Scaling up trail bridge technology: a cost-effective way to enhance access for millions of people in remote areas

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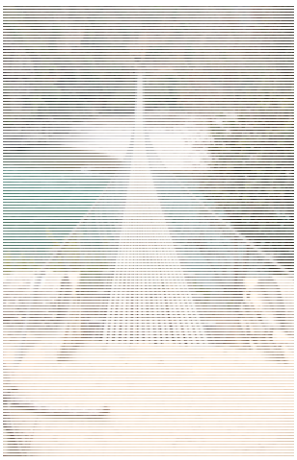
Experience from different countries such as Nepal and Ethiopia reveals that pedestrian trail bridges is a cost-effective technology that significantly enhances access to schools, health services and markets and thus contributes greatly to poverty reduction. Especially for remote, scattered areas, which are not likely to be equipped with road access in the years to come, trail bridge technology represents a promising alternative. This paper analyses challenges and factors of success to bring trail bridge technology to scale based on lessons learnt from different countries.

1. Setting the scene: Potential and challenges of trail bridges

1.1 Key challenges and trends in rural transport today

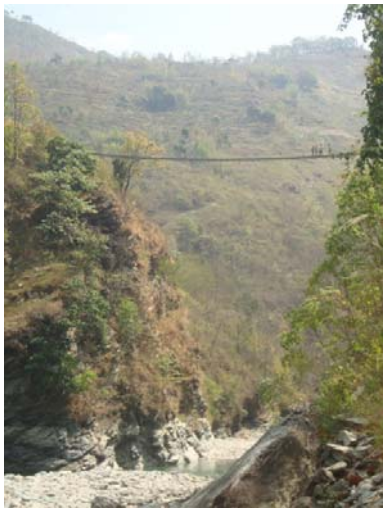
Recent studies confirm the importance of rural access for development. The International Food Policy Research Institute, for instance, demonstrated that rural access expenditure is one of the most effective ways in reducing rural poverty (Hine, 2014). Still, one billion people live more than two kilometres from an all-season road. Often access is denied due to the lack of safe river crossings. 45% of the total population in Africa and 30% in South Asia - 730 million in total - are without access (Rural Access Index, 2010). By 2030, over 2.5 billion people will live in rural areas (Donnges, 2003). It infers that a large section of rural poor will remain physically isolated from services and economic opportunities thereby exacerbating the efforts towards poverty reduction. With the advent of road funds, there have been improvements in the maintenance of rural roads. Yet, perhaps the majority of rural roads and tracks receive no systematic maintenance.

1.2 Potential and challenges of trail bridges



Providing road access to the rural population would require huge investments due to the remote and scattered character of many settlements. Therefore, reliance of the population in these contexts on trail-based rural transport infrastructure will continue to dominate for years to come. Pedestrian trail bridges in this regards have proved to be very successful in providing rural people with access to basic services and economic opportunities. People use trail bridges for various purposes such as going to schools, visiting health service centres, selling products at market centres, performing household chores, and attending social functions. In Nepal, for example, the more than 6,000 trail bridges in place contribute significantly to improve rural access. In 2015, the average daily human, livestock and two-wheeler traffic counts per

bridge was 208 persons, 29 livestock, and 14 two-wheelers respectively (Chhetry, 2015). Costs of trail bridges in Nepal have been considerably reduced during the last 40 years and amount now to approximately 415 -720 USD/m depending on the bridge type. This corresponds to about 10 USD/beneficiary (Tuladhar, 2007).



The trail bridge technology is primarily suitable in hilly countries anywhere in the world. However, it has also proved to be successful in plain areas such as in the southern plain of Nepal. Trail bridges have been built across the world: in Indonesia, Laos, Ethiopia, Tanzania, Burundi, Honduras, and Guatemala. Moreover, feasibility studies confirmed the appropriateness of the technology in Vietnam, India, Rwanda, and Cameroun. Despite the demonstrated effectiveness of trail bridges to enhance access for the rural poor, challenges remain in scaling up this technology globally. Knowhow on trail bridges is currently limited to a few countries, mainly Nepal and also Ethiopia. In many countries, the limited capacity of the government, private sector, and communities is a major impediment towards building cost effective sustainable trail bridges. Moreover, trail bridges are often considered as 'an addition' to other rural transport infrastructure and therefore do not get the priority they deserve. Finally, maintenance of trail bridges still often gets second priority as new construction is perceived as more lucrative.

