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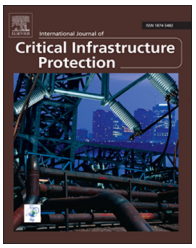

Infrastructure financing and development: A bibliometric review

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ABSTRACT

This paper conducts a comprehensive review of the literature published between 1989 and 2015 on infrastructure and related issues. The articles are classified and presented on the basis of publication source, publication year, country of origin, research methodology and focus area. The review reveals that most of the articles on infrastructure and related issues were published during the period 2010 through 2012. Furthermore, most studies are empirical in nature and the majority of the studies focus on infrastructure financing. Another key finding is that most of the studies deemed public–private partnerships to be the preferred source of infrastructure financing. The review offers a better understanding of infrastructure and related issues, and the position of existing research. The review also highlights the areas that are relatively less explored. Academicians, researchers and policy makers may use these observations as guidelines to conduct further investigations of infrastructure and related issues.

1. Introduction

The physical structures and networks that deliver the requisite services to various sectors and communities and facilitate the overall development of a nation are collectively referred to as infrastructure [124]. Broadly, infrastructure includes water supply, sewage, housing, roads and bridges, ports, power, airports, railways, urban services, communications, oil and gas production, and mining. Interestingly, Grimsey and Lewis [52] assert that there need not be a particular definition for the term "infrastructure" because it can be easily recognized and identified.

Infrastructure is the backbone of all economic activity. Strong linkages have been reported between improved infrastructure and the rising economy of a country: a 1% increase in the stock of infrastructure is associated with a 1% increase in GDP across all countries [144]. Several studies have noted that infrastructure greatly affects national economic growth and is a major factor that contributes to overall economic development [15,56,124]. Infrastructure services not only assist economic development, but also support agricultural and regional development, and help reduce poverty [5,19,72,95,96,98]. Infrastructure services are vitally important to surviving in a modern society and maintaining high living standards. Basic functions of modern society rely on infrastructure, without which essential services such as high quality education, health facilities, transportation systems, high-speed telecommunications services and proper sanitation facilities would not exist [146]. Improved infrastructure helps remove barriers such as poverty, unemployment, regional imbalances, poor livelihood, illiteracy and poor health, all of which negatively impact national development.

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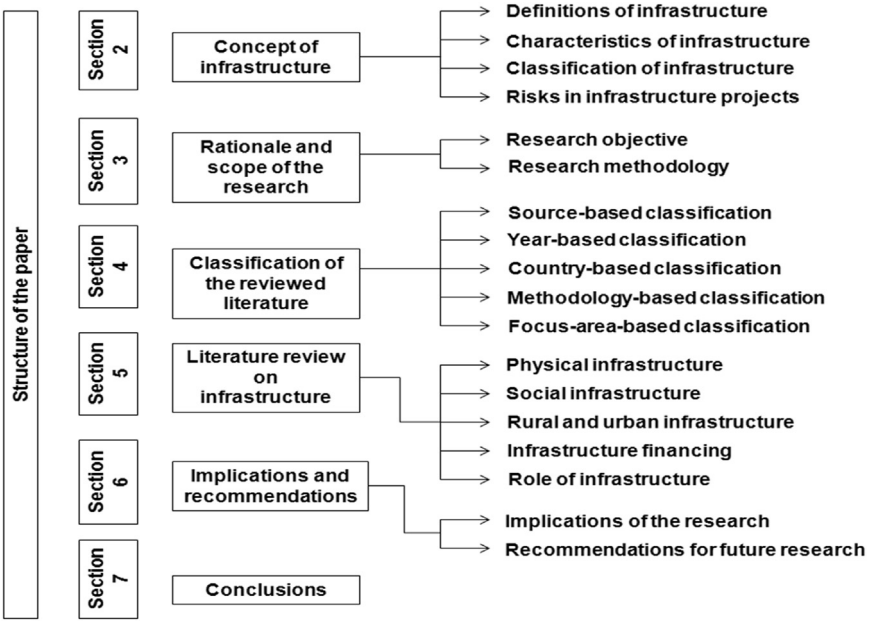

Fig. 1 – Organization of the research.

However, high-quality infrastructure needs enormous funds for construction, maintenance, operations and overall development. Some decades ago, governments were the only investors in the infrastructure sector, but government investment alone proved to be inadequate for infrastructure development. It was only after 1991 that many countries allowed private sector investments in their infrastructure sectors [2,52,123,124,129]. Private financing not only provides the required funds, but it also brings expertise, innovation, modern technologies and effective strategies that reduce the risks associated with infrastructure projects. While there are many private sources of finance, most studies consider public–private partnerships to be the best mechanism for infrastructure development [35,52,65,67,128].

Given the importance of infrastructure and finance for infrastructure development, these subjects have received much research attention around the world. Infrastructure, its nature and types, its role in the overall development of nations, and sources of finance and their importance for infrastructure development are some of the topics that have been studied by researchers.

While most studies on infrastructure and related issues are empirical in nature, some literature reviews have been conducted as well. Unfortunately, no attempts have been made to classify the research literature on infrastructure and related issues. A classification would provide valuable insights into the status of research in the domain. It would give structured information on publication venues, publication trends over the years, countries that have contributed the most to the literature, areas in which more (and less) studies have been conducted and areas (and contexts) that need more research attention.

This research seeks to fill the void by presenting a comprehensive review of 149 articles published from 1989 through 2015. The research, which is divided into six sections (Sections 2 – 7), as shown in Fig. 1, classifies the studies based on source, publication year, country, research methodology and focus area. Brief descriptions of the issues related to infrastructure (as provided by the reviewed studies) are also presented. Additionally, the areas that have received relatively less research attention and need more study are highlighted. These observations provide valuable insights and suggest directions for future research. Such an attempt has not been made before; this underscores the original contribution of this work to the body of literature in the field.

2. Concept of infrastructure

This section presents definitions of infrastructure as provided by several authors based on traits, types and risks in infrastructure projects.

2.1. *Definitions of infrastructure*

Although infrastructure is a topic that is widely discussed, a standard definition of infrastructure does not exist. Grimsey and Lewis [52] say that infrastructure is easier to identify than describe. The World Development Report [144] considers infrastructure as an “umbrella” for several activities. After reviewing myriad opinions and definitions given by authors, economists and planners, it can be concluded that infrastructure broadly covers roads, bridges, tunnels, railways, harbors, airports, tramways, subways, irrigation networks, dams and canals, water pipelines, water purification and treatment plants, potable water supply, power lines, power plants, power distribution networks, oil and gas pipelines, sanitation and sewage facilities, health and housing services, urban services, communications and telecommunications networks [102,125].

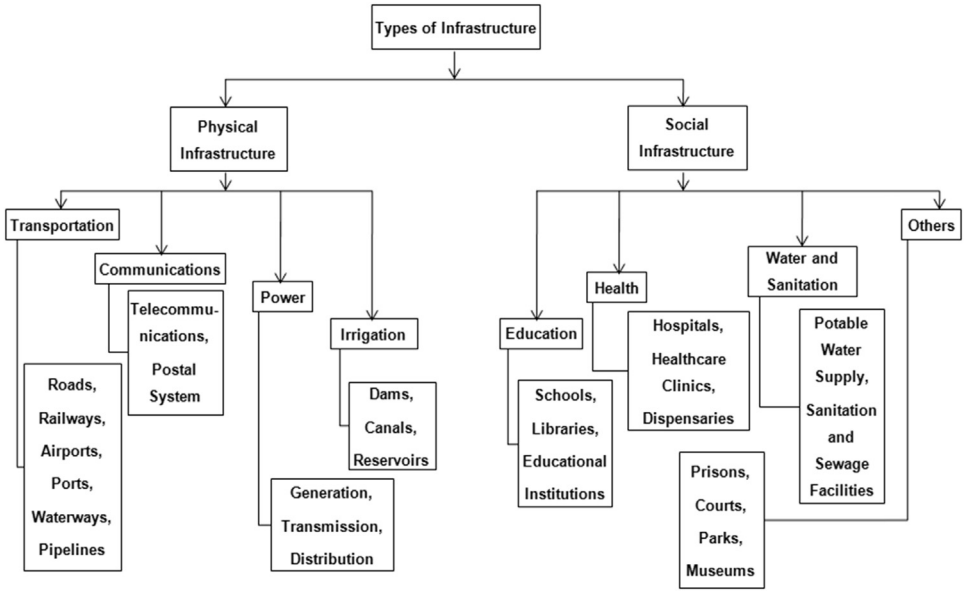

Fig. 2 – Classification of infrastructure.

2.2. *Characteristics of infrastructure*

It is important to identify infrastructure characteristics because they affect investment decisions related to infrastructure projects. Many private investors are unwilling to invest in infrastructure projects due to high risk, low returns, slow pace of maturity and long gestation periods. High risk, longer maturity, fixed and low (but positive) real returns, long sunk costs, high risk portfolios, long gestation periods, illiquid returns, high capital outlays, difficult valuations due to taxation, pricing rules, complex nature and involvement of multiple risks are some of the characteristics identified by researchers [2,52,59,88,117,123].

2.3. *Classification of infrastructure*

Authors, economists and urban planners have classified infrastructure mainly into two components based on its nature: (i) physical/economic infrastructure and (ii) social infrastructure. Physical/economic infrastructure covers the sub-sectors that directly contribute to production and economic activities [14,49,78,123]. Social infrastructure includes the sub-sectors that directly facilitate social development and raise the quality of life [49,52,78]. Fig. 2 further categorizes the physical and social infrastructures into multiple sectors [14,28,49,52,78,102,123,124,137,140].

2.4. *Risks in infrastructure projects*

Infrastructure projects are very expensive. Therefore, before making an investment, it is essential to analyze the various risks associated with an infrastructure project. Due to these risks, many investors are uncertain about investing in an infrastructure project, but if the risk is identified and recognized, then the rate of loss can be reduced [52,126].

