Federated Digital Platforms

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Twenty-first century infrastructure needs to respond to changing demographics, becoming climate neutral, resilient, and economically affordable, while remaining a driver for development and shared prosperity. However, the infrastructure sector remains one of the least innovative and digitalized, plagued by delays, cost overruns, and benefit shortfalls.

sustainable infrastructure | federated digital platform | governance | design | protocols | implementation | value chain | digitalization

1. Introduction

1.1. The Context of the Sutainable Infrastructure Challenge

Sustainable infrastructure development and delivery is a core task of societies [1]. It is the basis of increasing social and economic connectivity. Sustainable infrastructure can be understood as the manifestation of a collaborative and creative process of improving social and economic development. Infrastructure development and delivery are an essential part of this process. Various perspectives and goals, such as human-centered design, economic efficiency, and sustainability, must be considered and counterbalanced in a holistic manner. On the one hand, the development process is a solution-oriented dialogic process of counterbalancing trade-offs. On the other, it is a process of fitting the solutions in a technical, social, and cultural context expressed through regulations, standards, and technological systems, as well as implicit social and cultural norms. This process is highly complex and marked by uncertainty where many stakeholders must be coordinated to reach a shared sustainable goal [2].

In contrast to factor and efficiency-driven economies [3][4][5], for instance those in Asia, no significant progress in infrastructure development can be observed in recent decades in most Western countries [6]. Moreover, investments in infrastructure are declining, including the investments provided by the World Bank that have strongly receded in the past [7]. Although it is clear that infrastructure development is central to sustainable, economic, and social development, many infrastructure projects are blocked by civil protest, suffer substantial benefit shortfalls, are severely delayed, and experience major cost overruns [8][9][10][11]. Public legitimacy, political will, and the know-how to change this situation are lacking [12]. Promising infrastructure initiatives have been initiated by G20 member states (“The G20”, abbreviation for Group of Twenty, is the international forum that brings together the world’s major economies. Its members account for more than 80% of world GDP, 75% of global trade and 60% of the population of the planet. The forum has met every year since 1999 and includes, since 2008, a yearly Summit, with the participation of the respective Heads of State and Government, see: [13]), the OECD, the

World Economic Forum and by other initiatives on national and international levels. However, often such recommendations are not adopted and implemented into national planning and delivery processes [14][15][16][17][18].

Implementation visions and bankable sustainable infrastructure pipelines that bridge political cycles and are not prone to political risk are inadequate or lacking [19][20]. On the contrary, the lack of sustainable measures, flow-efficiency, sequential planning, discipline silos still determine common infrastructure practices.

1.2. Structure of the Article and Approach to Solution

The paper first discusses the problems arising in the development and delivery of sustainable infrastructure and concludes that those problems need holistic solution frameworks (see also **Figure 1**) and a holistic strategy for the future planning and implementation of infrastructure projects. The term “holistic” is understood as the integration of four different perspectives on infrastructure development [21], which are:

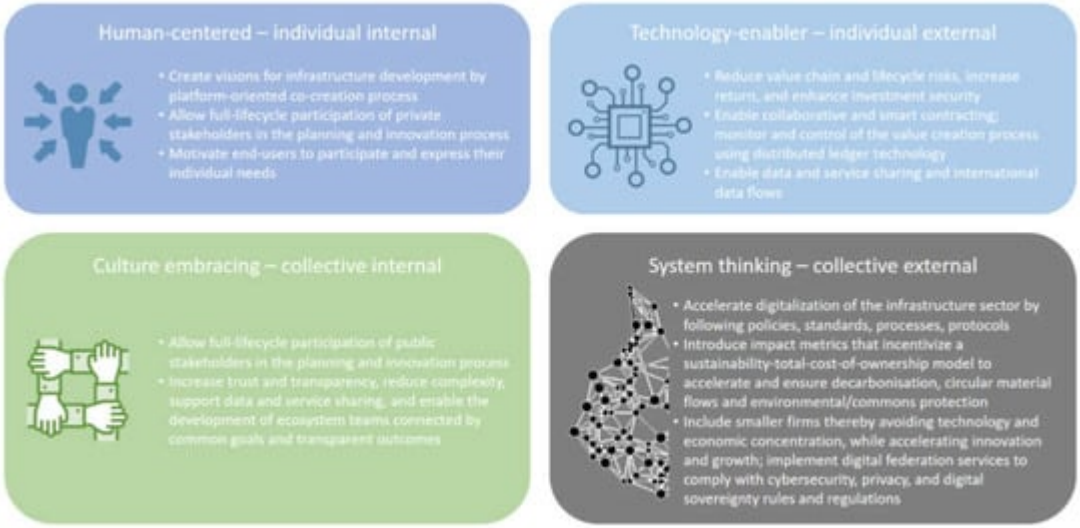

Figure 1. Holistic perspectives on infrastructure development.

