The social dimension remains under-researched.

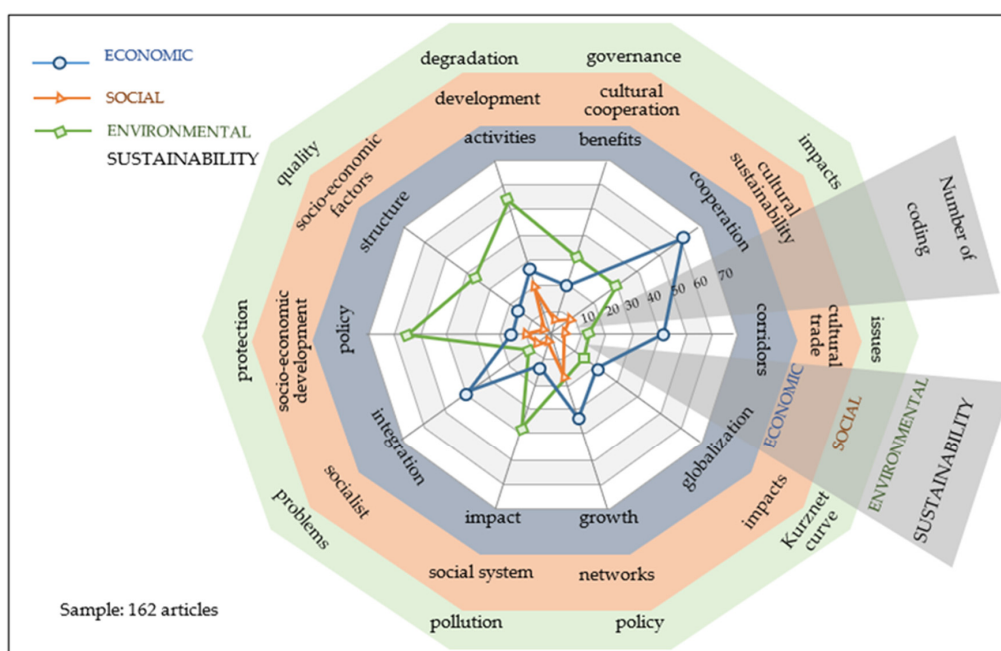


Figure 6. Net graph on sustainability dimensions. Source: Own elaboration, articles = 162.

In sum, the macro-level—comprising a specialized set of sustainability concerns along the NSR—indicates that issues of economic development are quite well researched. As a core of sustainable development, research so far has not sufficiently discussed the effects of the NSR on a local scale, including the residents as a local stakeholder group.

4.3. Meso-Level: How Is Local Sustainability Researched?

The analysis of the meso-level gives insights into the research characteristic of sustainability along the NSR. Therefore, a new set of articles evolves through the selection of relevant clusters; namely those that address the problem statement of local sustainability arising from the NSR impact. Those clusters are: *infrastructure*, *SDG*, *local development*, *assessing development*, and *economic development*. In general, keywords such as *development*, *countries*, *economics*, *region*, *infrastructure*, *policy* or *effects* underline the

thematic focus of this meso-level. This selection is completed by a content alignment, which finalizes 58 articles of the meso-set. To characterize the research, this section presents a more qualitative analysis on scales, concepts and theories, as well as applied methods.

4.3.1. Scales: On Which Spatial Scales Does Research Discuss Sustainability?

The majority of the selected articles discuss the NSR in a cross-country analysis, involving sampling of up to 141 countries (Table 5). These analyses mostly have a quantitative and comparative character. However, there is also more specific sampling available, such as by selecting certain corridors or supranational regions; for example, Eurasia or Central Asia. In addition, specific national case studies have been conducted across Eurasia, but also in Kenya and India. Besides analyzing NSR-countries, China itself has often been studied, both at the sub-regional and national level. Subordinated spatial scales of research are hubs [131], special economic zones and industrial parks [132,133], or certain urban networks [134].

Table 5. Spatial scales.

Various Countries (BR)	More Specifically Defined (O)
33–141 BandR Countries [115,132,135–151]	BRI perspective along the east-west axis [152] BRI and non-BRI countries [153] metropolitan economy [134] cities and regions within countries [154]
Supranational (SN)	
Eurasian countries [155–157]	
Kazakhstan and Eurasian economic union [158]	
Central Asia [159]	
Latin America and Caribbean (LAC) countries [160]	
China [165] (C)	Single countries (N)
western provinces of China [166]	Afghanistan [161]
Southwest China [167]	Kenya [162]
China and the countries along the BRI [168]	Kazakhstan [123]
China and neighboring countries (India, Vietnam and Indonesia) [122]	India [163]
	Algerian [120]
	Poland [131]
	Mongolia [164]
	Georgia [126]

Source: Own elaboration, articles = 58.

4.3.2. Concepts: Through Which Theoretical Concepts Is Research Addressing Sustainability?

Table 6 and Figure 7 assign the found concepts to the dimensions of sustainability, including the political dimension and the respective linkages in between the dimensions. Worth mentioning is the high share of research at the linkage of economic and environmental concepts.

Table 6. Applied concepts in sustainability research.

Sustainability Dimensions			
Economical	Social	Environmental	Political
Economic growth [115,142,150,169] Regional Labor Markets [162,166] Total factor productivity [136] Tourism development [123] Value chains—global [124,170]—regional [157] Global Trade Analysis Project model [136] Indirect trade relations [160] Impact of trade facilitation [138] Debt financing [135,162] Microfinance Institutions [148] Inclusive Finance [148] FDI Networks [171]	People-to-people cultural exchange, including traditional Chinese Medicine [137] Social Exchange Theory [123]	Vulnerable environment, and energy consumption [155] Environmental efficiency [153] Green Development Capability [149], resource [165]—energy [152]—water [159]	Development Aid Model [161] International development aid and FDI [147] International Capacity Cooperation [132] Modernization and globalization towards bilateral cooperation and strategic relationships [141] State-coordinated investment partnerships [172] Governance [124] Fragile state theory [161] Accumulation regimes, spaces of sovereign exception. elite development paradigm [172] Regionalism [158] Local stakeholders' views [123]

Table 6. Cont.

