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Interactions between improved rural access infrastructure and transport services provision

Report of Nepal Surveys

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Cover photo: Paul Starkey: Bus rounding hairpin bend with stone soling on the Kavre road studied in Nepal

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Abstract

The 'Interactions: Maintenance-Provision of Access for Rural Transport Services (IMPARTS)' project is examining how investments in low-volume rural road (LVRR) construction (provision) and maintenance (preservation) affect rural transport services (RTS). Improved RTS are vital for enabling access to facilities including markets, health facilities, education and socio-economic opportunities. While road investments are often justified by envisaged RTS improvements, few road authorities collect 'before' and 'after' RTS information. Two roads in Nepal and six roads in Tanzania were selected for IMPARTS Phase 2 surveys, because of good transport services data from previous studies. New surveys of traffic, users and operators on these roads started in October 2019. This report contains qualitative and quantitative data from the Nepal roads. The earth roads were built in Kavre and Sindhuli Districts in 2005-2009 using labour-based methods with some new alignments. The simple, well-engineered roads have survived many monsoons. Many cobblestone pavements on the steep gradients were in excellent condition and have allowed bus services to operate throughout the year. Both roads have allowed bus services to start and to continue. Buses fares have decreased, and the Rural Transport Premium was shown to have fallen. Passenger numbers are increasing, particularly on the busier sections near the start of the roads. Personal motorcycles are also increasing in number. Bus services are now supplemented by autorickshaws and minivans which had not been seen in previous surveys in 2007 and 2013. On the Sindhuli road, autorickshaws now serve remote rural areas, and jeeps and pickups are increasingly carrying paying passengers. The smaller transport services charge higher fares than buses but tend to be popular. The trend towards several complementary RTS should be encouraged. Routine road maintenance has declined and should be reintroduced to ensure water flows do not damage roads and make travelling difficult. The use of insufficiently supervised heavy machinery to widen parts of the roads has created muddy sections, impassable to some vehicles. The longevity of the benefits to transport services of simple labour-based road construction and maintenance techniques used should be learned and widely shared.

Key words

Nepal; Buses; Autorickshaws; Cobblestones; Transport services; Traffic counts; Rural mobility; Rural road outcomes; Rural road impacts; Rural road preservation; Rural road provision

Acronyms, Units and Currencies

4WD	Four-wheel drive
AfCAP	Africa Community Access Partnership
AsCAP	Asia Community Access Partnership
CIEDP	Commission of Investigation on Enforced Disappeared Persons
CPN-M	Communist Party of Nepal–Maoist
DCC	District Coordination Committee
DCRN	District Core Road Network
DFID	Department for International Development, UK
DoLI	Department of Local Infrastructure
DoLIDAR	Department for Local Infrastructure Development and Agricultural Roads, Nepal
DoR	Department of Roads
DRCC	District Road Coordination Committee
DRSP	District Roads Support Programme
DTM	Department of Transport Management
DTMP	District Transport Master Plan
eg	for example
GIS	Geographic Information System
GPS	Global positioning system
HD	High definition
IDMP	Indicative Development Potential Map
IMPARTS	Interactions: Maintenance-Provision of Access for Rural Transport Services
IRI	International Roughness Index
kg	kilogram
KII	Key informant interviews
km	kilometre
kph	kilometres per hour
LRN	Local Road Network
LVRR	Low-volume rural road
MoLD	Ministry of Local Development
NPC	National Planning Commission
NPR	Nepal Rupee (in December 2019, NPR 1 = GBP 0.0067 = USD 0.0088; GBP1 = NPR 149; USD 1 = NPR 113)
ReCAP	Research for Community Access Partnership
RRA	Rural Roads Class A (district road)
RRB	Rural Road Class B (village road)
RRC	Rural Road Class C (main trial)
RRD	Rural Road Class D (village trail)
RTP	Rural transport premium
RTS	Rural transport services
SDC	Swiss Agency for Development and Cooperation
SRN	Strategic Road Network
SWN	Scott Wilson Nepal
TRC	Truth and Reconciliation Commission
TRL	Transport Research Laboratory
UK	United Kingdom
UKAid	United Kingdom Aid (Department for International Development, UK)
UML	Unified Marxist-Leninist party
USD	United States Dollar
USDc	United States Dollar cents
VOC	Vehicle operating costs

Executive Summary

The 'Interactions: Maintenance-Provision of Access for Rural Transport Services (IMPARTS)' research project is studying how the provision and maintenance of low-volume rural roads (LVRRs) impact rural transport services (RTS) and the mobility of people and their goods. There should be an integrated approach to the provision-preservation-services continuum to ensure road investments are well planned, cost-effective and appropriate to the transport needs of rural communities.

The Phase 1 report highlighted the beneficial impacts of rural road investments on local populations. Transport services were a major mechanism in achieving these benefits, but few roads authorities collected information on transport services that would assist their planning and prioritisation. Phase 2 started in May 2019. Following visits to Ghana, Nepal and Tanzania, two roads in Nepal and six roads in Tanzania were selected for in-depth surveys and analyses because there was earlier data on transport services on these roads. This report presents qualitative and quantitative data on the Nepal roads, surveyed Oct-Dec 2019.

Surveys included traffic counts, interviews with operators and key informants, and obtaining travel patterns, preferences and opinions from 100 transport users (female and male) on each road. The two roads selected in Kavre and Sindhuli districts were built by the District Roads Support Programme (DRSP) using labour-based methods in 2005-2009. Both were simple earth roads with cobblestone sections at strategic points, notably on steep gradients and bends. Supporting structures were mainly made with stone gabions. The roads used simple but effective drainage solutions, with emphasis on drifts rather than culverts. The Kavre road was about 28 km and comprised 9.5 km through a busy and productive valley, and two sections climbing steep valley sides in areas with a low population of semi-subsistence farmers. The Sindhuli road was about 18 km and followed an undulating alignment in small hills alongside a wide valley. On both roads the original earth road and cobblestone sections had survived very well in contrast to an Otta seal surfacing that had largely disappeared. Both roads have experienced recent widening using machinery that had interfered with the original drainage and created muddy sections. On the Kavre road this was exacerbated by heavy trucks hauling rocks from a quarry. On both roads there were examples of farmers who irrigated crops causing water to flow onto the road.

The main transport services on both roads were 35-seater buses. There were four in each direction on both roads. This had not changed since 2007. Transport demand has been increasing on both roads, particularly on the sections nearest the urban end of the road. Where there is more demand complementary services have developed, operated by autorickshaws, minivans (on roads in relatively good condition) and jeeps/pickups. These charge more per passenger-km than buses but are popular for their greater timeliness. On the Sindhuli road, buses have increased their daily passengers, but decreased in popularity. They were the lowest rated transport services option, with only trucks considered more dangerous.

The number of enterprises along both roads has increased greatly. On both roads, motorcycles had been rare or absent in 2009, but were now rapidly increasing for personal use, and are the most common vehicles. Bus fares have decreased since 2013 and are now about USDc 5.5 per passenger-km. The Rural Transport Premium (RTP, the ratio of rural bus fares to long-distance bus fares) for buses has decreased from 5.4 in 2013 to 3.1 in 2019. The RTP is higher for low-capacity vehicles and is around 3 for minivans and jeeps/pickups. It is much higher for autorickshaws due to their point-to-point operations.

It is concluded that the original construction of the earth roads with strategic cobblestone sections allowed bus services to start operating. The impressive, long-term all-season passability of the roads has allowed buses to continue at reduced fares. However, transport demand depends on many socio-economic factors besides road condition. It is recommended that road condition be protected by returning to the routine maintenance system of lengthworkers. Cobblestones are not popular with road users or the road authorities (people aspire to blacktop surfacing) but are effective and enduring. This should be shared with policy makers to facilitate more extensive use of this technology. The long survival of the roads through many monsoons contrasts with short-lived 'bulldozer' roads. Road building and road maintenance require strict attention to engineering and drainage. While buses will continue as the main transport services, the growth of smaller, complementary services is popular and should be encouraged.

1 Background

1.1 Project overview

The Research for Community Access Partnership (ReCAP), funded by UKAid, commissioned TRL to undertake this research study to gain, and to disseminate, a greater understanding of how investments in low-volume rural roads (LVRRs) impact rural transport services (RTS) and the mobility of people and their goods. This project is known as IMPARTS (Interactions: Maintenance-Provision of Access for Rural Transport Services). It is exploring the interaction between the effective use of rural access and its dependency on the appropriate provision and preservation of LVRRs, and the resultant changes in rural transport service provision that are brought about through improved sustainable road performance.

There is understood to be a strong correlation between poverty and connectivity. Road access in rural areas can improve social welfare by increasing the proximity to, and quality of, basic services, and broadening livelihood opportunities, including agricultural production and marketing. Improved accessibility through the provision of rural road infrastructure and transport services can improve health and education outcomes by increasing attendance at clinics and schools and improving staff retention. Road infrastructure allows rural women and men to reach markets and income-generating opportunities. However, most rural people in low-income countries do not own motorised transport and therefore depend on various types of transport services for their mobility, access to services and earning potential.