Infrastructure project risks can be classified into three categories: (i) market-related risks due to financial markets; (ii) completion risk linked with infrastructure construction and operation; and (iii) institutional risk arising from rules, regulations, laws and public pressures. As shown in Fig. 3, the risks can be categorized as (i) commercial risks; (ii) financial risks; (iii) country and community risks; (iv) force majeure risks; and (v) other risks.

2.4.1. *Commercial risks*

These risks are mainly associated with the construction and operation of infrastructure projects. They include technical risks, construction risks, operational risks, performance risks, demand risks and input risks [52,67,73,80,85,94,127].

2.4.2. *Financial risks*

These risks are associated with the financial aspects of projects and primarily arise from poor hedging of revenue and increased costs of financing. The risks include equity risks, accounting and economic risks, liquidity risks,

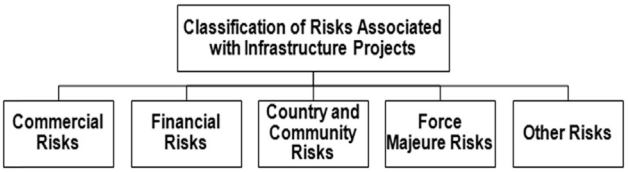

Fig. 3 – Risk classification of infrastructure projects.

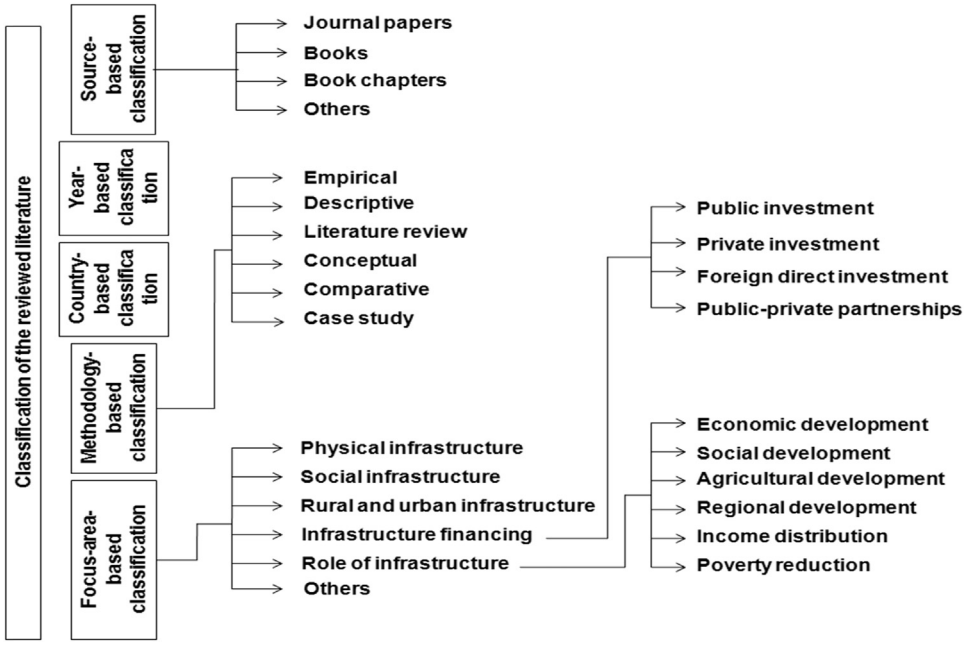

Fig. 4 – Classification of the literature.

bankruptcy risks, counterparty risks, refinancing risks, fluctuations in exchange rates, incorrect expectations of inflation and currency/devaluation risks [52,85,94,127].

2.4.3. *Country and community risks*

These risks arise from political and legal conditions in an economy, and public opinion. Examples include riots and domestic disturbances, currency inconvertibility and transfer risks, breaches of contracts and regulatory/political risks [20,40,52,67,94,127,131].

2.4.4. *Force majeure risks*

These risks cannot be controlled by infrastructure project participants. The risks include natural disasters, terrorism and war [40,52].

2.4.5. *Other risks*

Other possible sources of risk include lack of fidelity, theft and residual value risks [20,80,131].

3. Rationale and scope of the research

Infrastructure is essential to the socioeconomic development of a nation. Consequently, there is increasing apprehension about the status of infrastructures in developing countries and the urgent need to improve infrastructures and their financing. While several studies have focused on infrastructure, no single study covers all these issues. To address this gap, this paper reviews existing literature on infrastructure and presents the results in a structured manner to benefit future research. The paper defines the term "infrastructure," presents its characteristics and clarifies the types of risks that underlie infrastructure projects. The role of infrastructure in the various sectors is also highlighted and the sources of financing are discussed.

3.1. *Research objective*

The principal objective of this research is to provide a clear understanding of the status of research on various issues related to the infrastructure.

3.2. *Research methodology*

This research examines studies on various aspects of national infrastructures that have been published in journals and other venues. In all, 149 bodies of work – published and unpublished manuscripts – were analyzed to develop the categorization of literature presented in this paper.

4. Classification of the reviewed literature

A total of 149 items in the research literature were analyzed and categorized based on source, year of publication, country of origin, research methodology and focus area. This section presents detailed information about the literature review. Fig. 4 presents the entire basis of the classification.

4.1. *Source-based classification*

Of the 149 items that were reviewed, 95 were published in national or international journals, 10 were books, 11 were book chapters and 33 were conference papers, dissertations, theses, working papers and unpublished articles available on the Internet. The search sources included Google Scholar and other journals published by renowned publishing houses such as Elsevier (ScienceDirect), Sage, Emerald, Springer and

Table 1 – Distribution of the reviewed literature according to source.

Sources of reviewed literature	Number of items
Journal papers	
Acta Polytechnica	1
Agricultural Economics	1
American Economic Review	1
American Journal of Agricultural Economics	3
Applied Econometrics and International Development	1
ASEAN Economic Bulletin	1
Bulletin of the World Health Organization	2
China and World Economy	1
Construction Management and Economics	1
Economic and Political Weekly	2
Economic Development and Cultural Change	3
Economics of Education Review	1
EIB Papers	1
Energy Policy	3
Engineering, Construction and Architectural Management	1
European Economic Review	1
Finance and Development	1
Habitat International	1
Handbook of the Economics of Finance	1
Higher Education for the Future	1
International Journal of Applied Econometrics and Quantitative Studies	1
International Journal of Critical Infrastructure Protection	2
International Journal of Innovative Research and Development	1
International Journal of Interdisciplinary Research	1
International Journal of Project Management	6
International Review of Economics and Finance	1
Irrigation and Drainage Systems	1
Journal of African Economies	1
Journal of Business Management and Social Sciences Research	1
Journal of Comparative Economics	1
Journal of Construction Engineering and Management	1
Journal of Corporate Citizenship	1
Journal of Development Economics	6
Journal of Development Studies	1
Journal of Economic Cooperation and Development	1
Journal of Economic Policy Reform	1
Journal of Facilities Management	1
Journal of Financial Management of Property and Construction	1
Journal of Health Organization and Management	1
Journal of Hydrology	1
Journal of Infrastructure Development	1
Journal of Monetary Economics	1
Journal of Property Investment and Finance	2
Journal of Property Research	1
Journal of the Asia Pacific Economy	1
Journal of Transport Geography	1
Management and Labor Studies	1
Networks and Spatial Economics	1
Public Administration	1
Public Policy and Administration	1
Regional Science and Urban Economics	2
Renewable and Sustainable Energy Reviews	3
Research and Practice in Social Sciences	1
Research in Transportation Economics	2
The Annals of Regional Science	2
The Electricity Journal	1

Table 1 (*continued*)

Sources of reviewed literature	Number of items
Journal papers	
The IUP Journal of Infrastructure	1
Transforming Government, People, Process and Policy	1
Transition Studies Review	1
Transnational Corporations	1
Transportation	1
Transportmetrica A: Transport Science	1
Utilities Policy	1
World Development	6
Yale Law and Policy Review	1
Total (A) Journal Articles	**95**
(B) Books	**10**
(C) Book Chapters	**11**
(D) Others[a]	**33**
Total Items	**149**

[a] Includes unpublished articles accessed on the Internet.

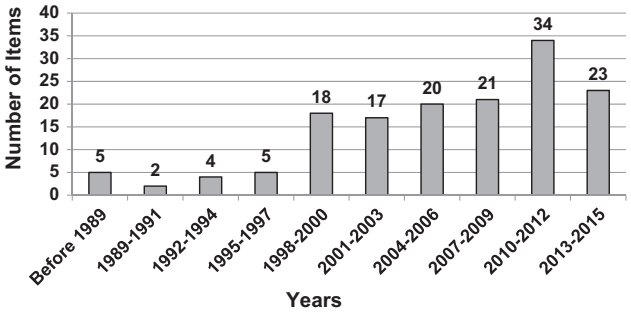

Fig. 5 – Year-based classification.

others. The search keywords used were infrastructure, role of infrastructure, infrastructure financing, public–private partnership, foreign direct investment, economic growth, poverty reduction, agricultural development and regional development. Table 1 shows the distribution of the reviewed literature according to sources.

4.2. *Year-based classification*

Research literature published during the period 1989 through 2015 is covered in this study. Fig. 5 presents the year-based classification of the surveyed literature. Note that five items published before 1989 (one published in 1983, one in 1984 and three in 1988) are included. Additionally, four items, officially published in 2016, are counted as being published in 2015 because they were completed and disseminated in 2015.

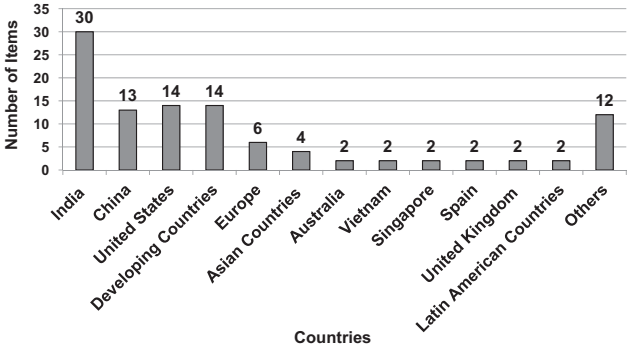

Fig. 6 – Country-based classification.