1.3 Objectives

The present paper aims at sharing experiences in the trail bridge sub-sector and at encouraging future exchanges and potential partnerships. The paper tackles several issues such as the development of cost-effective technologies, institutionalisation of trail bridge engineering training, private sector development, development of norms and standards, institutional building and policy development, as well as South-South collaboration.

2. From piloting to a sector-wide approach - 50 years trail bridge experience in Nepal

Nepal has been an evolving ground for trail suspension bridges over the last 50 years. In the beginning of the twentieth century, Nepal started building trail bridges in strategic locations. Bridges were manufactured in Scotland, dispatched in 'parcels' to Nepal and subsequently erected at the sites. The purpose of construction of these bridges was to consolidate the regime's military and administrative strength to rule the country and in some cases to promote trade. With the beginning of the democratic regime in 1951, the need for planned development was realised. It started with piloting of two bridges towards the end of 1950s. Today, one bridge is constructed every day. More than 6000 bridges have been constructed in total.

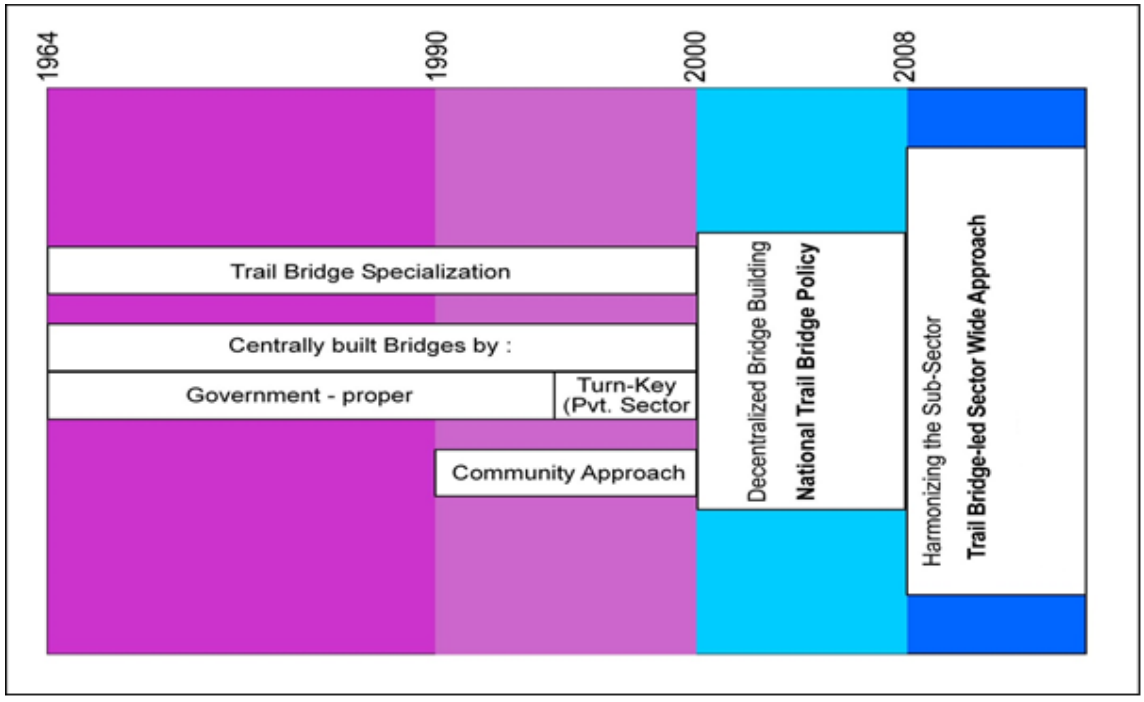


Figure 1 Trail bridge sub-sector development in Nepal: from piloting to a Sector Wide Approach

2.1 The different stages of development from pilot to a Sector Wide Approach

Long-term engagement with the government for institutionalization of trail bridges in the Government's system