Interfaces between Dimensions			
Environmental-Economical	Social-Environmental	All Dimensions	Economical-Social
Economic-environmental relationship-Kuznet [173] Green transition of the regional economy [145] Financial development, industrialization, transport and FDI on the environmental quality [140,146,173,174] Value added per capita, transport freight and CO2 emission [174]	Critical natural capital and the socioeconomic drivers [175]	Political-economic market [176] Geo-economic and geopolitical [177] FDI and Institutional Quality [144]	Social economy, local security and regional economic development [161] Socioeconomic development index [139] Population, urbanization and economic scenarios [178] Socio-Economic Impact [169]

Source: Own elaboration, articles = 58.

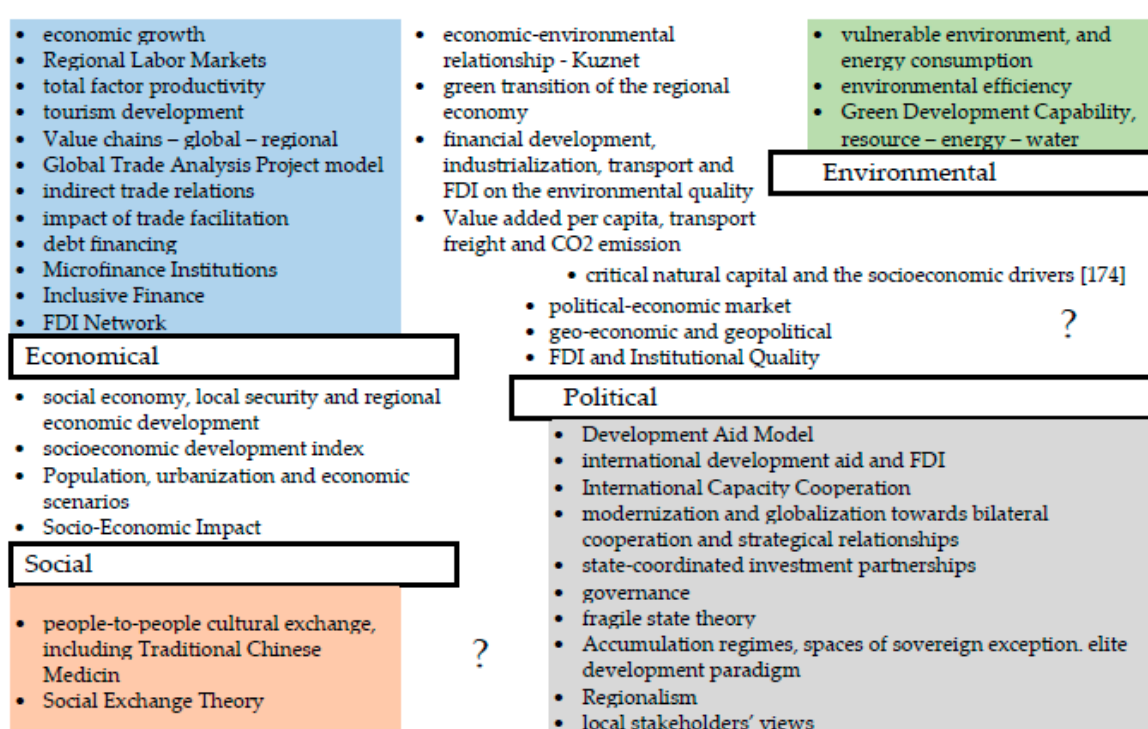


Figure 7. Linkages in sustainability research in addition to Table 6. Source: Own elaboration.

A research gap occurs in the social dimension. In general, the concepts reveal that precise theoretical approaches are missing, which makes a clear allocation towards several development streams (e.g., modernization, dependency) tricky. Partially, theoretical chapters are reduced to a minimum and represent a rather general explanation of the NSR, instead of a theoretical foundation, which leads also to an empirical analysis.

In the same way, research targets often remain broad, such as to research challenges and opportunities [162,170]. In fact, a significant share of the reviewed articles aim at understanding and measuring individual relationships, such as between growth and CO₂ emissions [141], trade and labor effects [166], infrastructure and (sustainable) economic development [114,115,169], or FDI and economic growth [146]. Only a few articles link the dimensions of sustainability [179].

4.3.3. Methods: Which Methods Are Applied to Research Sustainability?

Research on sustainability issues along the NSR is dominated by measuring economic effects and relationships between certain variables. Such research is supported by statistical data and the

use of economic models and indicators (Table 7). Only a few articles apply spatial models or more qualitative approaches. All in all, the current research misses consequent empirical methods, as a significant share of articles remain descriptive and utilize the methods of a case study or statistical analysis as an empty framework.

Table 7. Applied methods.

Statistical DFata (d)	Spatial Models [139] (s)
Data from Asian Development Bank [136], United Nations [162], World Bank [142] UNCTAD [160] or China's Customs Statistical Yearbooks [165] Data on Imports and exports [132], on finance [135,148], Labor-force [166] Panel data and time-series [115,175] Analyzed e.g., by regression [165,173] or super-slack-based measure model [153], cross-correlation analysis [180]	Spatial-temporal characteristics analysis [115] Spatial Durbin Model on different cooperative patterns [149] General equilibrium model and spatial distribution of people, economic activity, and transport [154] Complex network method [171] High-Resolution Settlement Layer (HRSL) [120] Population and urbanization projection model [178]
Economic models (e)	Various (v)
Econometric models and data [138] DEMATEL analysis [124,134] Econometric test process [141] Shift-Share Analysis [166]	Monte Carlo experiment [160] Delphi Issues with international experts [181] A scenario analysis method [163] Literature review [170] Policy documents [161,167] Interviews [126,161] Remote sensing monitoring [120,182] Questionnaires [123,169,170] Case study and comparisons [126,131,133,139,158]
Indicators and indexing (i)	
Index system and multi-hierarchy linear summation method [145] Principal component analysis on composite indexes for Economic growth, environmental degradation, and social well-being [139,176,179] Comprehensive Evaluation Index [114] SDG indicators [122]	

Source: Own elaboration, articles = 58.

4.4. Micro: How Is Sustainability Handled and Defined in the Local Context?

The micro-level is based on a manual in-depth analysis of coded statements, which occurred at the interface of spatial scales (*local, regional, national*) and the respective sustainability issues (*sustainability, development, as well as the single levels of the environment, economy and society*). As many codings mention more than one sustainability dimension, quotations from the articles are presented together with color-coding. Therefore, Table A1 (Appendix A) assists us in understanding the foundations of the research questions on local sustainability.