4.3. *Country-based classification*

Fig. 6 presents the country-based classification of the surveyed literature.

4.4. *Methodology-based classification*

The review of the literature identified six methodologies: (i) empirical; (ii) descriptive; (iii) literature review; (iv) conceptual; (v) case study; and (vi) comparative.

Empirical studies involve the application of observation or experience. Descriptive studies involve detailed explanations or representations of infrastructural sub-sectors and issues related to their financing. Literature reviews analyze multiple articles related to the infrastructure. Conceptual studies deal with the basic concepts and general issues related to the infrastructure. Case studies involve analyses of real infrastructures and infrastructure-related issues. Comparative studies involve the analysis of data from multiple countries.

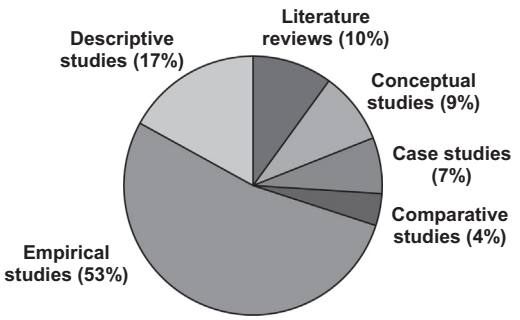

Fig. 7 – Methodology-based classification.

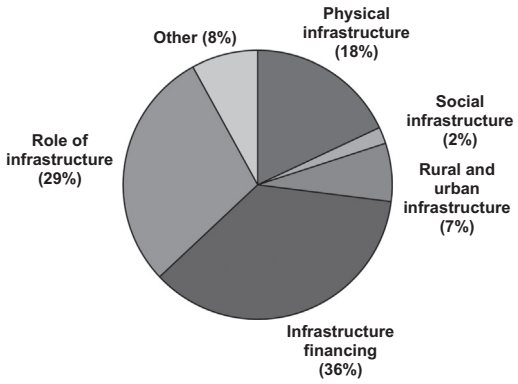

Fig. 8 – Distribution of the research literature.

Fig. 7 presents the methodology-based classification of the surveyed literature.

4.5. *Focus-area-based classification*

This section classifies the research literature into six categories: (i) physical infrastructure; (ii) social infrastructure; (iii) rural and urban infrastructure; (iv) infrastructure financing; (v) role of infrastructure; and (vi) other.

Fig. 8 presents the distribution of research literature according to the six categories. Note that infrastructure financing is a central research theme and constitutes a significant portion of the literature (36%).

4.5.1. *Physical infrastructure*

This category covers studies that focus on physical infrastructure sectors such as transportation, telecommunications and power. The physical infrastructure directly assists production functions. Further, it facilitates economic development. The most popular studies on physical infrastructure are by Gupta and Sravat [56], Sharma and Vohra [117], Roller and Waverman [112], Huang [57] and Sahoo and Dash [114].

4.5.2. *Social infrastructure*

This category covers the literature on social infrastructure sectors such as education and healthcare. The literature on social infrastructure is much less than that on the physical infrastructure. Major studies on social infrastructure are by Pal [95], Majumder [78], Ramani and Mavalankar [106] and Sapkota [116].

4.5.3. *Rural and urban infrastructure*

This category covers studies on rural and urban infrastructure. Both these sectors play a vital role in economic development. Important studies have been conducted in these areas by Ahmed and Hossain [3], Button and Rietveld [17], Mehta and Pathak [84] and Mahadevia [77].

4.5.4. *Infrastructure financing*

This category covers sources of infrastructure financing such as public investments, private investments, public–private partnerships, and World Bank and foreign direct investments. Fig. 8 shows that 36% of all studies are related to infrastructure financing, of which public–private partnerships has received the most attention. Key studies in this area are by Nijkamp and Rienstra [94], Mehta and Pathak [84], Jechoutek and Lamech [62], Erol and Ozuturk [37], Mundle [92] and Sader [113].

4.5.5. *Role of infrastructure*

This category covers the vital role of infrastructure in economic growth, social development, poverty reduction, agricultural development, regional development, balancing income distribution and improving livelihood. The most popular studies are by Ali and Pernia [5], Ahmed and Hossain [3], Aschauer [9], Hulten [60], Morrison and Schwartz [89], Antle [8], Binswanger et al. [13], Bhatia [12] and Fan et al. [43].

4.5.6. *Other*

This category includes studies in the various infrastructure sectors that focus on infrastructure projects, infrastructure regulations and the need for an evaluation of infrastructure financing.

5. Literature review on infrastructure

A number of empirical and theoretical studies have been conducted on various issues related to infrastructure. But the core issue of the discussion remains the same – to arrange more finance for infrastructure development. While many authors have worked on physical infrastructure variables such as transportation, power, communications and irrigation [56,112,114,117], comparatively little literature covers social infrastructure variables such as education, health and water and sanitation [72,78,95,106,116]. Even fewer studies have considered both physical and social infrastructures as variables [14,28,29,107]. This research covers most of the issues, including infrastructure financing, role of infrastructure, legal aspects of infrastructure projects and risks associated with infrastructure projects in the two types of infrastructure sectors.

5.1. *Physical infrastructure*

The research literature demonstrates that activities and services provided by the physical infrastructure such as transportation, power/electricity and telecommunications enhance the economic growth of nations [112,114,115,123]. Gupta and Sravat [56], Huang [57] and Kale and Pohekar [64] note that electricity is an essential element for improving living standards and facilitating national economic development. The energy sector needs large investments for the generation, transmission, allocation and distribution of power [117]. Lack of investments in the energy sector makes it very difficult to provide adequate power supply to all the sectors; hence, alternative sources such as captive power, wind power, biomass and biogas should be considered [64]. Most developing countries suffer from shortages of public funds in the energy sector that encourage or warrant private investment [33,56,62,133]. Huang [57] has identified some financing channels for rural energy such as international funding, commercial banks, financial institutions, government financing, private sector financing and the stock market.

Aside from the power sector, the transportation sector also plays a crucial role in national economic development [26,30,38,41,58,90,101,118,143,147]. Transportation is a sector that also needs significant investment and maintenance. However, due to long construction periods, some private investors refrain from investing in roadways [99]. Road improvements are sorely needed in developing countries and public–private partnerships are the best solution. Public–private partnerships can support road construction as well as road maintenance. Governments should spend more funds on road maintenance and repair instead of constructing new roads [41,42,143,144].

5.2. *Social infrastructure*

The development of a country is measured by its physical infrastructure and the human capital that has been developed through quality education, health, and water and sanitation facilities [15]. Proper development of human capital is essential because it is humans who can better utilize, maintain and expand the existing infrastructure [132]. Thus, social infrastructure growth is essential to developing human capital; education and health are the most important infrastructure services that enhance the quality of life [14,55,63,84]. Investments in these sectors also help enhance workforce skills, increasing their efficiency, improving productivity, eradicating poverty and improving livelihood and socioeconomic development [55,95]. Public–private partnerships are a suitable source of investments for these tasks. Several studies have analyzed the role of public–private partnerships in health, education and water management sectors, and have established that it is the best instrument for social infrastructure development [23,31,75,79,82,120,121,130,135,141].

5.3. *Rural and urban infrastructure*

Rural infrastructure includes rural electrification, roads and housing [123,124]. Urban infrastructure, on the other hand, includes electricity, urban transport, drinking water, sewage, sanitation, primary health services, gas distribution and environmental regulations. Well-developed economic and social infrastructures in rural and urban areas facilitate economic growth and help improve living standards [17,34,84,143,144].

Road connectivity to urban areas is essential to rural development [34,123]. A developed rural infrastructure increases agricultural productivity, generates employment opportunities, reduces poverty, grows local markets, improves livelihood, reduces price distortions in agriculture, raises living standards and expands domestic trade [3,8,13,18,38,43,50,68,90,105,139,143,145]. Government agencies are typically responsible for rural infrastructure development [59,123,143,144].

Improved urban housing and public utilities such as transport, electricity and gas distribution, health and education represent urban development [77,124]. While urban infrastructure development is a state government responsibility, it can be passed to local urban governments through municipal legislation [77].

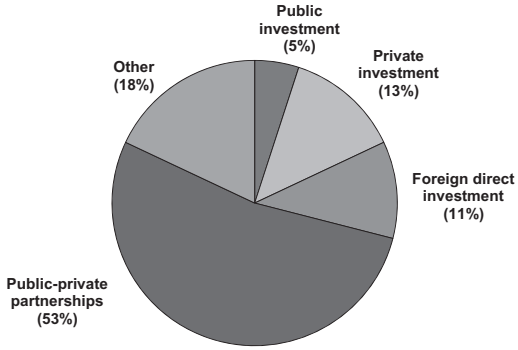

Fig. 9 – Distribution of the research literature on infrastructure financing.

5.4. *Infrastructure financing*

Investment is the lifeblood of every infrastructure project [2,52,123]. Infrastructure projects need massive funding for planning, design, construction, operation and maintenance. Lack of infrastructure financing is a universal problem and a key issue for discussion [37,78].

Until the late 1990s, governments were the main investors and the only entities accountable for developing all the infrastructure sectors. However, due to insufficient public investment, the infrastructure was in a dire situation in developing countries.

Starting in the late 1990s, the private sector began to enter the domain with significant funding as well as superior operating skills that helped minimize the risks associated with infrastructure projects [2,52]. Private investment in infrastructure can come from many sources, but public–private partnerships have become popular around the world [10,52,73,129]. Fig. 8 shows that a large part of the literature review is related to infrastructure financing. Fig. 9 demonstrates that a large number of studies on infrastructure financing focus on public–private partnerships.

5.4.1. *Public investment*

Some decades ago, the government was the sole investor in public infrastructure. The entire responsibility for the infrastructure, including construction, implementation, operation, maintenance and repair lay with government [45,56,88,123]. Infrastructure development, environmental protection, employment generation, provision of better living standards, higher income and economic development are the key goals of public investments. These investments develop the entire society, and not just a particular segment [142]. Public investment is different from private investment in terms of financial analysis, objectives and funding sources [47,142].