The United States Operation Mission was the first to launch a trail bridge building programme in Nepal. Within this framework, HELVETAS engineers built two pilot bridges. Based on the positive results, the government of Nepal established the Suspension Bridge Division (SBD) in 1964, to bring forward trail bridge building in a planned way. The Swiss Association for Technical Assistance (SATA, which later became the Swiss Agency for Development and Cooperation: SDC) started supporting the Government of Nepal technically and financially in 1974. HELVETAS, as an implementing agency of SATA, started supporting SBD through the Suspension Bridge Project (SBP). Since then, SDC and HELVETAS have been continuously supporting the Government of Nepal in developing trail bridge programmes. The long-term engagement provided the ground for

- knowledge transfer from Swiss experts to Nepali experts and the relevant Government departments ultimately leading to a pool of competent local experts[1]
- innovation, research and development of various cost effective, easy to implement and sustainable technologies and approaches and their standardisation in the form of standard design, drawing, and implementation manuals[2]
- development of policy, strategy, norms, standards, manuals and guidelines, which helped in harmonising the trail bridge building initiatives by different agencies
- building the capacity from the central level to the local government agencies

Thanks to these efforts, the programme is well institutionalised in the government. Currently it is being implemented under a Sector Wide Approach (SWAp) with the

[1] Nepali experts in trail bridges are now providing support to various countries for trail bridge building under South-South Cooperation: https://assets.helvetas.org/downloads/helvetas_sscu_brochure_2015.pdf

[2] See under http://www.nepaltrailbridges.org.np/2015/manuals

leadership of the Government and with technical and financial support of the donors (e.g. SDC, DFID, and ADB).

Decentralized bridge building to respond to high demand for trail bridges

Trail bridges are lifelines of rural Nepal. With more than 6000 rivers crisscrossing the country, inhabitants of the many settlements, without bridges, either need to spend hours to reach the other side of the rivers throughout the year or even remain isolated in the rainy seasons. Therefore, demand for trail bridges is high. A comprehensive study conducted in 60 (out of 75) districts in 2009 suggests that about 10'000 bridges are needed in Nepal. To meet this huge demand is a challenge. However, the current average annual construction output of one bridge a day is possible only due to **decentralisation of bridge building to the local government**. Until 1980, the bridges were built by the central agency. In 1989, HELVETAS piloted a simplified bridge technology to be implemented under a community approach, which opened the door for decentralisation of the bridge building through local government bodies. At present, the District Development Committees (local governments) are responsible for planning, implementing and maintaining trail bridges. This approach also helped to ensure equitable prioritisation of bridge i.e. giving priority to the most vulnerable people.

Simplification of technology and capacity building for scaling up of the outputs

As mentioned above, in the 1990s, the piloting and development of a simple technology based on traditional bridges (built by the local population in the past) was initiated. The idea was to develop a bridge technology that can be constructed by the local communities on numerous

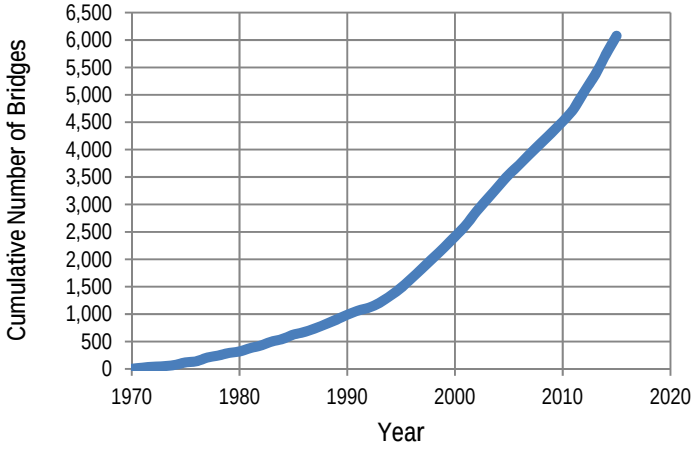


Figure 2 Cumulative number of bridges in Nepal

local trails (characterised by low traffic volume) with technical support of trained technicians. This proved to be a huge success. This technology is popularly known as Short Span Trail Bridge (SSTB) technology. The existing, more technically demanding, Long Span Trail Bridge (LSTB) technology, along with the SSTB were optimized, standardised and **manuals for survey, design, and drawing** were developed. The introduction of steel deck in place of wooden deck led to the emergence of **galvanisation plants** in Nepal. However, continuous monitoring and orientation for those plants to comply with quality standards was necessary. Likewise, in order to provide technical support to the communities building bridges, the need for local service providers was realised and local NGOs were contracted and capacitated to technically and socially support such communities. With these efforts, the massive increase in number of bridges constructed became possible.