The analyzed quotations and articles show that the NSR has the potential to foster sustainability in general, but also in local terms [114,120,159]. Its main strength may lie in its understanding as a global initiative [121], which goes beyond traditional aid models. The quotations mention the various relationships, which are strongly connected to sustainability. Led by economic concerns, which postulate the positive relationship between infrastructure and trade, and between trade and labor markets [166] or environmental sustainability [121], the research also indicates that top economic performance does not necessarily go hand in hand with sustainability performance [183]. Unfortunately, performance measurements remain vague and difficult to compare. Only seldom has current research considered the local scale. The high share of international datasets highlights this problem. Variables are the overall development statues, which influences FDI inflow, but also environmental quality [118,140], the industry structure [183], and the different spatial scales applied. For example, urban logistics face different challenges than rural logistics. It is certain that the NSR is going to change the overall spatial patterns [126] of infrastructure, specific sectors, and trade and living environments.

Still, challenges arise at the interface of resource usage and resource protection [171]. Hu et al. [184] call for recognizing local carrying capacities, while Tian and Li [114] demand a balance between trade and environmental issues. Some case studies indicate that environmental sustainability (also referring to the concept of strong sustainability) functions as the basis for further economic and social development [159,179]. In the case of transboundary water resources in Central Asia, Howard and Howard claim that *“countries need to recognise that the economic success of the “Silk Road Economic Belt” hinges on their ability to develop programs that can ensure the region’s water resources are managed in a sound and sustainable manner.”* [159].

Selected examples from the literature that used a case study method can further represent the local sustainability discussion. In the case of Kazakhstan, Daye et al. [123] found that the tourism sector is a likely winner from the BRI through creating job opportunities and overall prosperity. The positive attitudes of local stakeholders exceed opinions on the possible negative aspects, such as financial costs and indebtedness, or loss of local autonomy. With reference to the Russian part of the Ice Silk Road, Evseev et al. provided insight into the indigenous population in the arctic zone, which represents an especially vulnerable group. For the coastal infrastructure projects, the authors call for regional ecological and social stability through buffer zones. This emphasis on regulating and provisioning ecosystems opposes the need for technological improvements on infrastructure that could assist cleaner trade and manufacturing [121,140]. In opposition, the case of Algeria [120] underlines the necessity of road access as a development driver, and part of SDG goal 9. Therefore, the researchers found that during the Belt and Road projects, the access of the rural population to expressways increased significantly. The example of Georgia in the Caucasus region [126] reveals a highly complex picture of the NSR as a playground for various international interests. The case study shows a mixed picture of perceived benefits in infrastructure, but challenges in regional authority that limits self-determination towards sustainable development. It partially shows the uncertainty of stakeholders regarding the economic benefits of the projects.

In sum, the discussion on local sustainability is strongly connected to political considerations (authority, transparency, governance). On an operational level, a linkage between environmental and economic issues is present, which also shows a gap in the research around socio-economic and socio-environmental issues. Often, the social dimension is skipped by arguing that economic development will automatically increase the welfare and the quality of life of the residents. This gap may promote future studies that will question the social benefits [126], stress civil protests [178], and local autonomy [123,158] and local participation [145]. The need to critically evaluate the NSR and to strive for a more holistic approach to sustainability opens opportunities for further research.

5. Discussion: Future Directions in Local Sustainability

Building upon the theoretical introduction to various determinants (Figure 2), high complexity, risk, and uncertainty accompanies the sustainable implementation of various types of infrastructure over the four sustainability dimensions. Given a holistic setting, the local sustainability of mega infrastructure has only been addressed in a fragmented way in previous research. This article contributes to outlining future directions for local sustainability within the specific setting of the NSR. Therefore, this discussion addresses three sections for the support of local sustainability.

5.1. Building a Joint Understanding of Sustainability

Although there exists different approaches to sustainability or sustainable development, they have in common reliance on long-term perspectives, to include different scientific disciplines and to harmonize different interests. As a bottom-up process, it should also serve to foster the quality of life of the residents (Section 2.2).

The local sustainability along the NSR is hard to assess, as motivations of international donors and domestic authorities are unclear, or transparency is lacking at various stages of planning [135]. There is no doubt that the interests on the different scales can vary or even compete [185]. The joint

implementation of mega infrastructure in a sustainable way might only be possible if consensus is created, which is based on clear positions and responsibilities. This collective understanding of sustainability needs to go hand in hand with understanding and researching the basic variables of development: What are the effects of infrastructure? How can I monitor the effects? How can a region address the full potential of external investments? What is the role of local authorities? What are the benefits for locals?

The results of this study reveal that major relationships exist between infrastructure projects and economic growth. Researchers agree that infrastructure supports the latter (Section 2.1), but the effects of mega infrastructure as a public investment on sustainable development remain poorly understood [126]. However, economic growth is often considered alongside international trade and income effects for China. Though the concept of sustainable [186] or green trade [145] are gaining momentum, the local scale is frequently excluded. The aims to increase welfare and economic development, and achieve an inclusive and sustainable economy [121], often remain un-researched at the local scale. Attempts to create indicators and monitoring systems need to be extended here, and be included effectively in policy-making [122].

Taking the framework of the SDG provides the NSR with a “strategic policy framework for pursuing societal prosperity without undermining environmental sustainability” [175]. Although the SDGs are appreciated and to date have been widely implemented by institutions and companies [175], the NSR still needs to prove its international openness and the local sustainability of its implemented projects in the long term. Early studies have applied these factors in the context of the NSR [120,132]. The SDGs could help to recognize sustainable development as a holistic and integrated set of economic, social and environmental actions, paired with political responsibility [146,175,179]—even if the SDGs are not free of conflicts. Likewise, a focus on the overall setting of the SDGs could also increase depth in several sub-systems on several spatial scales; for instance, the evaluation of global environmental governance [125].

Finally, a joint understanding of sustainability lies at the core of many discussions in research in general (Section 2.2), but also in implementing the NSR; this should define the responsibilities, principles, and limitations as well. Especially in vulnerable regions, sustainable development is needed that reduces trade-induced emissions and preserves natural resources, which includes local authorities in decision-making and promotes labor markets and induces local welfare [185]. Such discussions should also take into account the many factors of mega infrastructure (e.g., Section 2.2). One needs to admit that the NSR is a critical geopolitical ground, which relies on power relations in bi- and multilateral settings, including political capitalism [187] and development cooperation [188]. Combined with power issues, the risk of debt and thus financial sustainability is of major concern for several countries [115,158], and probably hinders negotiations at eye level. Therefore, the choice of an adequate development model for nations or smaller local areas is of high importance.