5.4.2. *Private investment*

Private investment refers to the transfer of infrastructure development responsibilities from the public sector to the private sector [53]. In 1991, when the status of the infrastructure in many countries was dire, only private financing could assume all the responsibilities of the infrastructure sector. At this time, private financing continues to support

the increasing demand for infrastructure amenities and succeeds at a large level.

According to Sharma and Vohra [117], Sader [113] and Geltner [47], this type of investment is well-suited to developing the infrastructure sector. In addition to large amounts of funding, private financing brings other components, including modern technologies, better operating skills, effective risk reduction strategies and better planning for completing projects within the deadlines [48,52,56,123]. Private financing comes in many forms such as alternative service delivery, private finance initiatives, public–private partnerships and foreign direct investment. Regardless, there are two ways to privatize the infrastructure sector – the first is to privatize existing infrastructure facilities and second is to give the private sector the responsibility for constructing new infrastructure.

5.4.3. *Foreign direct investment*

Foreign direct investment refers to funds made available by foreign entities, but in contexts where the investors supervise their investments [108]. Sharma and Vohra [117] highlight various forms of foreign direct investment such as divestitures, concessionaire arrangements, joint ventures and green field ventures. Due to the lack of domestic investment, most developing countries did not have adequate infrastructure facilities. These nations needed financial assistance from foreign countries, much of which was provided by direct investments from abroad [70,108].

The research literature has documented the vital role that foreign direct investment has played in infrastructure sectors such as power, transportation, telecommunications, health and education [6,108,117]. Foreign direct investment and infrastructure are, in fact, two sides of the same coin – while foreign direct investment helps improve infrastructure status, well-developed infrastructure is instrumental in attracting more foreign direct investment [70].

5.4.4. *Public–private partnerships*

Public–private partnerships are the subject of much discussion in the literature [2,4,52]. The major characteristics of a public–private partnership are:

- Private financing supports the construction, operation, maintenance and overall development of infrastructure sectors.
- A longstanding contractual agreement exists between the public and private sectors for developing the infrastructure sectors.
- The partnership provides infrastructure services to citizens on behalf of the public sector.

Public–private partnerships take on various forms, such as build–operate–transfer/build–own–operate (BOT/BOO) arrangements, leasing, joint ventures, contracting out, design–bid–build (DBB), design–build (DB), design–build–operate (DBO), design–build–finance–operate (DBFO) and pure operation and maintenance [52,54,85,113].

Public–private partnerships play a vital role in various infrastructure sectors such as roads, power, railways, hospitals and healthcare, public housing, education, water and sanitation, waste-water treatment and social infrastructure [23,24,31,46,75,79,82,83,100,120–122,130,135,141]. The partnerships involve multiple parties such as financial institutions, contractors, special purpose vehicles (SPVs), public sector and private sector organizations. While private sector organizations have a profit motive, public sector organizations seek to provide the best services at low cost.

Fig. 10 illustrates the contractual relationships in a public–private partnership along with the parties that are involved. Government departments act as clients in the public–private partnership. A special purpose vehicle (SPV) is a group of private sector (corporate) entities that come together to design, build and operate infrastructure facilities. A financial institution provides funds to the private sector and provides facility management subcontractors for infrastructure development [32].

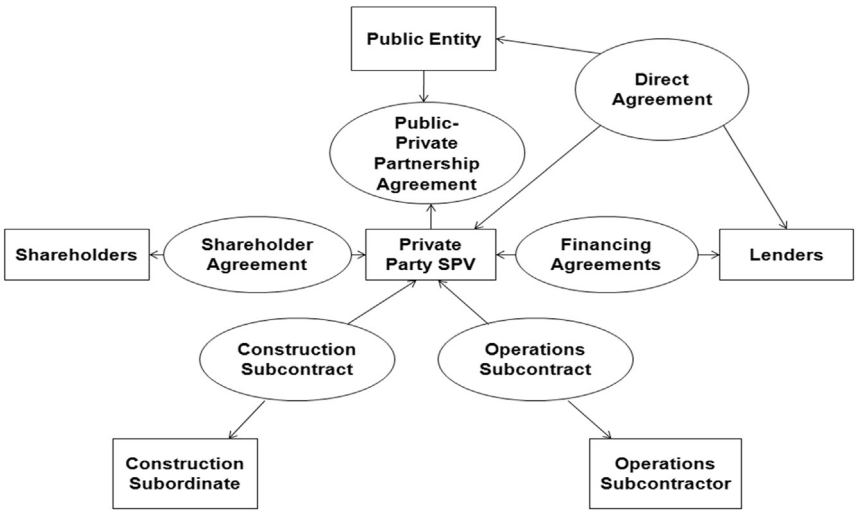

Fig. 10 – Contractual relationships in a public–private partnership [32].

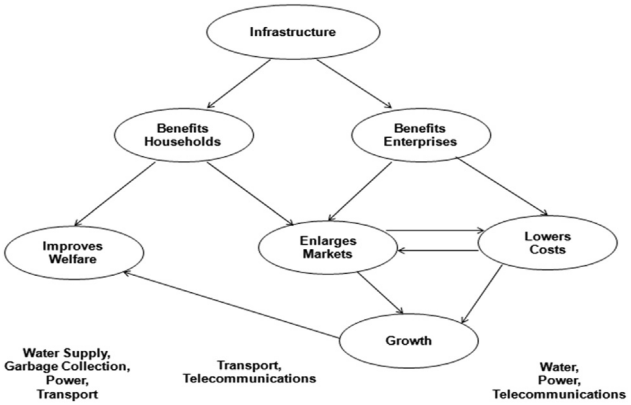

Fig. 11 – Roles of the physical and social infrastructures in overall national development [102].

Public–private partnerships are popular because they provide adequate funds and also enable proficient design, planning, scheduling, construction, maintenance and completion of infrastructure projects within the stipulated time periods [32,35,61,65,67,76,110,119,128,142]. Public–private partnerships also help reduce the risks associated with infrastructure projects, not only because of the multiple sources of finance (from the participating entities), but also due to the exchange of information and technical know-how related to the projects [148].

5.5. *Role of infrastructure*

Individuals in modern society demand an adequate quality of life and infrastructure services such as electricity, transportation, communications, potable water, sanitation facilities, health and education; indeed, these services are now considered to be basic requirements. Fig. 11 based on [102] clarifies the roles of the physical and social infrastructures in the overall development of a nation.

As shown in Fig. 12, the literature on the role of infrastructure can be divided into six sub-categories. It is clear that the role of infrastructure in economic development is a well-studied theme.

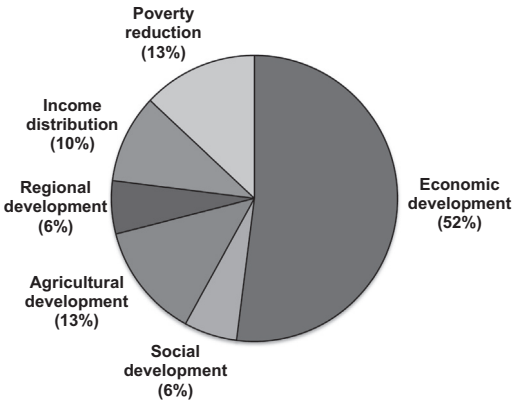

Fig. 12 – Distribution of the literature on the role of infrastructure.

5.5.1. *Economic development*

Before 1980, the role of infrastructure in economic development was almost totally ignored. In 1989, Aschauer [9] reported a strong link between infrastructure and economic development and stated that the reason for the slowdown of the U.S. economy was the lack of investment in public amenities [102]. After 1989, several studies empirically proved a strong relationship between infrastructure and economic growth across the world [16,21,25,27–29,39,44,60,89,101,104,114,115]. According to Wang [138], infrastructure mirrors the economic status and internal environment of a nation and the national economy greatly depends on infrastructure services. Some studies have also recognized this relationship in conceptual terms [1,19,58,123,144]. Infrastructure supports production functions, smooth progress of trade, lower costs, larger markets and higher employment, enhancing national economic development [16,56,84,117,123,124].

Achour and Belloumi [1] have discerned the causal relationship that exists between transport infrastructure, energy consumption and economic growth in Tunisia. They also note that huge investments were required in the infrastructure sectors to generate higher economic growth.

5.5.2. *Social development*

According to Brahmachary [15], the development status of a country cannot be measured only by its economic condition; social development should also be considered to determine the development status. Poor health and education infrastructures lead to low quality of life for citizens [81]. Physical and social infrastructure amenities play an important role in improving the well-being and quality of life of households [95,102,106]. Infrastructure amenities should be easily accessible to all groups of people, especially isolated communities [72]. Universal access to healthcare as well as potable water, sanitation, nutrition, primary education, communications and employment are prerequisites for a balanced lifestyle.

5.5.3. *Agricultural development*

Several conceptual and econometric studies have evaluated the impact of infrastructure investment on the productivity and output of agriculture, establishing that a positive effect exists [8,13,91]. It has been confirmed that well-developed rural infrastructure such as road connectivity, irrigation facilities, water supply, rural electrification, tube wells, primary health, sanitation and sewage, education facilities, storage and fertilizer sales depots help improve agricultural production at low cost, thereby increasing agricultural income [3,12,69,86,91,98,103,109].

Fig. 13 (adapted from [98]) shows the relationship between agriculture and infrastructure, and indicates the direct and indirect influences of infrastructure investments on agricultural output and productivity. According to Antle [7,8], Minten and Kyle [86], Qin and Zhang [103], Gohar et al. [51] and Moorhouse [87], transportation facilities in rural areas assist in connecting farmers and markets, which helps reduce transportation costs. Communications infrastructure reduces the gap between suppliers and farmers, while irrigation, water supply and modern inputs improve agricultural productivity and output.