The many benefits of LVRR are largely dependent on a sustained level of infrastructure performance linked to there being appropriate and affordable transport services: rural roads must be fit for purpose in terms of facilitating the movement of people and freight. Currently, infrastructure provision and preservation are largely disassociated from service provision. Therefore, this project is examining the relationships between LVRRs and transport services, and the links between LVRR-investment planning for provision and preservation, and the actual achievement in terms of rural transport provision.

1.2 Research objective

The core research objective is to examine the conditions in which rural transport services succeed or fail, and the relevance of infrastructure condition and level of service to that outcome.

Output: definitive guidelines on how the provision-preservation-services continuum can be improved in support of better livelihood opportunities for rural communities and have a positive impact on poverty reduction.

Impact: to improve accessibility and mobility for rural communities, and to improve the overall livelihood outcomes of those communities, and, in particular, vulnerable groups and individuals within those communities.

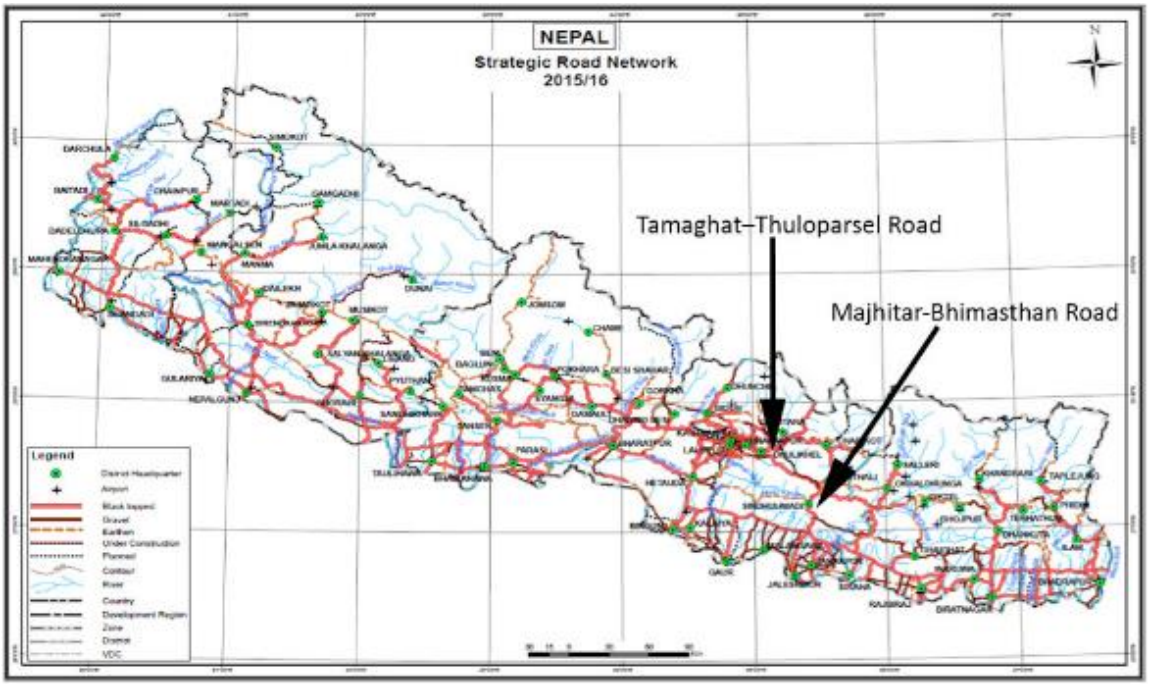
1.3 Activities and progress to date

Phase 1, which started in May 2018, involved a detailed literature review of the relationships between LVRRs, transport services and the outcomes and impacts for the rural populations (Starkey et al., 2019a). This cited impact studies from around the world on how rural road provision had affected the local populations, through improvements in mobility, agricultural production, access to medical facilities, education and poverty reduction. However, despite the large number of rural road projects in Africa, Asia, Latin America and island states, the number of clear impact lessons was surprisingly few. Most impact studies attempted to correlate various 'before' and 'after' datasets obtained through socio-economic surveys. Only a very small number of published studies have looked at transport services and the mechanisms by which these impacts had been achieved. Through liaison with road authorities in all 17 ReCAP countries, it was learned that while road investments are often justified by predicted improvements in transport services, few (if any) road authorities regularly collect 'before' and 'after' information on transport service provision. Good datasets relating to rural transport services are rare. Even traffic counts on LVRRs that have been consistently implemented over a period of time are difficult to find.

A project inter-regional stakeholder workshop was held in Arusha, Tanzania, in November 2018 and was attended by 39 participants from 12 ReCAP countries (Starkey et al., 2019b). The participants, who were mainly engineers from roads authorities, were motivated to understand transport services issues, and endorsed the need for more integrated approaches with transport services data informing the planning of road investments (construction and maintenance). The workshop concluded that roads authorities should try to collect, and use in their planning, simple transport services outcome indicators (such as modal distribution, tariffs, frequencies and journey times). Unlike *impact* indicators that may take five years or more to respond to road investments, transport services *outcome* indicators respond rapidly to road improvements. Importantly, they also respond quite quickly to road deterioration due to inadequate maintenance. Such transport services outcome indicators could be incorporated into road planning and maintenance management systems.

Phase 2/3 started in early 2019, and team members visited roads authorities and rural roads in Ghana, Nepal and Tanzania to select suitable research locations. Information and data on road planning and transport services in previous years was better in Nepal and Tanzania, and roads in these countries were selected for new surveys. The roads selected in Nepal, including some key features and existing data sources, are summarised in Table 1. The approximate location of these roads within Nepal is shown in Figure 1.

Figure 1 Map of Nepal showing strategic road network and approximate locations of the two roads studied



The Nepal research was carried out in collaboration with Scott Wilson Nepal. Following the development of the various survey forms, local researchers were trained to implement qualitative and quantitative surveys on the selected roads, allowing the implementation to start in September 2019. This report contains findings of various surveys carried out on two roads in Nepal.

1.4 Research tools and methods

The various research instruments and survey forms were presented in detail in a previous report (Starkey et al., 2019c), and includes traffic counts, user surveys, operator surveys and key informant interviews. These are summarised in Table 2. The quantitative surveys were implemented in collaboration with Scott Wilson, Nepal. The surveys and traffic counts were carried out from 16-29 October 2019 on the Tamaghat–Thuloparsel road and 29th November to 8th December 2019 on the Majhitar-Bhimasthan road.

Table 1 Summary of the roads surveyed in Nepal

Road	Investments	Data	Present situation	Infrastructure issues	Transport services issues	Planning issues
Tamaghat–Thuloparsel road in Kavre District (a historical name still in use). The first 9.5 km of the 32 km road go along a fertile plain with much mixed agriculture and increasing investments in enterprises. At Boharedovan (9.5 km) a bridge crosses the Jhiu Khola and the road climbs a steep valley side and decends to the large Sun Kosi River at Khahareghat (18 km). The road then ascends up the side of the Sun Kosi valley to Thuloparsel.	The road is essentially a well-engineered earth road, with cobblestone and stone soling paving at critical points. DRSP rehabilitated the first 9.5 km in 2002-5 and constructed an entirely new road from Boharedovan to Thuloparsel from 2005-2010. Initially there were lengthworkers, but routine maintenance is now minimal. Landslides are cleared when required and parts of the road have been recently widened for the benefit of quarry trucks	DRSP planning documents and 2013 evaluation with surveys	Road is accessible all year, with minor disruptions to clear landslides in the wet season. Where the surface becomes muddy it restricts the type of vehicles that are able to access the road. Busy first section but little traffic after 9.5 km (Boharedovan) apart from 4 daily buses and large trucks carrying stone from a quarry. Landslides always a threat to the road in the rainy season.	Good opportunity to study performance of engineered earth road with stone surfacing on steep sections and some Otta seal. Also, effects of heavy vehicles on a basic earth road. Drainage is crucial and farmers wanting irrigation can be in conflict with road drainage needs. Lack of maintenance is an issue. In some areas, landslides are prevalent in the wet season. Recent widening has led to muddy sections (impassable to low-clearance vehicles).	The first section is agricultural and quite economically active, and is served by buses travelling onto Kathmandu and as well as minivans (shared rural taxis) and autorickshaws (mainly point-to-point taxis). The minivans and autorickshaws do not serve the rest of the road, which seems largely due to low demand as the road has been motorable by such vehicles for several years. The long-distances bus services between Thuloparsel started soon after road construction, but do not seem to have diversified much. There are few public transport jeeps/pickups on this road, which may be linked to bus cartel issues. There are no motorcycle taxi transport services.	The road is the main access road for the catchment areas served, but the population density is quite low, beyond Bhoredovan (9.5 km). While longer, through routes are now possible with connecting roads, the low population density and rough roads do not currently favour such links.
Majhitar-Bhimasthan in Sindhuli District (historical name still in use). The 18 km road was constructed in 2006-2009 to Bhimasthan and then extended to Chakmake at 35 km. The road is mainly on the undulating side of a large river valley with mixed agricultural with irrigated rice production. Prior to the road access was seasonal along dry riverbeds (that are still used by some vehicles for dry-season access).	A new road alignment on the side of a river valley built by DRSP using labour-based construction methods between 2002 and 2007. Regular lengthworkers no longer present but there has been some maintenance and widening in the past year.	DRSP planning documents, 2009 evaluation traffic counts and 2013 evaluation with surveys	All-season road with gradually growing mixed traffic, including regular buses. Some muddy and difficult areas due to drainage issues and/or landslips, but still passable by most vehicles. Many steep areas protected by stone soling or cobblestone sections that are rough but passable. Freight traffic mainly retail suppliers and haulage of building materials (including by tractors and trailers).	Good opportunity to study performance of engineered earth road with stone surfacing on steep sections and some Otta seal. Drainage is crucial and farmers wanting irrigation can be in conflict with road drainage needs. General insufficient maintenance. Water crossings sound, minimal slope instability.	While buses are the main means of public transport, there are many Jeep/pickups also operating on the road. The buses complain of loss of market share and feel the jeeps/pickups are being protected by local politicians. Autorickshaws are gradually extending their operations, but mainly operate close to Majhitar. There are no motorcycle taxi transport services.	The road serves a rural catchment area without other roads. Apart from the study road, only dry season riverbeds allow some use of motorised transport. The road could be extended to join up with a national road, allowing through traffic to develop in the future