5.2. Supporting Mega Infrastructure Locally

There is a theory that mega infrastructure could be a driver for economic growth if implemented in a holistic manner, which means to include the development of infrastructure hubs, diversification and related services, to provide a local workforce, to recognize entrepreneurial opportunities, and much more (Figure 2). Implementing infrastructure thus should exceed its singularity, and opens up local and regional dimensions. Research and discussions on recent infrastructure projects worldwide assist in finding sustainable pathways.

In the discussion on stakeholders in mega infrastructure, researchers are calling to include local communities in all stages of planning and implementation, to secure the sharing of benefits or to “enable wellbeing and sustainable livelihoods” [181]. This is complemented by the expectation that the NSR can follow an environmentally sustainable path if a cross-stakeholders pathway is followed, and a monitoring system assists the project implementation [155]. The concept of private-public partnerships (PPP) is also relevant in this case [189]. Traditional performance measures on infrastructure are

inadequate for megaprojects of the extent of the NSR. Referring to the SDGs, mega infrastructure needs to show accountability. For example, an energy project such as a power station, wind farm, or solar array must show how it advances the goal of “*affordable and clean energy*” [53].

When external investments push infrastructure, it requires local vigilance, self-confidence, and flexibility towards the own development plans, reflecting the concept of global development. The selection of a respective development model is a strategic decision; it is about growth, dependencies, access to markets, and a lot more. The NSR can be defined as such an investment-led development model [121] to foster trade networks. Primarily, highly fragile states depend on such investments [161]. Development cooperation is a central concept of this. Alonso and Glennie [190] added the convergence of developing countries to higher levels of income and wellbeing, as well as participation in international public goods. The aims of development cooperation, or even foreign aid, certainly have changed over the decades, with a tendency to affect more areas of social life and a clear goal-orientation. Therefore, foreign aid combines the motivation of donors towards human development, democratization, sustainable resource management, and poverty reduction, but also the aims of the receiving countries [188,191]. In addition to investments and capital transfer, neo-classical approaches highlight the countries’ own policies; for instance, in adjustment programs and international development cooperation, converging in spillover theories and knowledge transfer [188]. The absence of evaluation leaves questions about the real effects of development aid on both the national and local scales [37]. In the case of Afghanistan and the NSR, researchers recommend reducing dependence on traditional development aid, and to focus more on sustainable aid models [161].

Several authors have recommended practical strategies to assist external investments, such as the creation of industrial parks along a transport corridor, linking local and international companies, involving the hinterland, and improving access to higher education and health services [88], which can be combined with tools of community involvement at a local scale [71]. This call for local adaption of the projects requires several preconditions, including financial impact assessment [135,145], international sustainability standards in domestic and international investments [177], support of inter-regional investments that promote the development of regional economies [171], and the promotion of ownership and control to the receiving countries [190]. Increasing human capital through education might be another prerequisite to participation by employing local workers. Often specific types of human resources are not available in sparsely populated areas, or the quality of the workforce in the least developed countries might not meet the requirements of mega infrastructure [71]. Further measures can be derived from the results of the SLR (Table 8).

Table 8. Local measures.

Local Cooperation	
Multiple party collaboration [192], including locals [155]	
Regional cooperation on green supply chains [145]	
Cooperation across branches [134]	
Dialogs, PPP, joint research, technology helps the environment [122]	
Local Policy	Local Entrepreneurship
Development of local and regional policy programs in accordance to NSR [118,159]	Economic zones as places of entrepreneurship, spillovers and cooperation [132]
Regional barrier-removing policies [156]	Entrepreneurial opportunities lie in the local support-linking sustainable development and local economies [184]
Determine the pace of development-moderate development might increase the quality of development, locally [193]	Promote the transition from agriculture and manufacturing to service industries [126]
New local collaborative models [194]	Planning and development of local hubs and hinterland connection [126]
Strong investment and finance framework support independence from inward FDI [115,135]	

Source: Own elaboration.

Reflecting the theoretical contributions to transport geography or local development, infrastructure projects have researched pre-requisites which should be taken into account, and which probably forces regions to diversify their economic model by moving from mere primary and secondary sectors to the operations of service transport and the planning of respective projects.

5.3. Introducing Governance Models and Regional Integration

Throughout the last decades, the different global regions have seen widespread cooperation, which has culminated in regional integration—either in relatively informal or formal organizations, such as the EU or the ASEAN [195]. There is a number of reasons why states or regions cooperate in development, such as factor endowment or joint problem solutions, with the aims of promoting trade, knowledge gains, preservation of peace and security, and financial stability [196].

In the same way, the NSR changes international relations and governance modes, develops institutions, activates new regional cooperation [53], and finally promotes regional integration. Integration processes along the NSR are based on increased connectivity. In this regard, regions are bound together by a decrease in travel and transport time, or the establishment of new regional supply networks. Researchers also perceive these infrastructural connections as a prerequisite for sustainable mobility, which should be researched further [120,170,197]. Regional integration is also a matter of multi-level governance that focuses the decision-making processes and their coordination among several levels, including the local, regional, and global [198]. The popularity of multi-level governance has evolved, as it raises questions about nation-states, central governments, and also about other levels and actors, including NGOs and PPPs [199].

The governance model of the NSR is still challenged by limited transparency and power issues, which has led to calls for increased communication, dialog, joint research, and research-collaboration [122]. The main challenge of the NSR countries might be to balance different investment projects from different partners or donors. Research in this regard remains fragmented and highly context-specific, and efforts are thus underway to obtain a better overview. As the potential of international cooperation is clear [200,201], there are calls to introduce international organizations to link spatial scales [121] or Multinational Development Banks [202]. In terms of the NSR, multi-level governance can serve as a means to foster the stepwise integration of regions into global processes and networks, and to include local conditions and requirements. It lies in the center of regional integration and the overall concept of regionalism; that regional cooperation is also fostered in a national bottom-up process. This matches the findings on the need for local policies and international cooperation, and to rethink administrative decentralization in international projects. This likewise opens the discussion on supplementary or alternative development models in opposition to the Belt and Road. Fostering smaller, but independent regional cooperation networks and thus trade and infrastructure networks could also meet the recent challenges of COVID-19. Reinforced by COVID-19, the need for regional networks to be organized in a robust and resilient manner has increased. The World Economic Forum perceives regional integration as a strategy to meet the challenges of COVID-19 [187]. Regional institutions therefore could act as agents binding regions together. As a result of the shock to global supply chains, national governments were forced to provide basic necessities [203] and strengthen local supply chains instead. It is not clear yet whether regional integration was strengthened during COVID-19, as results from Africa show the opposite tendency due to breaking of regional integration protocols in favor of securing national supplies [204].