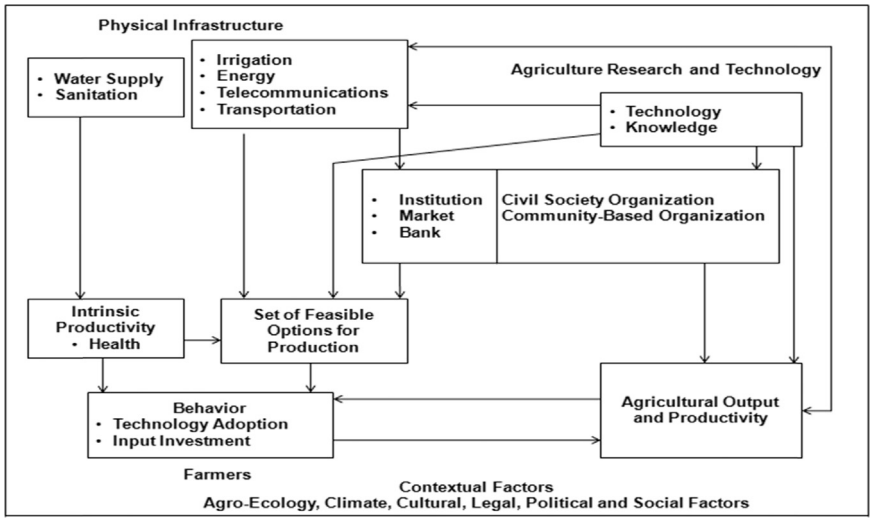

Fig. 13 – How infrastructure promotes agricultural development (adapted from [98]).

5.5.4. *Regional development*

Infrastructure services such as transportation, electricity, water supply, gas distribution, communications, education, sanitation and healthcare facilities are essential to the development of any region; unequal allocations of these services can result in regional imbalances [49,96]. Regional development is closely tied to infrastructure development. Several studies have analyzed the contributions of infrastructure to regional balancing; some of the studies have confirmed the positive relationship that exists between infrastructure and regional development [49,96,143,147]. A developed infrastructure across all regions provides essential services that facilitate the creation of employment opportunities and income generation.

5.5.5. *Income distribution*

Numerous studies have demonstrated the role of infrastructure in reducing income disparities [11,19,22,38,97,111,145,149]. According to Ghosh and De [49], regional infrastructure inequalities are responsible for imbalance in income distribution. Calderon and Serven [19] and Elhance and Lakshamanan [36] confirm that higher quality and quantity of infrastructure services in rural areas reduce income disparities. Insufficient funds in the infrastructure sector may be the root of problems such as regional disparities, unbalanced income distribution and poverty [49].

5.5.6. *Poverty reduction*

The contribution of infrastructure to economic development was acknowledged in the 1970s and 1980s, while its role in poverty reduction was identified in the 1990s. Several studies

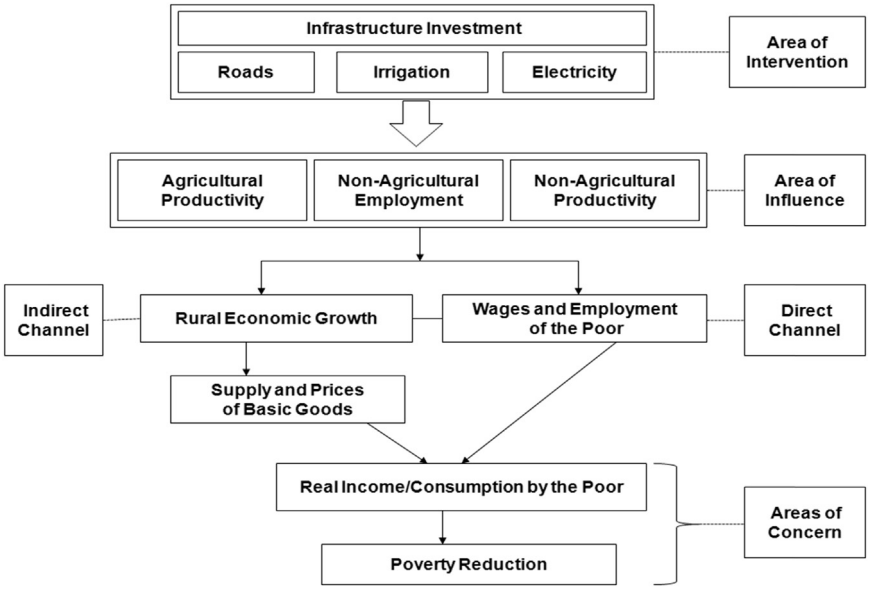

Fig. 14 – Role of infrastructure services in reducing poverty [5].

have revealed the contribution of infrastructure to poverty reduction [3,30,41,43,68,71,90,136,139]. Poor individuals cannot contribute to economic growth until they have employment opportunities and adequate access to infrastructure services [14,81,93,103]. Using the conceptual framework in Fig. 14, Ali and Pernia [5] have highlighted the roles of various infrastructure services in reducing poverty. Poverty creates obstacles to national socioeconomic growth; hence, it must be eradicated to spur economic development and improved quality life. Indeed, a well-developed infrastructure may well serve as a means to this end.

6. Implications and recommendations

This section presents the implications of this research and opportunities for future research.

6.1. Implications of the research

The literature serves as a ready reckoner and snapshot for researchers who work in or intend to work in the areas of infrastructure and infrastructure financing. After reviewing 149 publications and other items in the research literature, an effort was made to highlight the important areas in the infrastructure sectors that have attracted the attention of scholars and that are useful to the various stakeholders. The large database of studies developed as part of this work highlights the preferred and the weak areas of infrastructure development and financing. Indeed, new researchers may wish to focus on the areas that have received limited attention.

6.2. Recommendations for future research

This section presents some avenues for future research.

6.2.1. Sources of infrastructure financing

The research literature discusses various infrastructure financing sources for public and private investments. However, there are other financing sources for infrastructure sectors that may be studied further. These financing sources include Official Development Assistance (ODA); U.K. Infrastructure Finance Unit (IFU); U.S. Transportation Infrastructure Finance and Innovation Act (TIFIA loans); E.U. Africa Infrastructure Trust Fund (AITF); U.K. Infrastructure Investment Platform (IIP); Asian Infrastructure Investment Bank (AIIB); Southern Africa Development Committee (SADC); Advance Market Commitment (AMC); and International Finance Facility for Immunization (IFFIm). Researchers may wish to examine these infrastructure financing resources and determine their contributions to infrastructure development.

Although public–private partnerships have been used for infrastructure development at large scales in developed countries, they could contribute to infrastructure subsectors in developing countries such as parks and recreation, waste management, potable water, wastewater and sanitation, and healthcare [66]. Public–private partnerships have been successful in several developing countries, including Romania, Malaysia, China, India, Brazil, South Africa, Croatia, Poland and Lebanon. Researchers may wish to explore the contributions of public–private partnerships in other developing countries.

Researchers may also wish to investigate innovative sources of infrastructure financing. According to Levich et al. [74], innovative financing involves situations where lenders and borrowers look to transfer the price risk and credit risk and improve liquidity and credit enhancement and equity generation. Tufano [134] defines innovative financing as "the act of creating and then popularizing new financial instruments as well as new financial technologies, institutions and markets." Clearly, innovative sources of financing for infrastructure sectors are an important area of research inquiry.

6.2.2. Sector-specific studies

While researchers have studied the physical and social subsectors of infrastructure, there are several other sub-sectors that warrant research attention. These sub-sectors include public parks, government accommodation, waste management, prisons, police stations, courts, public housing, villages and isolated areas, and national monuments and icons. The development of these sub-sectors has the potential to enhance national socioeconomic growth. The role of public–private partnerships as a financing source for these subsectors is also an important research topic.

6.2.3. Role of infrastructure

The research literature explicitly recognizes the role of infrastructure in economic development, poverty reduction, agricultural development, and social and regional development. However, several other areas where economic and social infrastructure play a vital role have yet to be investigated. Supply chain management, employment generation, improving the livelihood of isolated groups and communities, rural development, manufacturing units and tourism development are some areas to which infrastructure is known to contribute. Researchers could explore other areas in which infrastructure plays a vital role.

6.2.4. Factors affecting infrastructure construction projects

Several factors affect infrastructure construction, including lack of raw materials, long gestation periods, technological issues, lack of communication between project participants, political issues and risk factors. Future research should focus on these areas and identify the determinants that may delay infrastructure construction. Researchers may use interpretive structural modeling to discern the enablers of and barriers to infrastructure construction projects.

6.2.5. Empirical evidence in infrastructure sectors

Several researchers have empirically demonstrated the role of infrastructure in economic development [9,16,114]; however, limited empirical research exists on the role of infrastructure in poverty reduction, agricultural development, tourism development, etc. Researchers have mostly worked with time series data; future researchers may wish to use panel data from many countries and compare the results of the national economies. The empirical findings would assist policy makers in crafting infrastructure development

initiatives. Researchers may use tools such as the autoregressive distributed lag model (ARDL), vector error correction model (VECM) and error correction model (ECM) to examine the relationships between infrastructure and its associated sectors. Software such as EViews and STATA could also be used to establish the relationships between infrastructure sub-sectors and linked sectors in which the sub-sectors play a vital role.

7. Conclusions

The development of a nation greatly depends on the status of its infrastructure. This study has reviewed the research literature on infrastructure and related issues and has presented the results in a systematic manner. The study reveals that infrastructure is the backbone of all economic and social activities, and helps reduce barriers to national development such as unemployment, poverty, regional misbalances and low productivity. Massive investments are required for the development of the physical and social infrastructure sectors. Although several sources of infrastructure financing exist, public–private partnerships are emerging as the preferred source for funding infrastructure construction, operations and maintenance. Policy makers and governments should attempt to leverage public–private partnerships to develop new infrastructure and operate their existing infrastructure at lower cost.

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REFERENCES

[1] H. Achour and M. Belloumi, Investigating the causal relationship between transport infrastructure, transport energy consumption and economic growth in Tunisia, *Renewable and Sustainable Energy Reviews*, vol. 56, pp. 988–998, 2016.