Table 2 Road survey data collection for the two Nepal roads

Indicator	Disaggregation	Data collected	Instrument	Sample size in Nepal	Comments
Modal share of passengers and freight	All public transport and freight modes. Passenger, Gender, Age (children), Freight	No. passengers per day per mode Estimated accompanied and unaccompanied freight per day per mode	Traffic counts with passenger counts and freight estimates.	12-hour traffic counts, two days at strategic points. Options for multiple locations if complicated routings.	Where market day surges envisaged, one will be a market day and one will be a non-market day
Passenger trips Passenger fares Passenger opinions and Passenger preferences	All public transport modes, Passengers for: Gender, Age (students, older persons), Occupations (students, farmers, commuters, etc), Disabilities	Typical origin and destinations and travel frequencies Modes used, Fares paid Transport options, Transport preferences, Opinions on different modes, Safety issues Accessibility issues	User questionnaires with purposive sampling at roadsides and villages to ensure respondent diversity.	100 per road	Where practicable, there should be an approximate gender balance among respondents
Vehicle operating costs and profitability Regulatory and safety issues	All public transport modes operating on road	Vehicle operating costs (VOC) components (daily fuel, ownership/hire costs, maintenance, etc). Tariffs charged, typical loads and trips per day, daily income. Regulatory charges etc.	Operator questionnaires	If practical, 100% of public transport vehicles operating on the surveyed roads, with a maximum fifteen operators for each transport type and 50 for whole road	It can be difficult to find and interview vehicle operators, unless they are at a transport stand waiting for passengers
Local perceptions of socio-economic impacts of existing transport modes	All public transport modes Education Health	Opinions of local professionals and leaders about advantages and disadvantages of different transport modes	Key informant interviews.	10 per road (including teachers, medical staff, agricultural extensionists, local dignitaries)	
Local perceptions of regulatory issues of existing transport modes	All public transport modes	Opinions of local police, enforcers and leaders about regulatory issues among the different transport modes	Key informant interviews.	3 per road	Experience suggests there will be few local enforcement officials or people responsible for local regulation
Road condition and maintenance	All local road authorities if more than one responsible		Key informant interviews.	3 per road	There may be only one engineer with knowledge of, and responsibilities for, the road

In addition to the quantitative data collection, there have been focus group discussions with key informants including vehicle operators and staff of the road authorities, and people aware of the history of the road (including the District Road Support Project) that implemented the early investments in the roads studied in Nepal.

Observations were made on the survey roads to determine key characteristics of the road that could have influenced the development of transport services. The assessments were undertaken using the following technologies:

- Visual assessment using standard data-collection forms on a drive-through survey.
- Videos of the road were taken using GPS enabled DashCams, which provided high definition video images of the road. The speed and GPS tracks have been embedded within the video. Finally, an accelerometer within the DashCam records the X, Y and Z movement of the camera within the vehicle, which can provide an indication of the roughest parts of the road.
- Roughness in the form of the International Roughness Index (IRI) was recorded using the World Bank smartphone app RoadLab. However, the results from this app are unreliable at slow speeds on fair and poor unsurfaced roads, and the app does not record below 15 kph. However, this information (or lack of it) has some value and can act as a check of the visual assessment.

1.4.1 Quantitative surveys

The same methodology was used on both roads, with interviews with 100 transport users, ten key informants and about twenty-five operators of transport services. Local district engineers were also interviewed. In the traffic surveys, 12-hour counts of all vehicle types and pedestrians were carried out at six sites (across both roads). In total, 14 12-hour traffic counts were undertaken. For most locations the counts were undertaken over two days covering a market and non-market day. Walking up both roads, the various enterprises observed (shops, workshops, tea shops) were counted, categorised and the gender of the responsible person noted. The overall data collected is summarised in Table 3.

Table 3 Summary of survey data collected for the two Nepal roads

Survey	Approach	Total people interviewed		
		Male	Female	Mean age (approx)
Users survey	Roadside interview of users	119	81	44
Key informants	Interviews of key opinion leaders	19	1	46
Transport operators	Interviews of transport operators	54	0	32
Road engineering issues	Interviews of road engineers	2		
Traffic survey	Roadside counts (14)			
Enterprise survey	Roadside observations of commercial activities	116	97	

Apart from the key informant interviews, respondents were selected randomly. Approximately 55% of those interviewed were from the Janjati caste, and 38% were of the Brahmin/Chhetri caste, while 7% of respondents were from the Dalit caste. As far as possible the results of the surveys were matched by earlier DRSP surveys carried out along the road, including those undertaken for the external reviews of Stickland (2009) and Starkey, Tumbahangfe and Sharma (2013).

1.4.2 Rural Transport Premium (RTP)

One of the ways of comparing rural transport services on different roads, within and between countries and over time is though transport tariffs, such as passenger fares. One specific indicator for such comparisons is the 'Rural Transport Premium' (RTP). This is the ratio between the cost of per passenger-km of the available public transport services on low-volume rural roads and the cost per passenger-km of standard-class, long-distance bus services. Being a ratio, there are no units or exchange rate issues, and many potential difficult issues, such as changes in fuel prices over time, the cost of living or idiosyncratic local pricing systems should be cancelled out. There will always be a RTP as long-distance buses are likely to be cheaper per passenger-km, as they tend to operate on better infrastructure (national trunk roads) and also benefit from two economies of scale (larger loads and longer distances). RTS typically use smaller

vehicles for shorter distances on poorer roads. As roads improve, vehicle operating costs come down, and fares tend to decrease, particularly if there is competition. If the roads are good, and transport demand is high, rural transport operators will tend to use larger-capacity vehicles, which also allows prices to come down. In subsequent sections of this report, the RTP indicator will be used to compare how transport services have changed over time.

2 Institutional context

2.1 Nepal geographic and political context

2.1.1 Political history

Nepal has undergone substantial political and social upheaval over the past 20 years. This has undoubtedly had an impact on the provision of infrastructure and the development of transport services. A decade-long political revolution started in the late 1990s with the increasing influence of the Communist Party of Nepal–Maoist (CPN-M), which led an insurgency at the reported cost of more than 13,000 lives, with the aim of overthrowing the kingdom and establishing a 'People's Republic'. This was achieved in 2008 and changed the prevailing political system in Nepal. The long conflict was based mainly in rural areas. The latest constitution, which was ratified in September 2015, confirms the country as a secular democratic republic. Under the 2015 constitution, Nepal formally adopted a two-level parliament with the change of government in February 2018.

Following local, provincial and national elections through late 2017, the Unified Marxist-Leninist party (UML) was elected as Nepal's new government in February 2018. The UML swiftly combined forces with the CPN-M to form a majority in parliament. A Truth and Reconciliation Commission (TRC) and a Commission of Investigation on Enforced Disappeared Persons (CIEDP) were formed and have held extensive hearings throughout Nepal during 2018.

In 2015, Nepal's population was 28.6 million. It had a gross national income (GNI) per head of USD 730. Nepal is slightly below average in the world corruption statistics, and is currently ranked at 128th (World Data, 2020). Previous independent reports of DRSP have noted corruption in transport services through the use of cartels to control prices and reduce competition.