These approaches to regional integration might serve as an alternative development strategy for countries along the NSR; not to reject the Chinese BRI, but to carefully elaborate the benefits and challenges of all options, and to focus on bottom-up processes to maintain and to take responsibility for local development. This is all the more relevant as the NSR faces not only the challenges of a single national mega infrastructure project, but a complex set of intervened and transnational mega infrastructures. Nevertheless, the local scale is strongly connected to the global initiative, and vice versa. Therefore, sustainable development will require cooperation across nations and among regions

and corridors [155,166,177]. In the same way, China's economic development is closely connected to its partners and to world economies [121].

6. Conclusions: Proposing a Research Agenda for the NSR

This study builds upon the emerging field of the NSR, and especially gains insight into the role of local sustainability. Therefore, this article started by claiming gaps in the local implementation of the various mega infrastructures that build the NSR. In summary, this study contributes the following: first, a comparison between the principles of local sustainability in mega infrastructure (Section 2) and the current scientific discussion on the NSR (Section 4), revealing that challenges resemble theory along the NSR—although research on the NSR has focused on bridging local interests and international politics (Section 5). Second, the SLR shows the gap in sustainability implementation in infrastructure. Third, the different scales of analysis, and especially the in-depth review on the micro-level, point to a research agenda for the NSR in line with theoretical streams based on seven dimensions:

1. International research collaboration: Especially through the global extent of the NSR and particular regional and local characteristics, cooperative research at the international level is seen as a decisive factor to take full opportunity of the NSR at a local level; for example, cooperation between international researchers and local universities of applied science.
2. Objectivity: As the NSR is strongly connected to geopolitical issues, reservations, prejudices, political intentions, and cultural barriers may impede objectivity in research. Objective research should also mean that international scholars engage in project monitoring based on transparency.
3. Scales: Current research focuses on the impacts in various countries. To derive learnings for local sustainability is difficult, which makes a case for in-depth case studies for particular regions or local areas, such as cities, hubs, and hinterlands.
4. Context: Researchers need to be aware that sustainability requires a high context- and culture-specific approach, which does not automatically meet the “first-world-view” on development or the Chinese perspective on economic growth. Even the implementation of transnational infrastructure projects requires dealing with local conditions.
5. Methods: Researchers are exploring the field through an increasing number of articles, often led by econometric models. Future research should widen the methodological perspective towards case studies and qualitative methods to gain deeper insights into local sustainability, especially in regard to impacts on residents, local governance, and policy mechanisms to identify factors for participation and regulation; examples are local case studies on specific infrastructure hubs through in-depth interviews with local authorities.
6. Theoretical concepts: Research on the NSR has been, to date, influenced by curiosity around rough insight into this complex field, often by skipping the theoretical depth. The NSR should be, in the future, recognized as a research field, offering a unique playground to develop and prove theories of sustainable development in different statues and regions. In first instance, the NSR provides theoretical proximity to concepts of economic geography—including transport and mobilities geography. In addition, non-NSR research on sustainable infrastructure requires an integrative model to provide systematization and guidance.
7. Transdisciplinary research: The complex setting of the NSR stresses the need for interdisciplinary research, or even a transdisciplinary approach, to accompany successful practical implementation. Against this background, transdisciplinary research aims to solve problems through decomposition and the synthesis of several disciplines [205]. Practically, this means bridging transport geography (e.g., connectivity, mobility, infrastructure), with economic concerns (trade, local development, local economics, employment, entrepreneurship), with natural science (environmental sustainability), but also with political science. To do so requires developing policy plans and forms of international collaboration. Finally, the research itself needs to be aware of entering a geopolitical field, which could also be assisted by cultural studies or behavioral science.

This article aimed to set up research directions for the NSR, with a special discussion of local sustainability. The NSR was analyzed through the method of SLR with a mixture of quantitative and qualitative factors. Based on these findings, this articles provide the starting point of a systematic analysis of local sustainability along the NSR, rather than providing an impact assessment. This contribution is limited by the range of an SLR, and the set criteria and focus. Thus, this article does not include further groundbreaking publications in the form of conference proceedings or edited volumes, and a detailed exploration of sustainability issues at a supranational or even global scale. The focus of this article lies in current NSR research, and evidence from former research on infrastructure assessment offers manifold theories and practical hints which need to be systematically included in future discussions. As an emerging research field, the NSR is about to enter the scientific discourse dynamically, and will probably provide further insights into local sustainability.

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Appendix A

Table A1. Statements on sustainable development.