[2] R. Agrawal, A. Gupta and M. Gupta, Financing of PPP infrastructure projects in India: Constraints and recommendations, *The IUP Journal of Infrastructure*, vol. 9(1), pp. 52–57, 2011.

[3] R. Ahmed and M. Hossain, Developmental Impact of Rural Infrastructure in Bangladesh, Research Report 83, International Food Policy Research Institute, Washington, DC, 1990.

[4] A. Akintoye, M. Beck and C. Hardcastle (Eds.), *Public–Private Partnerships: Managing Risks and Opportunities*, John Wiley and Sons, Hoboken, New Jersey, 2008.

[5] I. Ali and E. Pernia, Infrastructure and Poverty Reduction – What is the Connection? ERD Policy Brief No. 13, Economics and Research Department, Asian Development Bank, Manila, The Philippines, 2003.

[6] M. Alsan, D. Bloom and D. Canning, The effect of population health on foreign direct investment inflows to low- and middle-income countries, *World Development*, vol. 34(4), pp. 613–630, 2006.

[7] J. Antle, Infrastructure and aggregate agricultural productivity: International evidence, *Economic Development and Cultural Change*, vol. 31(3), pp. 609–619, 1983.

[8] J. Antle, Human capital, infrastructure and the productivity of Indian rice farmers, *Journal of Development Economics*, vol. 14(1), pp. 163–181, 1984.

[9] D. Aschauer, Is public expenditure productive? *Journal of Monetary Economics*, vol. 23(2), pp. 177–200, 1989.

[10] S. Babatunde, A. Opawole and O. Akinsiku, Critical success factors in public–private partnership (PPP) on infrastructure delivery in Nigeria, *Journal of Facilities Management*, vol. 10(3), pp. 212–225, 2012.

[11] J. Berdegue, E. Ramirez, T. Reardon and G. Escobar, Rural nonfarm employment and incomes in Chile, *World Development*, vol. 29(3), pp. 411–425, 2001.

[12] M. Bhatia, Rural infrastructure and growth in agriculture, *Economic and Political Weekly*, vol. 34(13), pp. A43–A48, 1999.

[13] H. Binswanger, S. Khandker and M. Rosenzweig, How infrastructure and financial institutions affect agricultural output and investment in India, *Journal of Development Economics*, vol. 41(2), pp. 337–366, 1993.

[14] P. Brahmachary, Infrastructure development in Nagaland, in *Rural Development in North East India*, K. Singha and G. Patikar (Eds.), Concept Publishing, New Delhi, India, pp. 138–150, 2010.

[15] P. Brahmachary, Development of Infrastructure in the Districts of Nagaland: Trends and Disparities, Ph.D. Thesis, Department of Economics, Assam University, Silchar, India, 2014.

[16] K. Button, Infrastructure investment, endogenous growth and economic convergence, *The Annals of Regional Science*, vol. 32(1), pp. 145–162, 1998.

[17] K. Button and P. Rietveld, Financing urban transport projects in Europe, *Transportation*, vol. 20(3), pp. 251–265, 1993.

[18] P. Buys, U. Deichmann and D. Wheeler, Road network upgrading and overland trade expansion in Sub-Saharan Africa, *Journal of African Economies*, vol. 19(3), pp. 399–432, 2010.

[19] C. Calderon and L. Serven, The Effects of Infrastructure Development on Growth and Income Distribution, Policy Research Working Paper 3400, World Bank, Washington, DC, 2004.

[20] C. Chapman and S. Ward, *Project Risk Management: Concepts, Insights and Techniques*, John Wiley and Sons, Chichester, United Kingdom, 1997.

[21] A. Chandra and E. Thompson, Does public infrastructure affect economic activity? Evidence from the rural interstate highway system, *Regional Science and Urban Economics*, vol. 30 (4), pp. 457–490, 2000.

[22] S. Chatterjee and S. Turnovsky, Infrastructure and inequality, *European Economic Review*, vol. 56(8), pp. 1730–1745, 2012.

[23] T. Chiu and C. Bosher, Risk sharing in various public–private partnerships (PPP) arrangements for the provision of water and wastewater services, presented at the *Conference on Public–Private Partnerships – Opportunities and Challenges*, pp. 11–21, 2005.

[24] M. Cingolani, PPP financing in the road sector: A disequilibrium analysis based on the monetary circuit, *Transition Studies Review*, vol. 17(3), pp. 513–550, 2010.

[25] J. Cohen, Economic Benefits of Investments in Transport Infrastructure, Discussion Paper No. 2007-13, OECD/ITF Joint Transport Research Centre, International Transport Forum, Paris, France (www.oecd-ilibrary.org/transport/economic-benefits-of-investments-in-transport-infrastructure_234665400468), 2007.

[26] A. Cosar and B. Demir, Domestic road infrastructure and international trade: Evidence from Turkey, *Journal of Development Economics*, vol. 118, pp. 232–244, 2016.

[27] T. Dang and S. Low, Building infrastructure for long-term growth – The case of Vietnam, presented at the *Thirty-Eighth AUBEA International Conference* (www.library.auckland.ac.nz/

external/finalproceeding/Files/Papers/46530final00056.pdf), 2013.
[28] R. Dash and P. Sahoo, Economic growth in India: The role of physical and social infrastructure, *Journal of Economic Policy Reform*, vol. 13(4), pp. 373–385, 2010.
[29] S. Demurger, Infrastructure development and economic growth: An explanation for regional disparities in China? *Journal of Comparative Economics*, vol. 29(1), pp. 95–117, 2001.
[30] S. Dercon, D. Gilligan, J. Hoddinott and T. Woldehanna, The impact of agricultural extension and roads on poverty and consumption growth in fifteen Ethiopian villages, *American Journal of Agricultural Economics*, vol. 91(4), pp. 1007–1021, 2009.
[31] D. Desai, Public–private partnership (PPP) – A key to expand the education infrastructure of India, *International Journal of Innovative Research and Development*, vol. 4(8), pp. 240–247, 2015.
[32] D. Devan, Public–Private Partnerships – Risk Management in Engineering Infrastructure Projects, M.Phil. Dissertation, Faculty of Engineering and the Built Environment, University of Johannesburg, Johannesburg, South Africa, 2005.
[33] J. Dunkerley, Financing the energy sector in developing countries: Context and overview, *Energy Policy*, vol. 23(11), pp. 929–939, 1995.
[34] P. Dutta, Role of infrastructure in rural development in the north-eastern region of India, in *Rural Development in North East India*, K. Singha and G. Patikar (Eds.), Concept Publishing, New Delhi, India, pp. 85–115, 2010.
[35] S. Eid, Financing Infrastructure Projects, M.Eng. Thesis, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, 2008.
[36] A. Elhance and T. Lakshmanan, Infrastructure-production system dynamics in national and regional systems: An econometric study of the Indian economy, *Regional Science and Urban Economics*, vol. 18(4), pp. 511–531, 1988.
[37] T. Erol and D. Ozuturk, An alternative model of infrastructure financing based on capital markets: Infrastructure REITS (InfraREITs) in Turkey, *Journal of Economic Cooperation and Development*, vol. 32(3), pp. 65–87, 2011.
[38] J. Escobal and C. Ponce, The Benefits of Rural Roads: Enhancing Income Opportunities for the Rural Poor, Working Paper 40, Group for the Analysis of Development, Lima, Peru (repositorio.grade.org.pe/bitstream/GRADE/87/1/ddt40EN.pdf), 2002.
[39] H. Esfahani and M. Ramirez, Institutions, infrastructure and economic growth, *Journal of Development Economics*, vol. 70(2), pp. 443–477, 2003.
[40] B. Esty, *Modern Project Finance: A Casebook*, Wiley, New York, 2004.
[41] S. Fan and C. Chan-Kang, Road Development, Economic Growth and Poverty Reduction in China, Research Report 138, International Food Policy Research Institute, Washington, DC, 2005.
[42] S. Fan and P. Hazell, Returns to public investments in the less-favored areas of India and China, *American Journal of Agricultural Economics*, vol. 83(5), pp. 1217–1222, 2001.
[43] S. Fan, P. Hazell and S. Thorat, Government spending, growth and poverty in rural India, *American Journal of Agricultural Economics*, vol. 82(4), pp. 1038–1051, 2000.
[44] J. Fedderke, P. Perkins and J. Luiz, Infrastructural investment in long-run economic growth: South Africa 1875–2001, *World Development*, vol. 34(6), pp. 1037–1059, 2006.
[45] K. Finkenzeller, T. Dechant and W. Schafers, Infrastructure: A new dimension of real estate? An asset allocation analysis, *Journal of Property Investment and Finance*, vol. 28(4), pp. 263–274, 2010.
[46] P. Galilea and F. Medda, Does the political and economic context influence the success of a transport project? An analysis of transport public–private partnerships, *Research in Transportation Economics*, vol. 30(1), pp. 102–109, 2010.
[47] D. Geltner, Commercial real estate, in *A Companion to Urban Economics*, R. Arnott and D. McMillen (Eds.), Blackwell Publishing, Oxford, United Kingdom, pp. 211–227, 2007.
[48] J. Gemson, K. Gautami and A. Rajan, Impact of private equity investments in infrastructure projects, *Utilities Policy*, vol. 21, pp. 59–65, 2012.
[49] B. Ghosh and P. De, Role of infrastructure in regional development: A study over the plan period, *Economic and Political Weekly*, vol. 33(47/48), pp. 3039–3043, 1998.
[50] J. Gibson and S. Olivia, The effect of infrastructure access and quality on non-farm enterprises in rural Indonesia, *World Development*, vol. 38(5), pp. 717–726, 2010.
[51] A. Gohar, S. Amer and F. Ward, Irrigation infrastructure and water appropriation rules for food security, *Journal of Hydrology*, vol. 520, pp. 85–100, 2015.
[52] D. Grimsey and M. Lewis, Evaluating the risks of public–private partnerships for infrastructure projects, *International Journal of Project Management*, vol. 20(2), pp. 107–118, 2002.
[53] D. Grimsey and M. Lewis, The governance of contractual relationships in public–private partnerships, *Journal of Corporate Citizenship*, vol. 2004(15), pp. 91–109, 2004.
[54] D. Grimsey and M. Lewis, *Public–Private Partnerships: The Worldwide Revolution in Infrastructure Provision and Project Finance*, Edward Elgar Publishing, Cheltenham, United Kingdom, 2007.
[55] M. Guisan, Indicators of social well-being, education, genre equality and world development: Analysis of 132 countries, 2000–2008, *International Journal of Applied Econometrics and Quantitative Studies*, vol. 9(2), pp. 156–181, 2009.
[56] J. Gupta and A. Sravat, Development and project financing of private power projects in developing countries: A case study of India, *International Journal of Project Management*, vol. 16(2), pp. 99–105, 1998.
[57] L. Huang, Financing rural renewable energy: A comparison between China and India, *Renewable and Sustainable Energy Reviews*, vol. 13(5), pp. 1096–1103, 2009.
[58] Q. Huang and N. Harata, Role of Transport Infrastructure in Economic Development: An Empirical Study for China, Department of Urban Engineering, School of Engineering, University of Tokyo, Tokyo, Japan (rdarc.itakura.toyo.ac.jp/webdav/ask/public/ACP2010/15.pdf), 2010.
[59] X. Huang, Diversity about the capital financing of rural infrastructure in China, in *Technology for Education and Learning*, H. Tan (Ed.), Springer-Verlag, Berlin Heidelberg, Germany, pp. 643–650, 2012.
[60] C. Hulten, Infrastructure Capital and Economic Growth: How Well You Use it May be More Important Than How Much You Have, Working Paper 5847, National Bureau of Economic Research, Cambridge, Massachusetts (www.nber.org/papers/w5847), 1996.
[61] B. Hwang, X. Zhao and M. Gay, Public–private partnership projects in Singapore: Factors, critical risks and preferred risk allocation from the perspective of contractors, *International Journal of Project Management*, vol. 31(3), pp. 424–433, 2013.
[62] K. Jechoutek and R. Lamech, New directions in electric power financing, *Energy Policy*, vol. 23(11), pp. 941–953, 1995.
[63] A. Jerome, Infrastructure, economic growth and poverty reduction in Africa, *Journal of Infrastructure Development*, vol. 3 (2), pp. 127–151, 2011.
[64] R. Kale and S. Pohekar, Electricity demand supply analysis: Current status and future prospects for Maharashtra, India, *Renewable and Sustainable Energy Reviews*, vol. 16(6), pp. 3960–3966, 2012.