- The individual internal perspective (human-centered),

  i.e., the needs-based perspective of direct and indirect users of infrastructure objects (subway, water supply, etc.);

- The individual external perspective (technology-enabled),

  i.e., the required competencies of all persons involved in the planning and implementation process;

- The collective internal perspective (culture-embracing),

  i.e., the consideration of cultural aspects in infrastructure development;

- The collective external perspective (system-thinking),

  i.e., the adaptation of planning to all legal and technical regulations.

Based on such holistic framework, the authors of this article propose to drive infrastructure development and delivery towards a much more integrated multi-stakeholder platform-oriented approach by using disruptive technologies. Such approach could enable solution-oriented, dialogical, and regulative processes.

1.3. Policy and Governance of Infrastructure Development and Delivery

As a global challenge, infrastructure is discussed on a multilateral level. It is a priority especially for the Group of 20 (G20) given the forum's broad representation of economic activity (its member states represent circa 90% of global GDP and 80% of global trade), its considerable influence on international policy coordination and framework design, as well as lose diplomatic linkages between the large economic blocs. Past discussions between G20 leaders have led to the establishment of the Global Infrastructure Hub, the Global Infrastructure Connectivity Alliance, G20 Principles for Quality Infrastructure Investment, and the G20 InfraTech agenda [22][23][24]. However, the authors of this paper believe that the uptake and implementation of recommendations by G20 member states can still be improved. The G20′s focus on investment finance needs to be complemented by an engineering design and delivery focus for sustainable infrastructure, as well as by an inclusive digitalization focus addressing the fragmentation of the industry.

2. Outcome of the Expert Interviews, Workshops, and Literature Assessment

There is an industry-wide consensus that driving best practices in infrastructure planning and delivery includes:

- A well-articulated vision for infrastructure that enables a systematic development of a robust pipeline of bankable projects and long-term plans with robust business cases;
- Strong project governance arrangements to enable strong project delivery including a more agile set of regulations to reflect optimal practice embracing new infrastructure technologies;
- The careful management of societal and environmental impacts to support project delivery. An early and thorough multi-stakeholder participation minimizes risks and maximizes positive overall outcome. Risk transfer needs to be carried out appropriately to maintain value for money;
- A procurement model chosen on the basis of project specifics and rigorously following established published guidelines.

However, this very condensed evaluation is not surprising. The common infrastructure problems are well known globally and are frequently analyzed and evaluated. However, in many cases the question arises as to why

governments and institutions do not simply implement leading practices and state-of-practice recommendations. The authors of this article and the key contributors to the article listed below have studied this question in depth and have developed the following hypothesis:

As the process of infrastructure development and delivery is very complex, the best practice approach is to decompose the overall task into smaller components which are understandable and manageable. This approach is a basic principle in our economy based on division of labor. The process of infrastructure development and delivery in most countries is, therefore, a stepwise phase process, where the next phase begins as soon as the preceding phase is closed [25]. The level of granularity of planning increases with each phase until it is brought to a constructible planning state. Such linear consecutive processes are called “waterfall model” [26].

Each phase is executed independently and has its particular composition of stakeholders. Often, project leadership also changes across different phases. The process is so segregated that a common understanding of the entire process does not exist among the majority of relevant stakeholders, and the process itself regularly loses sight of the desired outcomes. As a result, problems in the process are usually addressed in a specific phase or even within a sub-phase, while the entire process model is hardly questioned. This approach is seen as a common way of avoiding change.

Consequently, such complex multi-stakeholder processes tend to lead to a multi-dimensional principal-agent dilemma in which asymmetric information policies predominantly increases local efficiencies in the functional silos of the project. However, the optimization of the benefits of the overall system, or even more, the interests, needs, and requirements of the infrastructure asset users move entirely out of sight.