Article	Citation	Scale	Method	Statements on Sustainable Development Color Coding: Blue—Economic, Green—Environmental, Orange—Social, Grey—Political Issues
Ahmad, M., et al. (2020). Does financial development and foreign direct investment improve environmental quality? Evidence from belt and road countries	[140]	BR	i	<ul style="list-style-type: none"> financially developed economies get more FDI inflows and boost the host country's RandD in energy innovation, which subsequently improves the environmental quality
Bandiera, L., and Tsiropoulos, V. (2020). A Framework to Assess Debt Sustainability under the Belt and Road Initiative	[135]	BR	d	<ul style="list-style-type: none"> In countries with weak public investment management frameworks, the availability of funds in the immediate term may also induce borrowing countries to invest in large-scale infrastructure projects based on their ability to secure financing, rather than on the priority accorded to such projects in the government's overall development strategy.
Chen, Q., et al. (2019). Evolution of the Cultural Trade Network in "the Belt and Road" Region: Implication for Global Cultural Sustainability	[201]	BR	s	<ul style="list-style-type: none"> While the cultural trade network has promoted the integration of cultural diversity into the global market, to achieve global cultural sustainability more active trading relations with small-sized countries should be encouraged.
Chen, X., et al. (2020). Tracking national sustainability of critical natural capital and the socioeconomic drivers in the context of the Belt and Road Initiative	[175]	BR	s	<ul style="list-style-type: none"> As the latest consensus-based guidelines, the Sustainable Development Goals (SDGs) including a set of measurable targets and indicators proposed by the United Nations (2015) have been playing a critical role in promoting global and regional sustainability.
Chen, Y [Ya], et al. (2020). How can Belt and Road countries contribute to glocal low-carbon development?	[125]	BR	i	<ul style="list-style-type: none"> The construction of green BRI can not only provide powerful supports for BRI countries to achieve the 2030 sustainable development goals, but also help BRI countries to participate in global environmental governance.
Chubarov, I. (2019). Challenges and opportunities for the spatial development of Eurasia under the BRI: the case of the Eurasian Economic Union.	[156]	SN	s	<ul style="list-style-type: none"> Others tend to see the BRI as not merely a regional but as a global economic initiative in support of globalization and free trade that makes it potentially compatible with regional barrier-removing policies, such as the EAEU.
Coenen, J., et al. (2020). Environmental Governance of China's Belt and Road Initiative	[200]	BR	v	<ul style="list-style-type: none"> In order to meet the strict environmental regulations of the EU, the Chinese consortium set up a Safety and Environmental Protection Department, introduced noise-canceling technology to protect the marine environment, and collaborates with local companies.
Cui, L., and Song, M. (2019). Economic evaluation of the Belt and Road Initiative from an unimpeded trade perspective	[183]	BR	e	<ul style="list-style-type: none"> From the correlation and correspondence analyses, it was concluded that the top-performing countries do not necessarily have top performance in all five sustainability dimensions, and vice versa; the bottom-performing countries do not necessarily have the lowest performance in all five dimensions.
Cuiyun, C., and Chazhong, G. (2020). Green development assessment for countries along the belt and road.	[145]	BR	i	<ul style="list-style-type: none"> This research has focused on the distribution characteristics and risk analyses of resources and environmental factors in countries along the route, impacts of construction projects on regional resources and the environment, and the impacts of global climate change on the BRI. For regional cooperation, China has actively explored green supply chains that leverage purchasers to achieve improvements in environmental performance. the space left for Chinese overseas investment is mostly characterized by a high difficulty of developing natural resources, fragile local ecological environments, sensitive geopolitical politics, strong religious and local forces, and relatively weak economies.

Table A1. Cont.

Article	Citation	Scale	Method	Statements on Sustainable Development Color Coding: Blue—Economic, Green—Environmental, Orange—Social, Grey—Political Issues
Daye, M., et al. (2020). Exploring local stakeholders' views on the prospects of China's Belt and Road Initiative on tourism development in Kazakhstan	[123]	N	v	<ul style="list-style-type: none"> The findings suggest that while there is a strong support for the economic value of China's BRI for the sector, there are some concerns that it may undermine local autonomy and Kazakhstan's distinctive brand as a tourist destination. this study will also address the gap in the literature on local perceptions of multi-sectoral, regional infrastructural development projects that both include and impact tourism such as the proposed BRI. This points to the importance of measuring the attitudes of Kazakhstan tourism, civic and business stakeholders' attitudes to future development plans for tourism under the BRI, to determine whether there is some perception of risk that their local autonomy and overall sovereignty may be compromised by China's control of the investment landscape.
Evseev, A. V., et al. (2019). New look at territories of traditional nature use—traditional nature management lands at the coastal zone of the Ice Silk Road: a case study for the Russian Arctic	[197]	N	v	<ul style="list-style-type: none"> To meet ecological and social sustainable development tasks in the Arctic, ecological buffer territories are needed for reproduction of supporting, provisioning and regulating ecosystem services beneficial both for the ecosystem and local communities' sustainable development
Feng, T.-t., et al. (2019). Synergies of sustainable development goals between China and countries along the Belt and Road initiative	[122]	C	i	<ul style="list-style-type: none"> Several paths present themselves ahead, such as: to enrich and deepen creative dialogues between China and countries along 'the Belt and Road', discuss regional SDGs topics like 'food security, clean drinking water and sanitation facilities, clean energy, climate change, public health and so on, fashion new ways to cooperate with each other, and promote public-private partnership (PPP); to build united labs, research and development hubs, incubators, research and science infrastructure facilities, and big data platforms, guide resources/funds to activate mechanism to promote tech innovation, collaborate in setting up technology transfer institutions and tech banks to accelerate the transfer, expansion and promotion of environment-friendly technologies [...] based on bilateral and multi-lateral partnership agreements;
Galán, E. M., and Leandro, F. J. (2019). The Belt and Road Initiative: The Cornerstone of the New-Fangled Financial Institutionalism Led by China	[202]	BR	v	<ul style="list-style-type: none"> regarding the new MDB proposed by China, the AIIB, its aim was two-folded: "(i) promoting economic development and regional integration in Asia; and (ii) showing to the world that China was capable of leading a new MDB with the highest international practices in matters of governance, safeguard policies including environmental protection, resettlement, and debt sustainability, among others".
Gonzalez-Vicente, R. (2019). Make development great again? Accumulation regimes, spaces of sovereign exception and the elite development paradigm of China's Belt and Road Initiative.	[172]	C	t	<ul style="list-style-type: none"> Project-specific issues are influenced by governmental demands and civil society pressures, such as the percentage of Chinese versus local workers, environmental standards, or more broadly, the adequacy of a project within a country's long-term development vision
Gu, A., and Zhou, X. (2020). Emission reduction effects of the green energy investment projects of China in belt and road initiative countries	[119]	BR	d	<ul style="list-style-type: none"> the opportunities for BRI countries to achieve sustainable development and climate change targets at low investment costs have been greatly increased.
Hafeez, M., et al. (2018). Does finance affect environmental degradation: Evidence from One Belt and One Road Initiative region?	[118]	BR	e	<ul style="list-style-type: none"> Due to bi-directional causality within OBOR region, finance is a fruitful instrument for environmental scientists and regulatory authorities to devise short-run regional policies. pollution-halo hypothesis: multinational organization complies with the international environmental regulations and spreads green technology in the neighboring countries, which implies that FDI inflows mitigate the carbon emission and improves the environmental quality.

Table A1. Cont.