Institutionalised capacity building for sustainable knowledge transfer

Capacity building trainings to practitioners and regular engineering students (of different levels) started in the 1990s. **Engineering Colleges and Vocational Schools included trail bridge courses in their regular curricula and provided training to practitioners** with the support of HELVETAS. It not only led to bringing training to scale but also institutionalised trail bridge capacity building in colleges and vocational schools.

Rigorous quality monitoring and updated information system as requisite for compliance to the policy

Increasing the bridge output to respond to the huge demand was not an easy task though. Despite the efforts described above, ensuring quality of the bridges and compliance to the policy represented a challenge. This required rigorous monitoring efforts and updated information systems. For that purpose **computer based systems called Planning and Monitoring Information System** (PMIS), **Trail Bridge Strategy Information System** (TBSIS), and **Detailed Bridge Record** (DBR) were developed and maintained. These tools proved to be very effective in monitoring the bridge progress and the quality of construction as well as the maintenance needs of the existing bridges.

The National Trail Bridge Strategy has been prepared in and enforced since 2006. The Trail bridge programme has been implemented following a Sector Wide Approach (SWAp) since July 2009. The first phase of SWAp (2009-2014) has proved successful and its external review revealed that it has contributed significantly to the improvement in access for a large number of the rural population, especially those in remote areas and the marginalised (Ghimire, Tumbahangphe, and Shrestha, 2013). The second phase of SWAp is being implemented with decentralised technical assistance to the Government.

2.2 Current and future challenges in Nepal

Despite these achievements, a number of challenges remain.

- Although the trail bridge strategy gives priority to maintenance over new construction, maintenance of trail bridges often gets second priority in practice as new construction is perceived as more lucrative.
- Although the programme is being implemented under SWAp, no basket fund is yet formed and functional. Donors are channelling their funds through their own project mechanisms.
- Although the institutionalised capacity building is in place, continuously capacitating a large number of people required to meet the target of 500 bridges per year (according to the SWAp framework 2014-2019) is a challenge especially due to the high turnover of capacitated people in the local government and NGOs.
- The unstable political situation and lack of elected representatives in the local bodies are also barriers towards accountable trail bridge service delivery at local level.

3. Trail bridge sub-sector development in Africa: current status, lessons learned and challenges ahead

Demand for trail bridges is increasingly growing in Africa. The trail bridge technology was introduced among others in Ethiopia in 2003, and in Burundi in 2014. Cameroun is currently starting implementing pilot bridges.

3.1 Building institutional and technical capacity to sustain trail bridge initiatives in Ethiopia

Considering the very low road infrastructure development in Ethiopia and the very high construction costs of roads and bridges for motorised vehicles in remote areas with very rugged terrain, the trail bridge technology has become an important complement to the country's endeavours in providing basic access infrastructure to the rural community. The Government of Ethiopia recognises complementary transport measures such as tracks and trails, including pedestrian trail bridges, which are considered as integral parts of the rural transport system. 83 trail bridges have been constructed through cost sharing between HEVETAS and local governments so far, which benefited more than 498,000 men and women. Moreover, trail bridges are now aligned with the Government policy of the Road Sector Development Programme IV and have become part of the national Low Volume Roads manuals.

Policy dialogue resulted in the integration of trail bridges in the Agricultural Growth Programme, which is financed through a pool fund with World Bank loans and grants, and in the inclusion of trail bridge technology into the Growth Transformation Plan II (2015-2020). South-South technology transfer between Nepal and Ethiopia has been very effective in developing the trail bridge sector.