To understand the root causes, problems must first be addressed and related to the specific phase or component of infrastructure development and delivery. As mentioned earlier, the problems existing at this granular level are well known. This approach is necessary, but not sufficient; it is not sufficient since the overall problem of asymmetric information cannot be solved at the specific level of granularity. Moreover, the problem of slow planning processes or administrative hurdles will not be solved simply by accelerating the planning processes nor merely by reducing administrative hurdles. Instead, a system change is needed that allows for a holistic solution that can simultaneously address the four perspectives explained in Section 1.2.

In other industry sectors, we see that value creation evolves through trusted networks of collaboration, so-called value networks [27]. The underlying multistakeholder and multidisciplinary ecosystems increasingly become the backbone of our digitalized world, mobilizing specialized actors that share values, governance principles and common goals. Value networks are interactive, integrative and agile, and focus on people’s needs. In infrastructure development and delivery, however, such value chain integration is lacking [8] and very important to achieve usability and sustainable goals.

We can conclude that the global infrastructure gap [28] and the need to develop sustainable infrastructure cannot be eliminated by taking only the financial aspects into account; the whole value chain of development and delivery

has to be transformed into an integrated system, a value network, focused on end user needs but also on social requirements, as well as a much broader approach to value creation. The root cause is the existing fragmentation and lack of cooperation within the infrastructure value chain. Sequential (waterfall) planning and resource-efficiency (focusing on silos) are still common practice, compared to the necessary flow-efficiency and agility (across the value network), preventing a more impactful realization of broader goals.

Therefore, a holistic approach (**Figure 1**) of development and delivery of sustainable infrastructure is needed to integrate the value chain in this important economic sector. By focusing on the traditional "waterfall model," such integration cannot be achieved.

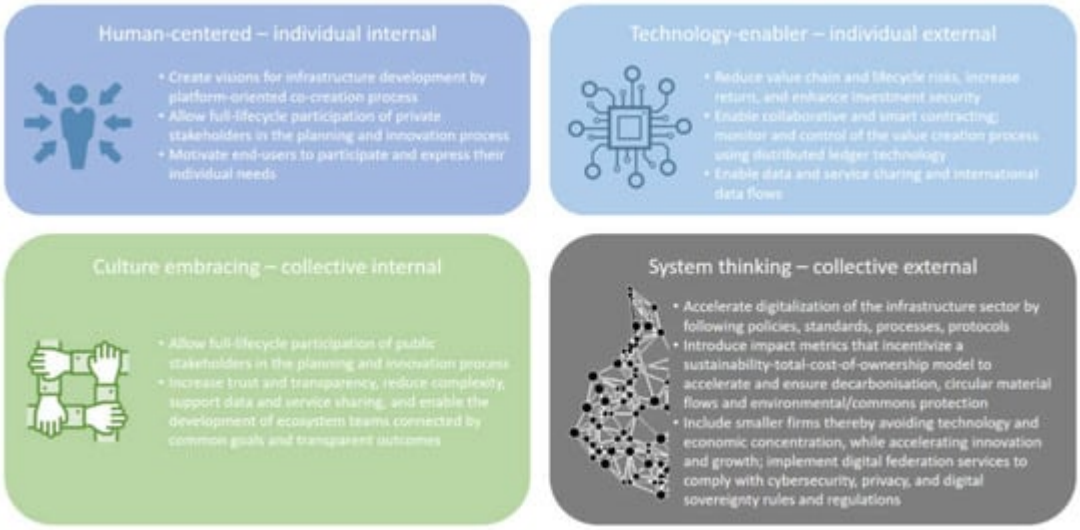

Figure 1. Holistic perspectives on infrastructure development.

References

1. Munyasya, B.M.; Chileshe, N. Towards sustainable infrastructure development: Drivers, barriers, strategies, and coping mechanisms. Sustainability 2018, 10, 4341.
2. Loorbach, D. Transition management for sustainable development: A prescriptive, complexity-based governance framework. Governance 2010, 23, 161–183.
3. Vares, H.; Parvandi, Y.; Ghasemi, R.; Abdollahi, B. Transition from an efficiency-driven economy to innovation-driven: A secondary analysis of countries global competitiveness. Eur. J. Econ. Financ. Adm. Sci. 2011, 31, 124–132.
4. Tan, K.-S.; Phang, S.-Y. From Efficiency-Driven to Innovation-Driven Economic Growth: Perspectives from Singapore; World Bank Publications: Herndon, VA, USA, 2005; Volume 3569.
5. Schwab, R.; Zahidi, S.; World Economic Forum. The Global Competitiveness Report. Special Edition 2020: How Countries are Performing on the Road to Recovery; WEF: Geneva,

Switzerland, 2020.