2.1.2 Administrative arrangements

The first level of subdivision in Nepal are Provinces, of which there are seven. Each province is further subdivided into districts, and each district into municipalities and rural municipalities. Before 2015, instead of provinces, Nepal was divided into developmental regions and administrative zones. The new constitution of 2015 dictated that all old municipalities and villages (which were more than 3,900 in number) should be restructured into 753 new municipalities and rural municipalities. The former 75 District Development Committees (DDC) have been replaced by 77 new District Coordination Committees (DCC) which have much less power than the old DDCs. At present there are 6 metropolitan cities, 11 sub-metropolitan cities, 276 municipalities, and 460 rural municipalities.

2.1.3 Geography

Nepal's land area is 147,185 sq km. Nepal lies on the southern edge of the Himalayas and has varied geography, with altitudes ranging from less than 100 m on the flat 'Terai' area bordering India in the south to 8,848 m at the peak of Mount Everest. The flat Terai plains account for about 19% of Nepal's land area, and the Himalayas for 16%. The majority of the country in between these extremes is known as the hilly region (although for many people it is truly mountainous). The mountainous terrain and the annual monsoons make Nepal a very difficult environment in which to construct roads, especially unpaved rural roads which are more vulnerable to the environment.

Despite two thirds of the country being hilly or mountainous, good road construction material is not easy to come by. Constructing roads in the steep and unstable terrain is a challenge, but appropriate standards and specifications have been developed by Nepal's roads authorities. Large landslides are a constant threat to Nepal's roads, caused by a combination of heavy monsoon rains and earth tremors. A technology called bioengineering was developed in Nepal in the 1980s and 1990s as a low cost and appropriate way to stabilise slopes. This is used to repair landslides and to stabilise cut slopes that are created when roads are built. Bioengineering is a combination of engineering and planting, to create a sustainable solution to slope instability. It has proven to be very effective and can be implemented at low cost. DFID commissioned a bio-engineering handbook and manual as part a project to rehabilitate and maintain the Dharan–Dhankuta road in the East of Nepal (Howell, 1999), and an ongoing ReCAP funded project is being undertaken by

Helvetas to Investigate a Participatory Approach for Roadside Protection of Rural Roads in Nepal (Project ref: NEP2071D).

2.2 Road authorities and District Roads Support Programme

2.2.1 Road authorities

The two main roads authorities in Nepal are:

- **Department of Roads (DoR)**: Responsible for the Strategic Road Network (SRN), 9,120 km. Established under the Ministry of Physical Infrastructure and Transport. The DoR manages the SRN, the majority of which is paved and provides the main connections between cities and towns. There is a strategic road that runs east to west along the Terai, and another strategic road from east to west in the mid-hills is under development. Many other strategic roads run approximately south to north from the Terai East–West Highway to connect the district centres.
- **Department of Local Infrastructure (DoLI)**: Responsible for the District Core Road Network (DRCN) 6,067 km and Local Road Network (LRN) 9,667 km. Established under the Ministry of Federal Affairs and Local Development. DoLI (formerly DoLIDAR) manages the district and local road networks in Nepal under a different Ministry. The majority of these networks are of gravel or earth construction. Many rural roads are not engineered and are in poor condition, and as a result the majority are vulnerable to the monsoon rains that come every year between June and September. DoLI has recently been restructured to support the new decentralised institutional framework.

2.2.2 District Roads Support Programme

The District Roads Support Programme (DRSP) was a Swiss funded project designed to support decentralisation in Nepal. The Swiss Agency for Development and Cooperation (SDC) funded the programme from its inception in 1999 until its completion in 2013. The programme was implemented by joint venture Swiss consultants FRISA-ITECO in association with SKAT (these names originated as acronyms but are now company names). Its national partners were principally the related districts and DoLIDAR (the Department of Local Infrastructure Development and Agricultural Roads) under the Ministry of Local Development (MoLD) of the Government of Nepal, as it was then.

The programme focused on improving access through the construction, maintenance and rehabilitation of rural roads; whilst enhancing social and economic opportunities of the poor living in the programme area. The programme worked in a holistic approach and followed a labour-based, environmentally friendly and participatory approach. The aspects of road construction and community development were implemented simultaneously. Wherever possible the programme used local road construction groups, employing the poorest and most disadvantaged people living within the road corridor. A strong emphasis was put upon participation of employing two thirds of workers from disadvantaged groups and 40% female workers.

The programme emphasised the optimum use of local resources, so that the community had the opportunity for employment through road construction, and involvement in income generating activities to provide sustainability. This uplifted their economic situation and also created the sense of responsibility or ownership of the road. DRSP's concept of 'make our road by ourselves' was appreciated by the communities. The community groups were empowered by the social intervention programme, through which different awareness programmes brought positive changes in the behaviour and the attitude of the community. DRSP focused on the integration of technical and social aspects, contributing to 'on road' as well as 'off road' activities. The DSRP philosophy followed the DoLIDAR Approach Manual (DoLIDAR, 1999).

DRSP also focused on providing opportunities to disadvantaged groups, including women, and resulted in Kavrepalanchowk district at that time having 81% of workers belonging to this category. DRSP also introduced certain principles to safeguard workers' welfare, which were new to Nepal. These included accident insurance for all, payment on time and public audits and hearings to maintain maximum transparency. Savings and credit groups also became well established along the Kavre roads, and it was reported that their turnover increased by almost 50% from 2008 to 2009. Figure 2 shows a public audit being implemented in Thuloparsel.

Figure 2 DRSP public audit at Thuloparsel in 2006

DRSP conducted an independent external review in July 2009 to assess the impact of DRSP roads (Stickland, 2009). The following major impacts were found in relation to food security, access to farm produce and employment generation:

- Together with supplementary activities (cash crops, savings and credit etc.) household incomes increased by a factor of almost 3 over a ten-year period, within the area served by DRSP road corridors.
- A major benefit was the reduction of freight costs, leading to price reductions in shops along the road and also expanding the market for local produce.
- With the increase in income, the average food sufficiency of the population along the road corridors surveyed increased from 4 months to 7.5 months.

Quote: from Babu Lal Tamang, group coordinator (2009) – "The road is very important for us because it passes through our villages, which helps us in finding a market to sell vegetables and milk that is produced in huge quantities within our village."

Where there is no existing alignment, the new route for the road has to be agreed with the local community. DRSP used a process called 'walkover or reconnaissance surveys' which involved the DRSP team initially consulting with the local district council and identifying local people to accompany them on a walk-through of potential alignments. The alignments were assessed from technical, social, environmental and commercial perspectives, in line with the District Transport Master Plan (DTMP) findings. An alignment would be agreed that serves the local community best and ensures that the community is served equitably, and the poorest people do not suffer or lose land as a result of the road. Figure 3 shows a walkover survey near Thuloparsel, with DRSP staff working together with local people to identify the road alignment, plus an example of the type of map that is produced from a walkover survey.

Figure 3 DRSP walkover, reconnaissance survey team and related map

DRSP Planning

The two Nepal roads in this study were planned using the DTMP methodology approach (DRSP, 2001), which involves all important stakeholders at crucial stages of the planning process. A District Road Coordination Committee (DRCC) is formed, which is constituted as a legislative body for updating the DTMP, provides policy and decisions, and approves the reports of the DTMP. The district collects all potential road linkages proposed by local people and assesses them on an objective basis. This involves collecting secondary data from district sources to assess the following criteria, which are then scored according to development potential:

- Existing/Potential Agriculture
- Existing/Potential Horticulture
- Existing/Potential Livestock farming areas
- Existing/Potential Key Growth Centres
- Service centres
- Existing/Potential High Valued Cash Crops
- Forest areas
- Potential sites for hydropower development
- Potential sites for tourism
- Historical/Religious places

When this is complete the information is plotted on a base map (1:25,000) and presented for discussion and validation by the DRCC and DDC. The final plan is prepared in GIS format, showing the criteria above on different layers of maps. This whole process provides a good basis for planning of rural roads and takes into account indirectly the potential for transport services development.

2.3 Transport services types and their regulation

2.3.1 Transport services types in rural Nepal

In recent years its vehicle fleet growth rate has been substantial, for both commercial vehicles and motorcycles, the latter growing at over 15% per year. In contrast in the same period GDP growth averaged 4.4% per year. Table 4 provides data on Nepal's vehicle fleet, showing the great importance of motorcycles, and their rapid rate of expansion.

Table 4 Nepal's vehicle fleet and growth rate

	Vehicle numbers	Vehicles per 1000 people	Growth rate (2010 to 2015)
Motorcycles	1,520,000	54.3	15.1%
Passenger cars	160,000	5.7	8.4%
Commercial vehicles	150,000	5.2	11.3%

Source: IRF (2017)

Rural transport services are dominated by 35-seater buses that operate on fixed routes to and from large towns, including the capital, Kathmandu. They are mainly made by Tata and may be brought in as second-hand vehicles from India. On inter-urban roads there are also larger buses and air-conditioned buses, but the medium-size 35-seater buses are common in Nepal, particularly on roads with hilly sections and hairpin bends.