However, in order to successfully scale up the positive results achieved so far, **large investments in institutional building** will be needed. HELVETAS directly contributes to this end by developing capacity for planning, implementation, and quality assurance. Anchoring trail bridge technology within the **technical and vocational education and training institutes and technical universities** will help to establish in-country capacity for maintaining and further developing trail bridge building knowhow. Trail bridge projects will be planned and implemented through

public-private partnerships. In these partnerships, public authorities such as Rural Roads Authority and local government bodies as clients will plan and contract out survey, design, quality assurance, bridge condition assessment and maintenance of trail bridges to private consultants. To enhance sustainability, both the demand side (i.e. number of bridges integrated in a development plan and budgeted for) and the supply side (i.e. network of well-trained government and private actors contributing to implementation of bridges) will be strengthened. Additionally, Rural Roads Authorities need to update their respective **trail bridge registers** as well as maintaining trail bridges through reactivating **bridge maintenance committees** and linking them with the local administrations. Finally, policy efforts to prioritise the trail bridge sub-sector and ensure that trail bridges are integrated in the **transport master plans** (and thus effectively budgeted) need to be continued.

3.2 First lessons learned from the pilot trail bridge initiative in Burundi and challenges ahead

Given Burundi's topography and hydrology, the potential for scaling up trail bridge technologies is high. The pilot phase conducted with the support of the HELVETAS South-South Cooperation Unit in Nepal resulted in the implementation of seven bridges. Strong ownership by the central government (Road Authority) was a factor of success. The demonstrated effect of the pilot bridges has triggered increased interest of the government and the community for trail bridges. Even though communities were involved in bridge building, a stronger participation and ownership will be required to ensure appropriate operation and maintenance of the bridges as a key element of sustainability. Also the involvement of the local governments will need to be strengthened. For the pilot phase, steel parts had to be imported from Nepal. In order to develop the trail bridge sub-sector, capacity of government institutions,

education institutes, and private sector will need to be developed in terms of survey, design, construction supervision and monitoring. Moreover, local steel factories able to produce steel parts of the required quality will need to be promoted. Finally, it is now time for the government to develop a long-term vision, plans and policies for the development of the trail bridge sub-sector.

4. Promising approaches to bring trail bridge technologies to scale

The following table summarises key challenges and promising solutions when bringing sustainable trail bridge services to scale based on experiences from different countries.

Areas	Key challenges	Promising solutions
Developing cost-effective trail bridge technologies	Absence of qualified fabricator and galvanisation plant	Promotion of local fabricators and galvanisation plants by building their capacity (training, orientation, exposure)
	Limited local capacity in survey, design, construction monitoring	Capacity building of the government (national government, regional offices, local governments) and educational institutes through training, on the job training, curriculum development and Training of Trainers
Developing skills and businesses around trail bridges	Absence of qualified fabricator and galvanisation plant	Promotion of local fabricators and galvanisation plants by building their capacity (training, orientation, exposure)
		Continued orientation to the private sector e.g. consultants and fabricators on quality
Developing norms and standards	New technology thus the Government's reluctance and limited capacity	Impact of trail bridges are known only after their demonstration thus importance of pilots and impact assessments
		Working with the government from the very beginning
Institutional building and policy development	Unclear roles and responsibilities	Clarify roles and responsibilities of all actors (communities, Government, NGO, private sector) along all phases of the project cycle (see Table below) including the responsibilities for payment.
	Low capacity in the government system and existing (training) institutions	Engage with the government (central and local) and build capacity through training, on the job training, coaching, etc. Involvement of all the stakeholders from the very beginning. For this purpose, a 'public private partnership approach' could be promoted in which key actors are engaged and take responsibility to build cost effective quality bridges. The government should facilitate implementation through the private sector (manufacturers, construction companies, civil society groups/communities).
		Work with the existing institutions incl. TVET institutions, local governments and capacitate them
	Lack of policies	Demonstration of the impact of bridges
		Documentation of learning and dissemination
		Advocacy and lobby to ensure that bridges are integrated into transport masterplans and budgeted
		Develop norms, standards, manuals, guidelines and information system as necessary

As mentioned above, clarifying roles and responsibilities of the different actors is a precondition towards scaling up the trail bridge technology. The table below illustrates roles and responsibilities of the different actors along the project cycle on the basis of the Nepal experience.