[65] Y. Ke, S. Wang, A. Chan and P. Lam, Preferred risk allocation in China's public–private partnership projects, *International Journal of Project Management*, vol. 28(5), pp. 482–492, 2010.
[66] S. Ketkar and D. Ratha, Innovative financing for development: Overview, in *Innovative Financing for Development*, S. Ketkar and D. Ratha (Eds.), World Bank Publications, Washington, DC, pp. 1–24, 2009.
[67] A. Khan, Risk factors in toll road life cycle analysis, *Transportmetrica A: Transport Science*, vol. 9(5), pp. 408–428, 2013.
[68] S. Khandker, Z. Bakht and G. Koolwal, The poverty impact of rural roads: Evidence from Bangladesh, *Economic Development and Cultural Change*, vol. 57(4), pp. 685–722, 2009.
[69] C. Kingombe and S. di Falco, The Impact of a Feeder Road Project on Cash Crop Production in Zambia's Eastern Province between 1997 and 2002, Working Paper No: 04/2012, Graduate Institute of International and Development Studies, London School of Economics, London, United Kingdom (core.ac.uk/download/pdf/6552909.pdf), 2012.
[70] C. Kirkpatrick, D. Parker and Y. Zhang, Foreign direct investment in infrastructure in developing countries: Does regulation make a difference? *Transnational Corporations*, vol. 15(1), pp. 143–171, 2006.
[71] P. Lanjouw, Rural non-agricultural employment and poverty in Ecuador, *Economic Development and Cultural Change*, vol. 48 (1), pp. 91–122, 1999.
[72] D. Leipziger, M. Fay, Q. Wodon and T. Yepes, Achieving the Millennium Development Goals: The Role of Infrastructure, World Bank, Washington, DC (sarpn.org/documents/d0000615/P628_Infrastructure.pdf), 2003.
[73] L. Leruth, Public–private cooperation in infrastructure development: A principal-agent story of contingent liabilities, fiscal risks and other pleasant surprises, *Networks and Spatial Economics*, vol. 12(2), pp. 223–237, 2012.
[74] R. Levich, E. Corrigan, C. Sanford and G. Votja, Financial innovations in international financial markets, in *The United States in the World Economy*, M. Feldstein (Ed.), University of Chicago Press, Chicago, Illinois, pp. 215–277, 1988.
[75] B. Li and A. Akintoye, An overview of public–private partnership, in *Public–Private Partnerships: Managing Risks and Opportunities*, A. Akintoye, M. Beck and C. Hardcastle (Eds.), John Wiley and Sons, Hoboken, New Jersey, pp. 3–30, 2003.
[76] B. Li, A. Akintoye, P. Edwards and C. Hardcastle, Critical success factors for PPP/PFI projects in the UK construction industry, *Construction Management and Economics*, vol. 23(5), pp. 459–471, 2005.
[77] D. Mahadevia, Urban infrastructure financing and delivery in India and China, *China and World Economy*, vol. 14(2), pp. 105–120, 2006.
[78] R. Majumder, Infrastructure in India: Issues in the New Millennium, Department of Economics, University of Burdwan, Bardhaman, India (mpra.ub.uni-muenchen.de/12813/1/MPRA_paper_12813.pdf), 2009.
[79] M. Martinho, Public–Private Partnerships in the Healthcare Sector, M.Sc. Dissertation, School of Business and Economics, Catholic University of Portugal, Lisbon, Portugal, 2013.
[80] T. Matsukawa and O. Habeck, *Review of Risk Mitigation Instruments for Infrastructure: Financing and Recent Trends and Developments*, World Bank Publications, Washington, DC, 2007.
[81] D. Mavalankar, K. Ramani, A. Patel and P. Sankar, Building the Infrastructure to Reach and Care for the Poor: Trends, Obstacles and Strategies to Overcome Them, Center for Management of Health Services, Indian Institute of Management Ahmedabad, Ahmedabad, India (core.ac.uk/download/pdf/6443351.pdf), 2005.
[82] M. McKee, N. Edwards and R. Atun, Public–private partnerships for hospitals, *Bulletin of the World Health Organization*, vol. 84(11), pp. 890–896, 2006.
[83] S. Meduri and T. Annamalai, Unit costs of public and PPP road projects: Evidence from India, *Journal of Construction Engineering and Management*, vol. 139(1), pp. 35–43, 2013.
[84] D. Mehta and P. Pathak, Financing of urban services in India: A case for appropriate pricing and cost recovery, *Habitat International*, vol. 22(4), pp. 487–502, 1998.
[85] T. Merna and C. Njiru, *Financing Infrastructure Projects*, Thomas Telford, London, United Kingdom, 2002.
[86] B. Minten and S. Kyle, The effect of distance and road quality on food collection, marketing margins and traders' wages: Evidence from the former Zaire, *Journal of Development Economics*, vol. 60(2), pp. 467–495, 1999.
[87] I. Moorhouse, Asset management of irrigation infrastructure – The approach of Goulburn-Murray Water, Australia, *Irrigation and Drainage Systems*, vol. 13(2), pp. 165–187, 1999.
[88] N. Mor and S. Sehrawat, Sources of Infrastructure Finance, Working Paper, Centre for Development Finance, Institute for Financial Management and Research, Chennai, India (papers.ssrn.com/sol3/papers.cfm?abstract_id=2597915), 2006.
[89] C. Morrison and A. Schwartz, State Infrastructure and Productive Performance, Working Paper 3981, National Bureau of Economic Research, Cambridge, Massachusetts (www.nber.org/papers/w3981), 1992.
[90] R. Mu and D. van de Walle, Rural roads and local market development in Vietnam, *Journal of Development Studies*, vol. 47(5), pp. 709–734, 2011.
[91] Y. Mundlak, D. Larson and R. Butzer, Determinants of Agricultural Growth in Indonesia, The Philippines and Thailand, Policy Research Working Paper 2803, World Bank, Washington, DC, 2002.
[92] S. Mundle, Financing human development: Some lessons from advanced Asian countries, *World Development*, vol. 26(4), pp. 659–672, 1998.
[93] K. Nakhro, Role of infrastructural facilities in rural development, in *Rural Development in North East India*, K. Singha and G. Patikar (Eds.), Concept Publishing, New Delhi, India, pp. 116–137, 2010.
[94] P. Nijkamp and S. Rienstra, Private sector involvement in financing and operating transport infrastructure, *The Annals of Regional Science*, vol. 29(2), pp. 221–235, 1995.
[95] S. Pal, Public infrastructure, location of private schools and primary school attainment in an emerging economy, *Economics of Education Review*, vol. 29(5), pp. 783–794, 2010.
[96] A. Patra and A. Acharya, Regional disparity, infrastructure development and economic growth: An inter-state analysis, *Research and Practice in Social Sciences*, vol. 6(2), pp. 17–30, 2011.
[97] J. Pi and Y. Zhou, Foreign capital, public infrastructure and wage inequality in developing countries, *International Review of Economics and Finance*, vol. 29, pp. 195–207, 2014.
[98] P. Pinstrup-Andersen and S. Shimokawa, Rural infrastructure and agricultural development, in *Rethinking Infrastructure for Development*, F. Bourguignon and B. Pleskovic (Eds.), World Bank Publications, Washington, DC, pp. 175–203, 2007.
[99] O. Pokorna and D. Mockova, Models of financing and available financial resources for transport infrastructure projects, *Acta Polytechnica*, vol. 41(6), pp. 51–53, 2001.
[100] N. Pongsiri, Public–private partnerships in Thailand: A case study of the electric utility industry, *Public Policy and Administration*, vol. 18(3), pp. 69–90, 2003.
[101] R. Pradhan and T. Bagchi, Effect of transportation infrastructure on economic growth in India: The VECM approach, *Research in Transportation Economics*, vol. 38(1), pp. 139–148, 2013.
[102] R. Prud'homme, Infrastructure and development, *Proceedings of the Annual World Bank Conference on Development Economics*, pp. 153–180, 2005.