Figure 4 Tata 35-seater buses on the Kavre Road

On inter-city routes there are also minibuses that offer higher-priced services that are quicker and depart at more regular intervals. The models used are often Toyota Hiace, and sometimes these forms of transport are known as 'Hiaces'. However, such vehicles mainly operate on the 'black-topped' national roads, and not on rural roads (see Figure 5).

Smaller forms of public transport include minivans, that are vehicles with about 6-8 passenger seats. These include the Tata Magic models (see Figure 5). They may operate point-to-point services for particular customers, or may provide short-distance, route-based services.

Figure 5 Toyota Hiace (left) on highway and Tata Magic minivan on the Kavre Road

On rural roads there are a range of 'utility' vehicles including 'jeeps' and pickups (single and double cabs) that are used by entrepreneurs, authorities, NGOs and most businesses and organisations needing to work in rural areas. Models include Mahindra Bolero and Tata Scorpio (see Figure 6), the more expensive Toyota options of Hilux and Landcruiser. Some of these are licensed as public transport vehicles. Some are hired for specific journeys (such as religious festivals) and some operate as route-based transport services from

rural areas to market towns. They generally operate on shorter routes than do buses, and seldom compete directly with buses, due to the power of bus cartels.

Figure 6 Pickups, jeeps and utility on the surveyed roads

Autorickshaws (see Figure 7) generally operate point-to-point services for individual clients (or groups) in urban and rural areas, but some operate route-based services. In Kathmandu there are three-wheeler, route-based 'tuk-tuk' services, but these are seldom seen elsewhere in Nepal. Motorcycle rickshaws are used for freight, notably short-distance deliveries in urban areas. Two-wheeled tractors with trailers (see Figure 8) have similar niches to the freight motorcycle rickshaws and are sometimes used for freight transport in rural areas.

Figure 7 Passenger autorickshaws and a freight autorickshaw on the surveyed roads

Motorcycles are widely used for personal transport, in urban and rural areas, and their use is growing rapidly. However, professional motorcycle taxis are not generally present in Nepal. Their absence is unlikely to be due solely to regulatory processes, as there are many unlawful transport services practices on rural roads (passengers on bus roofs and services provided by 'private' jeeps and pickups). When questioned about motorcycle taxis, most people seem to think it is not a 'traditional' practice and has not been tried.

The poor condition of many roads in Nepal, combined with favourable tariffs for agricultural vehicles, has led to the use of tractors and trailers on roads in poor condition (see Figure 8). This used to be for all types of freight, including retail goods, but increasingly light trucks are used for retail deliveries, and nowadays tractors and trailers generally carry construction materials, such as sand, stone and bricks. Such materials are also carried in greater quantities by large commercial 'tipper' trucks (see Figure 9).

Figure 8 Four-wheel tractor and trailer (left) and two-wheel tractor on the survey roads

Figure 9 Heavy construction material tipper trucks (left) and multipurpose light truck (right) on the Kavre road

2.3.2 Department of Transport Management and transport regulation

The regulatory body for transport services is the Department of Transport Management (DTM) that was established in 1984. The key regulatory legislation is contained in the Vehicle and Transport Management Act of 1992 and Vehicle and Transport Management Rules of 1997, and subsequent minor amendments. The legislation distinguishes private vehicles and passenger transport services (including buses, minibuses, jeeps, car taxis and autorickshaws) and freight transport services (including pickups for hire and different sizes of trucks). Taxis and autorickshaws and freight vehicles are licensed without specifying routes. Buses and minibuses are allocated routes. The DTM has relatively little funding and few staff, and concentrates on the administrative functions of issuing licenses and certificates. Public service vehicles are theoretically 'tested' for road worthiness every six months. However, there are very few testing centres and the certificates are often issued for the necessary fee (and something extra) without visual inspection of the vehicles. There is little presence in rural areas, except for small offices in what used to be the district towns. There is little or no proactive planning relating to rural transport services.

All forms of public transport have associations, and some of these are powerful cartels, preserving monopolistic practices, sometimes with violence against competition. Historically there have even been explosions in DTM offices claimed to have been caused by the cartels. There is generally an over-supply of buses and freight vehicles (generally old vehicles, mainly bought second-hand in India). The cartels operate rotas to share the market between the existing vehicle owners, and they discourage new entrants to the market.