Article	Citation	Scale	Method	Statements on Sustainable Development Color Coding: Blue—Economic, Green—Environmental, Orange—Social, Grey—Political Issues
Hafeez, M., et. Al.. (2019). An empirical evaluation of financial development-carbon footprint nexus in One Belt and Road region.	[206]	BR	d, e	<ul style="list-style-type: none"> financial entities must develop policies and strategies in a manner consistent with national and regional sustainability models in order to strengthen their global standards for the establishment of sustainable banks.
Han, M., et al. (2020). Carbon inequality and economic development across the Belt and Road regions	[207]	BR	e	<ul style="list-style-type: none"> The model integrates economic networks and ecological endowments by examining the physical balance of resource use and environmental emissions for a regional system.
He, and Cao (2019). Pattern and Influencing Factors of Foreign Direct Investment Networks between Countries along the “Belt and Road” Regions	[171]	BR	s	<ul style="list-style-type: none"> the practice of the Belt and Road initiative will greatly promote the economic integration process and sustainable development of these three major regions. According to Mundell’s research, when the volume of trade between the host country and the home country is very large, the host government will set up relevant trade barriers to the home country enterprises, so as to protect the development interests of domestic enterprises.
Hou, J., et al. (2020). A global analysis of CO 2 and non-CO 2 GHG emissions embodied in trade with Belt and Road Initiative countries	[192]	BR	e	<ul style="list-style-type: none"> China should lead the collaboration with multiple parties to build a green, low-emissions, and sustainable system of rules under the BRI framework in the areas of policies, projects (infrastructure), trade and trade agreements, finance, culture, and other relevant areas, in order to promote BRI countries’ green development and global climate governance.
Howard, K. W. F., and Howard, K. K. (2016). The new “Silk Road Economic Belt” as a threat to the sustainable management of Central Asia’s transboundary water resources	[159]	SN	s	<ul style="list-style-type: none"> Such a project would bring profound economic benefits to the entire region and create wealth and prosperity in some of the world’s most impoverished areas. Central Asian countries need to recognise that the economic success of the “Silk Road Economic Belt” hinges on their ability to develop programs that can ensure the region’s water resources are managed in a sound and sustainable manner.
Hu, D., et al. (2017). On the Environmental Responsibility of Chinese Enterprises for Their FDI in Countries within the One Belt and One Road Initiative	[184]	C	v	<ul style="list-style-type: none"> Sustainable development should take into account the carrying capacity of the local environment. Enterprises could achieve a steadier and more sustainable development by linking their development with that of the local community through mechanisms of information exchange, participation, and benefit sharing. Elastic environmental standards leave room for random explanations, causing uncertainty in the determination of responsibility, while low environmental standards may trigger protest and conflicts from local communities and opposition parties.
Jia, Z., et al. (2020). Monitoring of UN sustainable development goal SDG-9.1.1: Study of Algerian “Belt and Road” expressways constructed by China	[120]	N	s	<ul style="list-style-type: none"> China’s Belt and Road infrastructure interoperability major projects are fast, which has strongly promoted local socioeconomic development and population growth.
Jianying, X., et al.. (2020). Partitioned responses of ecosystem services and their tradeoffs to human activities in the Belt and Road region.	[193]	BR	s, e	<ul style="list-style-type: none"> our results suggested that rational utilization of water resources, maintaining a moderate population size and industrialization speed, and improving the utilization efficiency of resources, which could provide references for achieving sustainable development goals (SDGs) at a regional scale.

Table A1. Cont.

Article	Citation	Scale	Method	Statements on Sustainable Development Color Coding: Blue—Economic, Green—Environmental, Orange—Social, Grey—Political Issues
Kang, L, et al. (2018). Harmony in Diversity: Can the One Belt One Road Initiative Promote China's Outward Foreign Direct Investment?	[194]	BR	e	<ul style="list-style-type: none"> our main argument is that China's OBOR initiative, as a new regional cooperation model used to accelerate China's transformation from an FDI receiver to an FDI provider for the next stage of sustainable development, is an important strategy to sustain its economic growth by continuing its long tradition of economic, institutional, and cultural convergence with the OBOR countries.
Li, P. et al. (2015). Building a new and sustainable "Silk Road economic belt	[155]	SN	v	<ul style="list-style-type: none"> Any effort to build the New Silk Road in an environmentally sustainable will fail without the full support of the local people.
Liu, Y. (2019). China's Implementation of Goal 9 of the 2030 Agenda for Sustainable Development:	[132]	BR	d	<ul style="list-style-type: none"> Construction of special economic zones and industrial parks is an important method used by China in its constant exploration of deepening economic system reform and improving opening-up quality, and also a crucial platform and approach for the Chinese industry to undertake outbound industrial transfer, foster China's small and medium-sized enterprises, and further promote industrial clustering, upgrading, and regional development. At a local level, all provinces, cities, and autonomous regions develop their implementation and action plans to keep pace with the BRI and capacity cooperation, depending on their own development planning, location related advantages, and industrial features, with a focus on enabling local enterprises to be the main force of going out to participate in international capacity cooperation and explore new cooperation models
Pechlaner, H., et al.. (2019). Local service industry and tourism development through the global trade and infrastructure project of the New Silk Road—the example of Georgia	[126]	N	v	<ul style="list-style-type: none"> While the environmental impacts remain unclear, the interviewees envision many social benefits. analyzing the transition from infrastructure towards logistic services and regional services is crucial, since the development of the tertiary economic sector is assumed to cause regional interlinking beyond the mere transportation of goods This dynamics in turn affects the pattern of movement of persons and goods, as well as the spatial pattern of economic activities on site, resulting in a higher accessibility and an increased regional productivity A further precondition to allow local service development is the utilization of hubs and gateways to provide supportive and logistic services in order to exceed the mere transit traffic.
Pieper, M. (2020). The linchpin of Eurasia: Kazakhstan and the Eurasian economic union between Russia's defensive regionalism and China's new Silk Roads	[158]	SN	v	<ul style="list-style-type: none"> both the Russian and Kazakhstani governments look at China's economic power with a mix of awe and alarm, as do local communities in Kazakhstan. The resulting economic and political consequences in 'BRI' partner countries debunk the persistent myth of Chinese aid as development assistance 'with no strings attached'.
Qi, X., et al. (2019). Relative importance of climate change and human activities for vegetation changes on China's silk road economic belt over multiple timescales	[208]	C	e	<ul style="list-style-type: none"> to ensure sustainable socioeconomic development in the Silk Road Economic Belt, and particularly in arid and semi-arid regions, vegetation should be protected from human activities to prevent ecosystem loss.