[103] Y. Qin and X. Zhang, The Road to Specialization in Agricultural Production: Evidence from Rural China, Dyson School of Applied Economics and Management, Cornell University, Ithaca, New York, 2012.
[104] H. Qian and H. Noboru, Transport infrastructure and economic development: An empirical study for China, *Proceedings of the Seventh International Conference on Traffic and Transportation Studies*, pp. 166–173, 2010.
[105] I. Rajaraman, Financing rural infrastructure in developing countries: The case of India, *Applied Econometrics and International Development*, vol. 5(2), pp. 53–68, 2005.
[106] K. Ramani and D. Mavalankar, Health system in India: Opportunities and challenges for improvement, *Journal of Health Organization and Management*, vol. 20(6), pp. 560–572, 2006.
[107] P. Rao and B. Srinivasu, Infrastructure development and economic growth: Prospects and perspective, *Journal of Business Management and Social Sciences Research*, vol. 2(1), pp. 81–91, 2013.
[108] R. Rath and S. Samal, An impact of foreign direct investment (FDI) on infrastructure development for the economic growth in India: An economic survey of an Indian scenario, *International Journal of Interdisciplinary Research*, vol. 2(5), pp. 78–95, 2015.
[109] T. Reardon, K. Stamoulis and P. Pingali, Rural nonfarm employment in developing countries in an era of globalization, *Agricultural Economics*, vol. 37(S1), pp. 173–183, 2007.
[110] E. Reeves, Public–Private Partnerships in Ireland: A Review of the Experience, Department of Economics, University of Limerick, Limerick, Ireland (www.nerinstitute.net/download/pdf/reeves_neri_2013_ppp.pdf), 2013.
[111] B. Resosudarmo and Y. Vidyattama, Regional income disparity in Indonesia: A panel data analysis, *ASEAN Economic Bulletin*, vol. 23(1), pp. 31–44, 2006.
[112] L. Roller and L. Waverman, Telecommunications infrastructure and economic development: A simultaneous approach, *American Economic Review*, vol. 91(4), pp. 909–923, 2001.
[113] F. Sader, *Attracting Foreign Direct Investment into Infrastructure: Why is it so Difficult?* World Bank Publications, Washington, DC, 2000.
[114] P. Sahoo and R. Dash, Infrastructure development and economic growth in India, *Journal of the Asia Pacific Economy*, vol. 14(4), pp. 351–365, 2009.
[115] P. Sahoo, R. Dash and G. Nataraj, Infrastructure Development and Economic Growth in China, IDE Discussion Paper No. 261, Institute of Developing Economies, Chiba, Japan (ir.ide.go.jp/dspace/handle/2344/923), 2010.
[116] J. Sapkota, Access to Infrastructure and Human Development: Cross-Country Evidence, Working Paper No. 70, JICA Research Institute, Tokyo, Japan (repository.ri.jica.go.jp/dspace/handle/10685/132), 2014.
[117] A. Sharma and E. Vohra, Foreign direct investment in the electricity sector: The Indian perspective, *The Electricity Journal*, vol. 21(7), pp. 63–79, 2008.
[118] A. Sharma and E. Vohra, Critical evaluation of road infrastructure in India: A cross-country view, *Engineering, Construction and Architectural Management*, vol. 16(1), pp. 73–91, 2009.
[119] C. Sharma, Determinants of PPP in infrastructure in developing economies, *Transforming Government: People, Process and Policy*, vol. 6(2), pp. 149–166, 2012.
[120] O. Shiji, Public–private partnership and Indian higher education, *Higher Education for the Future*, vol. 1(2), pp. 139–153, 2014.
[121] J. Sindane, Public–private partnerships: Case study of solid waste nanagement in Khayelitsha-Cape Town, South Africa, in *Public and Private Sector Partnerships: The Enabling Mix*, L. Montanheiro and M. Linehan (Eds.), Sheffield Hallam University Press, Sheffield, United Kingdom, pp. 539–564, 2000.
[122] L. Singh and S. Kalidindi, Criteria influencing debt financing of Indian PPP road projects: A case study, *Journal of Financial Management of Property and Construction*, vol. 14(1), pp. 34–60, 2009.
[123] S. Singh, G. Batra and G. Singh, Role of infrastructure services on the economic development of India, *Management and Labor Studies*, vol. 32(3), pp. 347–359, 2007.
[124] S. Singhal, G. Newell and T. Nguyen, The significance and performance of infrastructure in India, *Journal of Property Research*, vol. 28(1), pp. 15–34, 2011.
[125] P. Sinha, D. Arya and S. Singh, Evolution of Financing Needs in the Indian Infrastructure, Faculty of Management Studies, University of Delhi, New Delhi, India (mpra.ub.uni-muenchen.de/38741/1/MPRA_paper_38741.pdf), 2012.
[126] N. Smith, T. Merna and P. Jobling, *Managing Risk in Construction Projects*, John Wiley and Sons, Hoboken, New Jersey, 2009.
[127] P. Starr, The meaning of privatization, *Yale Law and Policy Review*, vol. 6(1), pp. 6–41, 1988.
[128] B. Steijn, E. Klijn and J. Edelenbos, Public–private partnerships: Added value by organizational form or management? *Public Administration*, vol. 89(4), pp. 1235–1252, 2011.
[129] L. Tang, Q. Shen and E. Cheng, A review of studies on public–private partnership projects in the construction industry, *International Journal of Project Management*, vol. 28 (7), pp. 683–694, 2010.
[130] T. Tanninen-Ahonen, PPP in Finland: Developments and attitudes, *Proceedings of the International Symposium of the CIB W92 on Procurement Systems*, pp. 631–639, 2000.
[131] M. Thobani, Private infrastructure, public risk, *Finance and Development*, vol. 36(1), pp. 50–53, 1999.
[132] A. Tiwari, *Infrastructure and Economic Development in Himachal Pradesh*, Indus Publishing, New Delhi, India, 2000.
[133] R. Tongia and R. Banerjee, Price of power in India, *Energy Policy*, vol. 26(7), pp. 557–575, 1998.
[134] P. Tufano, Financial innovation, in *Handbook of the Economics of Finance, Volume 1A*, G. Constantinides, M. Harris and R. Stulz (Eds.), Elsevier, Amsterdam, The Netherlands, pp. 307–335, 2003.
[135] R. Utt, How Public–Private Partnerships Can Facilitate Public School Construction, The Heritage Foundation, Washington, DC (www.heritage.org/Research/Reports/1999/02/Partnerships-Aid-Public-School-Construction), 1999.
[136] D. van de Walle, Choosing rural road investments to help reduce poverty, *World Development*, vol. 30(4), pp. 575–589, 2002.
[137] R. Wagenvoort, C. de Nicola and A. Kappeler, Infrastructure finance in Europe: Composition, evolution and crisis impact, *EIB Papers*, vol. 15(1), pp. 16–39, 2010.
[138] S. Wang, An analytical model for benchmarking the development of national infrastructure items against those in similar countries, *International Journal of Critical Infrastructure Protection*, vol. 13, pp. 3–18, 2016.
[139] P. Warr, Road Development and Poverty Reduction: The Case of Lao PDR, Research Paper Series No. 64, Asian Development Bank Institute, Tokyo, Japan (adb-test.atmire.com/bitstream/handle/11540/4169/2005.03.rp64.roads.poverty.laopdr.pdf?sequence=1), 2005.
[140] B. Weber and H. Alfen, *Infrastructure as Asset Class: Investment Strategies, Project Finance and PPP*, John Wiley and Sons, Chichester, United Kingdom, 2010.
[141] R. Widdus, Public–private partnerships for health: Their main targets, their diversity and their future directions, *Bulletin of the World Health Organization*, vol. 79(8), pp. 713–720, 2001.

[142] A. Wojewnik-Filipkowska and D. Trojanowski, Principles of public–private partnership financing – Polish experience, *Journal of Property Investment and Finance*, vol. 31(4), pp. 329–344, 2013.
[143] H. Wong, R. Luo, L. Zhang and S. Rozelle, Providing quality infrastructure in rural villages: The case of rural roads in China, *Journal of Development Economics*, vol. 103, pp. 262–274, 2013.
[144] World Bank, World Development Report, Infrastructure for Development, Washington, DC, 1994.
[145] F. Yamauchi, M. Muto, S. Chowdhury, R. Dewina and S. Sumaryanto, Spatial Networks, Labor Supply and Income Dynamics: Evidence from Indonesian Villages, IFPRI Discussion Paper 00897, International Food Policy Research Institute, Washington, DC (citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.226.7384&rep=rep1&type=pdf), 2009.
[146] A. Yates, A framework for studying mortality arising from critical infrastructure loss, *International Journal of Critical Infrastructure Protection*, vol. 7(2), pp. 100–111, 2014.
[147] N. Yu, M. de Jong, S. Storm and J. Mi, Spatial spillover effects of transport infrastructure: Evidence from Chinese regions, *Journal of Transport Geography*, vol. 28, pp. 56–66, 2013.
[148] S. Zhang, A. Chan, Y. Feng, H. Duan and Y. Ke, Critical review on PPP research – A search from Chinese and international journals, *International Journal of Project Management*, vol. 34(4), pp. 597–612, 2016.
[149] N. Zhu and X. Luo, Nonfarm Activity and Rural Income Inequality: A Case Study of Two Provinces in China, Policy Research Working Paper 3811, World Bank, Washington, DC, 2006.