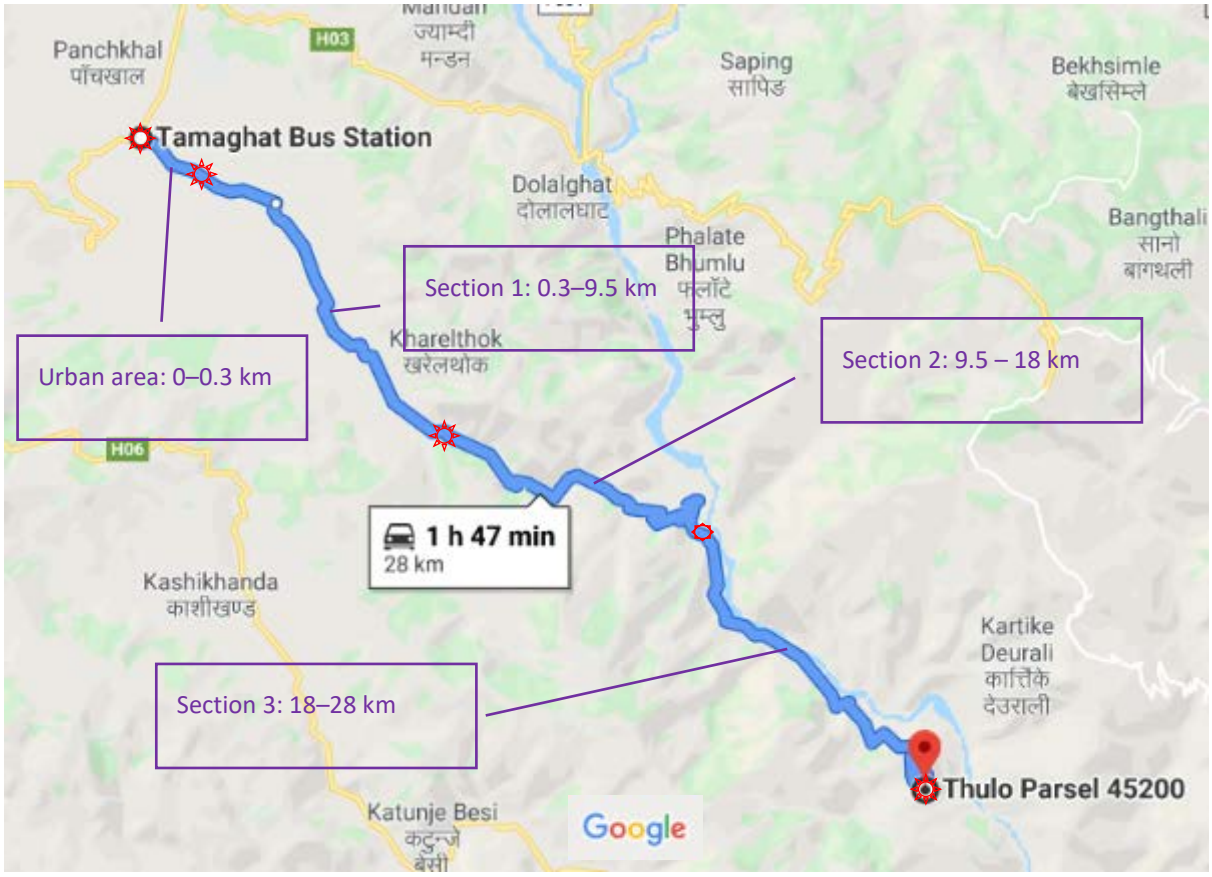
3 Tamaghat–Bhoredovan–Thuloparsel Road

3.1 Road geography, history and condition

3.1.1 History and alignment

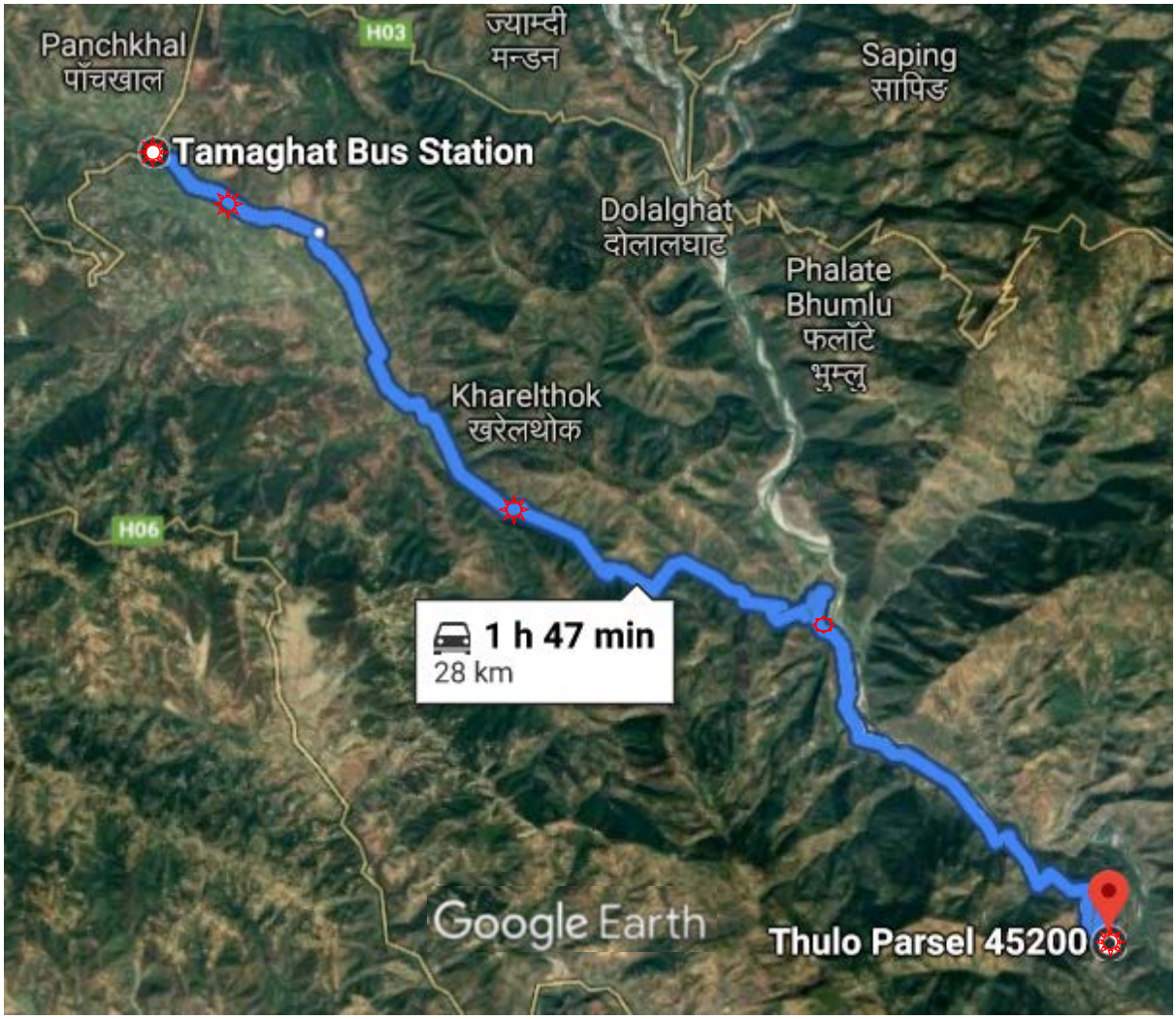
The road is about 28 km long and is mainly earth, with some short sections of cobblestone and gravel spot improvements. This road was constructed under the overall management of the DRSP in the 2000s. The road can be divided into three homogenous sections for the purposes of this research. The first section identified existed before DRSP, and the second and third sections were new alignments selected and implemented under DRSP but undertaken by the Rural Community Infrastructure Work (RCIW) programme, which used food-for-work as a payment methodology. The alignment of the road can be seen in Figure 10.

Figure 10 Tamaghat–Thuloparsel road alignment, showing sections and distances



A road alignment is shown with a Google Earth background Figure 11. This shows how the road follows the flat river course in Section 1, before climbing and descending valley sides Sections 2 and climbing up for most of Section 3.

Figure 11 Road alignment on Google Earth background showing the terrain



Section 1: Tamaghat-Bhoredovan (Jhiu Khola bridge)

The road starts at the junction with the Arniko Highway. The first 300 m (approximately) section is urban and is not being included in this study because the study is primarily looking at rural transport. However, as the introductory section of the road linking it to the main road, it cannot be ignored. The surface was originally Double Bituminous Surface Dressing (DBST). It has deteriorated with the gravel base showing in many areas. Average width is approximately four metres, but this varies due to lack of maintenance.

Section 1 (300 m–Jhiu Khola bridge at 9.5 km) starts at the end of the urban section and continues to the bridge at Jhiu Khola. The layout of the bridge and subsequent junction are shown in Figure 12. Section 1 alignment is fairly flat and follows the side of the valley, alongside Jhiu Khola (Khola means river in Nepali). The road on this section is essentially an earth surface. It was constructed using the typical DRSP philosophy of using local materials, labour based construction and natural compaction. There are some sections where spot patching has been applied using locally available gravel, but the road is not an engineered gravel road. Steep areas have been treated with cobblestone or stone soling and are motorable all year, even though they have high roughness. A large cobblestone drift is still intact and effective. Width varies between 4 m and 5 m throughout, some original culverts have been retained but drainage primarily relies on drifts and side drainage that is discharged to surrounding land and water courses, as is typical with DRSP roads.

Figure 12 Road junction and Jhiu Khola bridge at Bhoredovan

The Jhiu Khola bridge is shown in Figure 13, with sustainable technologies visible such as gabion retaining walls adjacent to the abutments.

Figure 13 Jhiu Khola bridge at Bhoredovan

Section 2: Bhoredovan (Jhiu Khola Bridge) to Khahereghat

Section 2: Jhiu Khola Bridge at 9.5 km to Khahereghat at 17.5 km: After the bridge at Jhiu Khola the road splits into two directions, a right-hand turn leads to the ridge alignment due south, and the left hand alignment leads along the Jhui Khola to the junction with the Sun Khosi near Khahereghat. The road alignment constructed by DRSP is the left-hand turn leading to Khahereghat and is therefore considered for this study. The alignment is largely through a hilly area, so moderate variations in horizontal and vertical alignment were observed. The steeper sections have been treated with stone soling or cobblestones, but would still be challenging for some vehicles, especially in the wet season if not maintained properly.

Section 3: Khahereghat - Thuloparsel

From Khahereghat at 17.5 km along the Sun Khosi and then up the valley side to Thuloparsel at 24.9 km. This section is again an earthen surface constructed in line with DRSP principles. This section of the road was not present before DRSP and the alignment was selected using a walkover or reconnaissance survey, as discussed in Section 2.2. This involves the DRSP team initially consulting with the local district council and identifying local people to accompany them on walks-through potential alignments. The road width varies between 4 m and 5 m and is inconsistent due to lack of maintenance and vehicles driving over the shoulders and surrounding land to avoid areas of deterioration. There is little variation in width in areas that are cut and fill, due to the limited alignment, as mentioned earlier. Drainage is poorly maintained, but key crossing areas are functional. The bridge at Jhiu Khola is about 10 years old and in good condition.

3.1.2 Road status and condition

In general, the road is in fair to poor condition, but is motorable up to Jhiu Khola bridge all year, with some vulnerabilities beyond the bridge where the road may be impassable to some vehicles for short periods of time. The road can be considered in three sections, plus the initial urban portion.

Section 1: Tamaghat-Bhoredovan (Jhiu Khola bridge)

In the urban section, much of the blacktop surface is no longer present and there are muddy areas, although the base does appear to be stable and the road would be passable in all situations. Drainage is poorly maintained but is functional.

Into the rural section, the road is in fair to poor condition, but there are no impassable areas and the base has retained its stability, with no potential impassable locations. The road width is inconsistent due to lack of maintenance, because in areas where the surface has deteriorated, drivers have driven over the shoulders to avoid them. In cut areas (where the road has been constructed in the side of the valley using cut and fill), there is little scope for widening or variation in width. An example of the transport operators' problems attributable to the narrow width are illustrated in Figure 14.

Figure 14 Narrow section between Tamaghat and Bhoredovan where passing other vehicles is problematic

Drainage is poorly maintained, but key crossing areas such as streams and rivers are functional. Some culverts which existed before DRSP have been retained and are effective but need monitoring. Drifts installed by DRSP are in good condition and function well. Most drifts rely on gabions to form the main structure of the drifts and can have either a stone soling or concrete surface. Side drains have been converted for use as irrigation ditches, which is having a detrimental effect on the road surface in some areas. There seems to be no control by the local roads authority over the use of side drains and local people are allowed to divert water along and across the road at will.