Table A1. Cont.

Article	Citation	Scale	Method	Statements on Sustainable Development Color Coding: Blue—Economic, Green—Environmental, Orange—Social, Grey—Political Issues
Saud, S., et al. (2019). The nexus between financial development, income level, and environment in Central and Eastern European Countries: A perspective on Belt and Road Initiative	[173]	BR	d	<ul style="list-style-type: none"> The Dynamic Seemingly Unrelated Regression long-run panel results reveal that (i) financial development index and income negatively impact on environmental quality; (ii) energy consumption is the key determinant of CO2 emissions and reduces environmental quality; (iii) urbanization and trade both enhance environmental quality via reduction of carbon emissions; and (iv) the environmental Kuznets curve hypothesis supported for the selected panel countries.
Shao, Z.-Z., et al. (2018). Evaluation of large-scale transnational high-speed railway construction priority in the belt and road region	[143]	BR	v	<ul style="list-style-type: none"> relying on the BandR construction, China will play a leading role in regional economic cooperation, which is not only conducive to the economic development of the countries along the Silk Road, but is also of great importance for the promotion of the international division of labor, international cooperation, and integration of regional economy.
Sun, et al. (2019). Does the “Belt and Road Initiative” Promote the Economic Growth of Participating Countries?	[142]	BR	e	<ul style="list-style-type: none"> At present, the protectionist forces of various countries are gradually rising, raising the tariff rates of imported goods to promote the economic recovery of their own countries, which directly affects the volume of trade among countries.
Sun, Q., et al. (2019). Synergetic Effect and Spatial-Temporal Evolution of Railway Transportation in Sustainable Development of Trade: An Empirical Study Based on the Belt and Road	[209]	BR	d	<ul style="list-style-type: none"> Sustainable trade is a new trade model that is driven by the concept of sustainable development, which aims to promote economic growth, enhance social capital and integration into environmental management, and participate in regional trade development. take advantage of the railway transportation of the countries along BandR, realize the effective flow of goods between the countries, and form sustainable development that is based on the sharing of railway resources.
Tian, G., and Li, J. (2019). How Does Infrastructure Construction Affect Economic Development along the “Belt and Road”: By Promoting Growth or Improving Distribution?	[114]	BR	d, e	<ul style="list-style-type: none"> In bringing these two concepts [Maritime Silk Road and Silk Road Economic Belt] to fruition, “The Belt and Road Initiative” (OBOR) has opened a new channel for production, trade, and economic cooperation between China and numerous countries around the world.
Tian, X., et al. (2019). Trade impacts of China’s Belt and Road Initiative: From resource and environmental perspectives	[165]	C	d,i	<ul style="list-style-type: none"> The unbalance between trade development and environmental issues also imposed an “ecological imbalance” on China’s provinces, leading to regional disparity.
Wang, C., et al. (2020). Railway and road infrastructure in the Belt and Road Initiative countries: Estimating the impact of transport infrastructure on economic growth.	[115]	BR	s	<ul style="list-style-type: none"> From the perspective of financial sustainability, the large projects will raise the risk of debt distress and may expand debt to unsustainable levels in several BRI borrower countries.
Yang, Y., and Fan, M. (2019). Analysis of the spatial-temporal differences and fairness of the regional energy ecological footprint of the Silk Road Economic Belt (China Section)	[210]	C	e	<ul style="list-style-type: none"> Maintaining the spatial equilibrium between the ecological environment and economic growth is the basis for the sustainable development of a region.

Table A1. Cont.

Article	Citation	Scale	Method	Statements on Sustainable Development Color Coding: Blue—Economic, Green—Environmental, Orange—Social, Grey—Political Issues
Yang, Z., and Zeng, X. (2019). Envisioning the Impact of the Belt and Road Initiative on Regional Labor Markets	[166]	C	d	<ul style="list-style-type: none"> As a major commitment of the initiative, investment and trade are predicted to attract ample attention, which may create the potential for regional cooperation and development, especially in parts that were relatively forgotten in the previous round of economic globalization, such as central Asia. the BRI is a way for China to sustain its economic growth, by exploring new forms of international economic cooperation with new partners, bringing with it new opportunities for relatively less developed regions; for instance, western China. when the western regions change the industrial structure through import and export trade and introduce more labor into the local market, the local labor structure changes, and thus generates a force for regional development.
Yin, W. (2019). Integrating Sustainable Development Goals into the Belt and Road Initiative: Would It Be a New Model for Green and Sustainable Investment?	[121]	BR	t	<ul style="list-style-type: none"> International organisations and regional inter-government cooperative associations play a critical role in China's external effort to integrate SDGs into the BRI and promote green and sustainable investment along the BRI. Climate change is already having a significant impact, especially on vulnerable countries and populations. the national environmental protection consciousness of many countries is very strong, which results from promoting the notion of environmental protection by the local media, civil societies, and non-governmental organisations (NGOs). This initiative aims to address the 'infrastructure gap', promote mobilisation and efficient allocation of economic resources and deep integration of markets, and encourage the countries along the BRI to coordinate their economic policy and deepen regional cooperation for the purpose of creating an open, inclusive, and balanced regional social and economic cooperation framework that benefits all. SDGs and BRI share consensus or notions in many respects, e.g., sustainable investment, infrastructure development, and cooperative mechanism; they are also mutually supportive of development agendas in certain areas. The land expropriation problems involved in construction project need to be communicated adequately with the local government and people. It requires aligning SDGs and the BRI firstly at the policy level, and integrating relevant projects into the national and local government development agendas.
Zhang, Y., et al. (2019). Addressing the Insufficiencies of the Traditional Development Aid Model by Utilizing the One Belt, One Road Initiative to Sustain Development in Afghanistan	[161]	N	v	<ul style="list-style-type: none"> It [Information Platform] assists with investments in Afghanistan that support the development of Afghan private enterprises, improve local employment, and promote economic transformation The findings provide a better understanding of the BRI in promoting the internal dynamism required to develop the regional economy, and fill a gap in the literature with regard to the applied and theoretical economic growth models for stabilizing and sustaining the development of fragile and conflict-affected states.

BR—Belt and Road Countries, O—Other, N—Countries, C—China, SN—Supranational, d—Data, e—economic and environmental modelling, s—spatial models, i—indexing and indicators, v—various.

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