Project cycle phases / steps	Actors
Planning	
Bridge demand	Community
Prioritisation of bridge demands	Local government
Bridge planning / budgeting	Local / national government
Disbursement of funds from the national to the local government	National government
Procurement (hiring of local NGO & consultant)	Local government
Site Investigation, Survey and Design incl. cost estimate	Local NGO / consultant / contractor
Settling potential disputes over land	Community / Local government
Establishment of User's Committee (UC)	Local government and Community + support of local NGO
Construction	
Contract agreement with community (UC) or with contractor	Local government & Community or Contractor
Procurement of goods	National government (steel cables), local government (steel parts and cement), steel parts workshops
Collection of local materials	Community with support of local NGO or Contractor
Bridge layout and foundation excavation	Community with support of local NGO or Contractor
Construction, bridge erection, cable setting	Community with support of local NGO or Contractor
Post-construction	
Formation of Bridge Maintenance Committee (BMC)	Community with support of local NGO
Appointment of Bridge Warden (BW) and training on routine maintenance	Local government and community
Handing over of tools for maintenance	Local government
Routine maintenance	Bridge warden
Bridge Condition Investigation every 3 years (Bridge Record)	Local government
Annual maintenance plan and budgeting	Local government

5. Conclusions

Rural transport infrastructure and services that improve access to markets, economic opportunities, goods, and services are fundamental to the achievement of many of the Sustainable Development Goals. Given the huge investments needed for roads and bridges for motorised vehicles, the trail bridge technology has a tremendous potential to improve access for the poorer population of remote or scattered areas. The impact of the 6000 bridges in Nepal for instance is impressive in terms of safety, education, health, economic opportunities, and social impact.

However, the trail bridge technology is only known in a few countries in the world. Besides, trail bridges are often considered as 'an addition' to other rural transport infrastructure and therefore receive little attention. So what does it take to develop the trail bridge sub-sector? Based on lessons learned from different countries where trail bridges are being implemented, the following recommendations can be made.

Demonstrating impact. Creating evidence, demonstrating impact by implementing pilot bridges from the beginning contributes considerably to raise interest and demand for this technology. Creating evidence is a requirement for gradually integrating this technology into policies.

Quality and sustainability. The experience in Nepal revealed that bridge cost per meter has been considerably reduced during the decades of bridge development. Cost-effective technologies now exist. One factor of success is **not** to compromise on bridge quality. Introducing norms and standards and institutionalising quality assurance for example for the design, construction, as well as steel parts, etc. is a requirement. Moreover, as for any other type of infrastructure, maintenance mechanisms must be put in place from the very beginning: a trained bridge warden, availability of tools/spare parts, and finances to cover the cost of maintenance.

Institutionalising knowhow. To shift from piloting bridge technologies to a larger scale implementation, institutionalising know-how is a prerequisite. Integrating trail bridge knowhow in technical schools and universities curricula is an important step. Investments are required not only in construction but also in capacity development. All actors involved in planning, implementation, maintenance, and monitoring:

communities, private sector, education institutes and government (at national, regional, and local levels) must be capacitated through training, on the job training, curriculum development, and Training of Trainers. Finally, refresher training must be offered. The experience in Nepal also highlighted the importance of decentralisation and strong local (district) governments to support the scaling up of trail bridges.

Private sector development. Experience in different countries confirmed that the private sector plays a key role in scaling up trail bridge technologies: not only for the production of good quality steel parts but also for the design and construction of trail bridges.

Integration into policies. Finally, integrating trail bridges as an element of the transport policy is crucial. Clarifying roles and responsibilities regarding trail bridge planning, implementation, maintenance, and monitoring, identifying the needs, and prioritising the needs into transport masterplans, but also allocating the corresponding budget for both construction and capacity development, and monitoring implementation through information systems and bridge records are other key elements for the successful scaling up.

How to unfold the potential of South-South Cooperation?

The different country experiences also confirmed the importance of South-South cooperation for the development of the trail bridge sub-sector globally. The strong trail bridge poles in Nepal and Ethiopia (HELVETAS South-South Cooperation Unit) represent a huge potential. However, there is still room to unfold the potential of South-South cooperation. Interaction through various fora such as AfCAP, enhanced coordination among trail bridge experts in various countries (alliance of trail bridge building nations), continuous efforts in information sharing towards governments and donors in the sector are some elements identified to strengthen South-South cooperation in the years to come. This in turn should benefit the millions of disadvantaged people who still lack access to education, health services and markets.

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