Section 2: Bhoredovan (Jhiu Khola Bridge) to Khahereghat

The first part of Section 2 from the bridge for approximately 2 km is poorly drained and recently the surface has become very muddy in the wet season. It seems that this problem arose when this section of the road was partially widened in the past year. In contrast to the DRSP original work, this was undertaken with heavy machinery, with no effort to stabilise the cut slopes or compact the surface. The problem has been severely exacerbated by the heavy trucks using the quarry near Khahereghat. These have created deep ruts that hold water, and lead to the problems illustrated in Figure 15. This shows the road after heavy rain, when it is accessible only to robust, high clearance vehicles (that include the 35-seater buses). The sections constructed by DRSP that have not been modified are still in good condition and motorable all year, which demonstrates that the DRSP philosophy was sound and when implemented properly provided a high quality and durable road. The drifts built by DRSP are in good condition and function well.

Figure 15 Muddy section close to Bhoredovan on the section to Khahereghat

There is one area, close to the quarry, where the stone soling surface has recently been overlaid by what appears to be a waste product from a quarry stone crusher. This was presumably added to reduce the roughness and may have been an intervention by the quarry or local organisations to produce a smoother ride. However, there appears no engineering basis for such an intervention. The result is that the surface has already eroded severely during heavy rains. The smooth sections appear to be decreasing rapidly, with the vertical edges produced by erosion potentially hazardous to motorcycles.

Figure 16 Recently laid but eroding stone-waste surface placed on top of stone soling near the quarry

Section 3: Khahereghat - Thuloparsel

The Khahereghat-Thuloparsel road section has received little or no maintenance since its completion and is in fair to poor condition, with some impassable areas for low-clearance vehicles during periods of heavy rainfall and potential landslides. The road base is fairly stable and there are no areas that have completely lost their shape. Steep areas have been treated with cobblestone or stone soling and are motorable all year, even though they have high roughness.

This section is also vulnerable to small landslides (in the Nepal context), which can nevertheless block the road for anything from a few hours to a few days. When the road was originally constructed the vulnerable areas were bio-engineered, but there have been no such interventions since, so the road will remain vulnerable to landslides due to the cut and fill nature of the construction.

3.1.3 Road roughness

Road roughness is important for transport services operators as it affects vehicle operating costs, as well as journey times. The roughness of this road was measured using a smartphone app. However, due to the slow speeds that could be achieved it was not possible to measure IRI for the majority of the road because IRI cannot be measured using RoadLab below a survey speed of 15 km/h. Most of the road could only be driven at between 10 and 15 km/h, so very few measurements were taken. It can therefore be assumed from the World Bank roughness scale (Gillespie, Paterson and Sayers, 1986) that the IRI is in excess of 20 m/km.

Overall the road running surface is poor and does not provide a good level of comfort. However, a previous study on DRSP roads in Nepal (Stickland, 2009) suggested that journey time was not the most important factor for road users and passengers. A more important consideration was the provision of a reliable transport service, regardless of the time it takes to travel. Roughness is important, but passability may be more crucial for transport services.

3.1.4 Road maintenance

The road was completed by DRSP in approximately 2010, following several years of construction. The 'Green Roads' philosophy adopted by DoLI recommends constructing a road in phases over three to five years (GTZ, 1999). In the first year a 1 m wide alignment is cleared to define the route. This is monitored and widened to 3 m - 3.5 m in the second year so that any weak areas or areas susceptible to landslides and natural problems can be identified and the road realigned if necessary. In the final year the road is widened to 5 m and structures are incorporated. DRSP did refine the methodology as the project built up experience over several years, but the principles remained the same. Compaction of the natural surface is carried out using pedestrian rollers where possible. In theory this whole process should make it easier to maintain the road.

When the road was completed there were lengthworkers present on the road, assigned 3 km each to maintain using simple hand tools. These were employed locally but were trained and supported with tools, equipment and safety clothing by DRSP. Following discussions with local people the lengthworkers were dispensed of some three to four years ago, so there has been no routine maintenance on this road during that time. Figure 17 shows a DRSP lengthworker at completion of the road.

Figure 17 DRSP lengthworker in 2009 (left)). Lady voluntarily clearing landslip into a side drain in 2019 (right)

There was evidence that local community members were carrying out some emergency type maintenance, for example where small landslides had blocked a drain (see Figure 17), but there is no coordinated effort for routine maintenance on the road.

Routine maintenance was effective when DRSP were training and supporting the lengthworkers, even though their wages were being paid by the district on a contract basis. Routine maintenance helps to keep the road open during times of heavy rainfall and can help to maintain a smoother running surface.

3.1.5 Comment on construction in 2009

The Tamaghat – Bohredovan – Khahereghat - Thuloparsel Road was seen by DRSP as a good example of a rural road that benefits the community, typically showing the impact roads have on the development of a community as well as being an example of synergy between different projects with similar objectives, in this case RCIW and DRSP, with input from DFID. DRSP outcome monitoring in September 2009 made the following observations.

The three main sections of the road (not including the urban section from 0–0.3 km) include rehabilitation of the existing road (Tamaghat – Bhoredovan, 0.3 – 9.0 km) and two section of new construction with RCIW food for work through the UN World Food Programme (WFP) (Bhoredovan – Khahereghat at 18 km and Khahereghat – Thuloparsel at 28 km). Figure 18 shows a tractor and trailer on Section 1 of the road before rehabilitation. This demonstrates that the road was inaccessible during the wet season and would have

been in poor condition during the dry season. Wide ruts are visible, most likely caused by tractors, which would have seriously limited access to vehicles with 4WD and high clearance.

Figure 18 Tamaghat-Bhoredovan section in 2000 (left) and in 2004 (right)

A completed part of Section 1 in 2004 is shown in Figure 18 (right). This shows that the road has a good camber to shed water from the surface and low roughness. At that time the road was consistently motorable throughout the year and buses were already running regularly.

The photograph in Figure 19, taken around 2009, shows a newly constructed section of the road between Bhoredovan and Thuloparsel. This is the hilly area of the road so significant cuts had to be made in the hillside to accommodate the road. These areas were bio-engineered later to minimise the risk of landslides.

Figure 19 Bus on Bhoredovan-Thulopasel section in 2009 (left) and in 2019 (right)

3.1.6 Key informant interviews on engineering issues

Key informant interviews (KIIs) were carried out with local engineering and technical specialists. The enumerators used a basic guide for these interactions and recorded the results in a notebook, so the interviews were semi-structured.

In Kavre three key informants were consulted over the history and condition of the road from an engineering perspective. The key informants were the Senior Divisional Engineer, Infrastructure Development Office, Kavrepalanchowk; the Engineer at the Infrastructure Development Office, Kavrepalanchowk; and the Sub-engineer at Panchkhal Municipality. The Infrastructure Development Office's (IDO) main role is to carry out construction and maintenance of Provincial, Strategic and District roads and bridges within Kavre.

This road was completed almost 10 years ago, so none of the respondents were in position when DRSP was active. Recent maintenance/improvement has included some spot gravelling and installation of culverts and drifts. Their responses on the current condition of the road correspond with the observed condition during the field trips, namely that:

- The first section up to Bhoredovan is largely motorable all year, but there are issues with landslides during the monsoon which can cause disruption beyond Bhoredovan, limiting the transport to buses, trucks and 4WD vehicles with good clearance.
- Routine and emergency maintenance is carried out by the municipalities that the road passes through. The IDO only carries out large scale rehabilitation and upgrading on this road (which includes the gravelling and culverts mentioned earlier). The municipality generally clears landslides and repairs the road surface.
- There is a 3 crore (30 million) Rupees budget approved for widening and cross drainage on the first 3 km of the road, close to Tamaghat. 50 lakh (5 million) Rupees has been allocated for maintenance of the section from 3 km to 9 km. All maintenance below 1 crore (10 million) Rupees is carried out by forming user committees of 9 – 15 members from beneficiaries in the local community (this is a principle that was used by DRSP and other rural road projects in Nepal).

It was the opinion of the respondents that to improve traffic flow would take long term rehabilitative maintenance/upgrading and widening, along with effective routine and emergency maintenance. The current maintenance regime has not been effective in improving transport services, mainly due to the problems beyond Bhoredovan with landslides and poor road surface. The main problems were perceived to be landslides, lack of cross and side drainage, and narrow sections.

The authorities frequently receive complaints from the public in the form of requests to clear landslides. Specific challenging areas include steep areas which are difficult for trucks to negotiate and the muddy area just past Bhoredovan.

3.2 Socio-economic and transport context

The rural economy has been largely based on mixed agriculture, with rice an important crop everywhere in the catchment area. In Section 1 of the road (the first 9.5 km) the land is relatively flat and fertile. On this section there is evidence of farmers specialising in several crops popular with urban markets, including various squash varieties, melons, cauliflowers and Irish potatoes. A large, commercially-oriented market garden with polythene shelters, was established though a donor-funded project. There is a dairy and some poultry farms. There is a large brickworks, providing employment and transport opportunities, although many of the labourers appear to be low-status Dalit migrants. Investment in new buildings is high on this section of the road, with many buildings having housing on top of commercial premises. These are used as retail outlets, artisan workshops (notably carpentry and metal work), vehicle repairs and stores. While still clearly deeply routed in agriculture, this first section is beginning to appear peri-urban, with economic activities increasing (as shown by the results of the enterprise survey).