6. Rowley, A.H. Foundations of The Future: The Global Battle for Infrastructure; World Scientific: Toh Tuck Link, Singapore, 2020.
7. Ramamurti, R.; Doh, J.P. Rethinking foreign infrastructure investment in developing countries. J. World Bus. 2004, 39, 151–167.
8. Cantarelli, C.C.; Flyvbjerg, B.; van Wee, B.; Molin, E.J.E. Cost overruns in large-scale transportation infrastructure projects: Which explanations can be given? In Proceedings of the 2008 First International Conference on Infrastructure Systems and Services: Building Networks for a Brighter Future (INFRA), Rotterdam, The Netherlands, 10–12 November 2008.
9. Flyvbjerg, B.N.; Bruzelius, N.; Rothengatter, W. Megaprojects and Risk: An Anatomy of Ambition; Cambridge University Press: Cambridge, UK, 2003.
10. Flyvbjerg, B.; Holm, M.K.S.; Buhl, S.L. What causes cost overrun in transport infrastructure projects? Transp. Rev. 2004, 24, 3–18.
11. Flyvbjerg, B. Policy and Planning for Large-Infrastructure Projects: Problems, Causes, Cures. Environ. Plan. B Plan. Des. 2007, 34, 578–597.
12. Tallberg, J.; Zürn, M. The legitimacy and legitimation of international organizations: Introduction and framework. Rev. Int. Organ. 2019, 14, 581–606.
13. G20. About the G20, G20 website. 2021. Available online: https://www.g20.org/about-the-g20.html (accessed on 5 August 2021).
14. Ougaard, M. The transnational state and the infrastructure push. New Political Econ. 2018, 23, 128–144.
15. GIHub. Forecasting Infrastructure Investement Needs and Gaps. G20 Global Infrastructure Outlook 2021. Available online: https://outlook.gihub.org/ (accessed on 30 April 2021).
16. GIHub. Global Infrastructure Hub—A G20 Initiative. 2021. Available online: https://www.gihub.org/ (accessed on 2 August 2021).
17. OECD. OECD Infrastructure Working Group (IWG). 2021. Available online: https://www.oecd.org/g20/topics/infrastructure/ (accessed on 2 August 2021).
18. WEF. WEF Infrastructure Initiatives. 2021. Available online: https://www.weforum.org/projects/infrastructure-4-0 (accessed on 2 August 2021).
19. Bielenberg, A.; Kerlin, M.; Oppenheim, J.; Roberts, M. Financing Change: How to Mobilize Private-Sector Financing for Sustainable Infrastructure; McKinsey Center for Business and Environment: London, UK, 2016; pp. 24–25.

20. Cuttaree, V.; Mandri-Perrott, X.C. Public-Private Partnerships in Europe and Central Asia: Designing Crisis-Resilient Strategies and Bankable Projects; World Bank Publications: Herndon, VA, USA, 2011.
21. Wilber, K. Integral Politics: Its Essential Ingredients—Integral Life. 2018. Available online: https://integrallife.com/integral-politics-its-essential-ingredients/ (accessed on 2 August 2021).
22. World Bank. Infratech Value Drivers. 2020. Available online: https://openknowledge.worldbank.org/handle/10986/34320 (accessed on 2 August 2021).
23. World Bank. Infratech Policy Toolkit. 2020. Available online: https://openknowledge.worldbank.org/handle/10986/34326 (accessed on 2 August 2021).
24. G20 Infrastructure Working Group. G20 Riyadh InfraTech Agenda, G.I.W. 2020. Available online: https://cdn.gihub.org/umbraco/media/3008/g20-riyadh-infratech-agenda.pdf (accessed on 2 August 2021).
25. Fellows, R.; Liu, A.M. Managing organizational interfaces in engineering construction projects: Addressing fragmentation and boundary issues across multiple interfaces. Constr. Manag. Econ. 2012, 30, 653–671.
26. Benington, H.D. Production of large computer programs. Ann. Hist. Comput. 1983, 5, 350–361.
27. Allee, V. The Future of Knowledge; Taylor & Francis: Oxfordshire, UK, 2009.
28. Moser, H. Barriers to Bankable Infrastructure: Incentivizing Private Investment to Fill the Global Infrastructure Gap; Rowman & Littlefield: Lanham, MD, USA, 2016.