Transport services have responded to this increased transport demand, combined with reasonable road conditions, and about 20 minivans operate along the road, running from Bhoredovan (or an intermediate point) to Tamaghat throughout the day. They generally wait for a full load but may leave earlier in the hope of picking up passengers in the villages along the way. There are also many autorickshaws that operate from the larger villages, including Bhoredovan and travel to Tamaghat. Most of the bus services on Section 1 are long distance routes from Thuloparcel and other destinations, but there are two buses a day that go from Bhoredovan to Kathmandu.

The second section of the road is sparsely populated with few villages and houses close to the road. The agricultural cropping generally takes place in the valley bottom where irrigated rice is grown. Along the road is the large and active stone quarry, with many tipper trucks collecting stones each day. There is little other traffic on the road, other than the four daily buses to and from Thuloparsel. While people along the road use these bus services, they also say that the footpath in the valley only takes about an hour to reach Bhoredovan, where there are often waiting minivans. So many prefer to walk, unless they know a bus is about to arrive.

At the end of the second section, on the banks of the Sun Khosi river is the large village of Khahereghat. This is mainly an agricultural village, with a few enterprises benefiting from its status as a bus stop by a junction. The village was connected to the far bank of the Sun Khosi village by a trail bridge (that could also

be used by motorcycles). This is less used by motorcycles now as a steel truss and plate girder road bridge (60 m and 40 m) was built in 2018 by the Local Bridge Section of DoLIDAR. There is a road from the bridge that connects Dolalghat in Ramechhap District, but to date the road is little used, and no public transport services regularly operate on this road. A small number of utility vehicles and motorcycles use this road each day.

The third section of the road climbs up from the Sun Knosi river at Khahereghat passing several small villages on its journey up the hillside to Thuloparsel. There are some terraced rice fields, small patches of maize and beans and some livestock keeping. This is semi-subsistence farming with little market-orientated production. The population density is low. Thuloparsel is a large, extensive farming village, with a small number of shops and other enterprises. There is another road that travels south from Thuloparsel, through more low-density farming communities. It is possible to reach the national network this way, but the distance to Kathmandu and other large towns is much greater, and so Tamaghat road is the clear preference when people of Thuloparsel need to travel to town.

During its construction phase, the Tamaghat-Thuloparsel road works generated an average of 50,000 person days of employment per year. The road served 11 villages with a combined population of more than 35,000. At completion of the DRSP road monitoring showed a sharp increase in export of milk and fresh vegetable from the area. This was estimated at the time to be worth more than Rs 50 million per year. In 2009, DRSP reported it had been monitoring the outcomes of the road for more than two years, and the results showed a positive trend towards achieving a significant impact. An important outcome of any road is that it generates traffic. Although there are many factors that will influence this, the road showed a positive increase in traffic (especially jeeps) along the first section from 2 a day to 14 a day and a reduction in fares from 10 NPR/km to 3.5 NPR/km. In addition, the amount of services, which includes shops, pharmacies, schools and link roads, almost doubled from 2008 to 2009 (albeit from a very small base).

3.3 Survey findings

3.3.1 Development along the road corridor

The purpose of the Enterprise survey was to record particular economic activities along the road, but outside the junction town of Tamaghat. Traditional crop farming and livestock raising were not included, but large-scale agricultural enterprises were. The 2019 survey recorded 93 different enterprises from 3.5 km to Thuloparsel (28 km from the start of the road). Most (52) enterprises were run by men, with 36 run by women and five run jointly. In total 22 different activities were found. Predominantly there was a mixture of retail shops, agricultural stores and food outlets (tea-shops and bars). There were also workshops for tailors, carpenters and blacksmiths and one small hotel. The larger agricultural investments were all on the first 10 km section of the road and included two large-scale poultry farms, a dairy and a large market-garden investment. Economic activity was found to be concentrated towards Tamaghat. It was found that approximately 70% of the enterprises were recorded within the first 10 km of the road, with the remaining 30% distributed along the remaining 22 km.

A similar study of enterprises was carried out in 2013, under DRSP. In this case only 19 different enterprises were recorded along the road. In that survey, retail establishments and ‘tea shops’ predominated. Two enterprises were run by men, six by women, and the remainder jointly. Overall it appears that there has been a substantial expansion of roadside businesses, and, as the 2019 survey showed that with the larger proportion of men now involved, together with more artisanal work, may indicate that there is greater demand now, together with more income in the rural economy.

3.3.2 Road infrastructure

Questions were asked from key informants about their opinions on the adequacy of different aspects of the road infrastructure as well as identifying key issues. The results are summarised in Table 5 and Table 6.

Table 5 Opinions on the adequacy of road infrastructure from ten key informants

Road attribute	Average score* *Rating out of 10*
Road connections	5.4
Alignment	4.2
Pedestrian access	3.8
Surface	2.9
Structures	2.5
Width	1.8
* 10 = very good. 0 = very bad	

Overall views were not favourable. Most of the key informants felt that road maintenance was inadequate. Of most concern to the key informants was road width, dust and being slippery and muddy in the wet season. Traffic behaviour, road connections and road alignment were less of a problem. Harassment by officials was not considered a problem on this road.

Table 6 Assessments of key road issues by key informants (ranked)

Possible problem issues	Number of respondents answering yes or no *(N = 10)*	
	Yes	No
Road too narrow	10	0
Too dusty	10	0
Surface too rough	9	1
Slippery or muddy	9	1
Lack of shelter for pedestrians	8	2
Pedestrians and cyclists at risk	7	3
Subject to flooding	5	5
Poor alignment	5	5
Poor junction layout	4	6
Too steep	3	7
Road works obstacles	3	7
Poor driver behaviour	2	8
Traffic too fast	0	10
Harassment from police/officials	0	10

Vehicle operators were asked their opinions on the adequacy of the roads and the specific problems of the road infrastructure that adversely affected their businesses. Their responses are summarised in Table 7. Vehicle operators were concerned with road roughness, the road being slippery or muddy when wet, factors contributing to high operating costs and dust. Bus drivers were particularly worried by the slipperiness of the road, while the muddiness was difficult for autorickshaws and the roughness was of particular concern to the minivans. Overall, the risks of getting stuck, ride comfort and high travel times were not perceived to be a serious problem.

Table 7 Operators' perceptions of road factors adversely affecting their business

Importance of road problems adversely affecting transport business			
Problem issue	**Autorickshaw** *(n = 9)* *Mean score out of 10*	**Minivan** *(n = 5)* *Mean score out of 10*	**35-seater bus** *(n = 9)* *Mean score out of 10*
Road roughness	8.7	9.4	8.3
High operating costs	9.3	8.8	8.3
Road too muddy	9.3	7.4	8.7
Slippery when wet	7.7	7.6	9.0
Dust	8.3	8.2	7.7
Risk of vehicle damage	8.4	7.4	7.2
Uncomfortable	5.1	5.2	7.3
High travel times	4.7	4.0	7.6
Risk of getting stuck	5.1	3.2	4.9
Average Score	7.4	6.8	7.7
* 10 = very serious problem. 0 = not a problem			

Questions were asked of users as to which vehicle type would be best for roads in different conditions. The results are shown in Table 8. There was a marked preference for 35-seater buses for all conditions and a clear rejection of motorcycles for transport services.

Table 8 Users' perceptions of which vehicles were best for different road conditions

	Number of responses from 100 interviews *(n = 100)* **Which vehicles best for**		
	Smooth roads	**Rough roads**	**Wet roads**
35-seater bus	68	69	73
Minivan	14	5	2
4-wheel drive	1	5	6
Autorickshaw	7	3	1
Trucks	0	4	4
Car	6	0	0
Minibus	1	0	0
Pick-up or utility	0	0	0
Paid motorcycle	0	0	0
Total responses	97	86	86

3.3.3 Traffic and trip making

Besides the traffic surveys, a range of questions were asked from users and vehicle operators about the change in traffic patterns and the causes behind the changes.

Traffic data is shown in Table 9. The table shows traffic volumes for three sections of the road. For the middle section at Bhoredovan, traffic data was collected from surveys in 2007, 2009, 2013 as well as for the 2019 survey. The earlier surveys were undertaken by DRSP (DRSP, 2007, Stickland, 2009, Starkey et al., 2013). As can be seen traffic is much higher on the first section, which is closer to the town of Tamaghat, while for the last section traffic is much lighter. The first section is the only part to record autorickshaws, and motorcycle traffic is particularly heavy.

Table 9 Historic and recent daily traffic counts along Tamaghat-Thuloparsel Road

	Section 1: *Tamaghat-Boharedovan 'Busy' section in valley*	**Section 2:** *Borharedovan-Khahereghat Remote mountainous section*				**Section 3:** *Khahereghat-Thuloparsel Very remote hilly section*
	2019	**2007**	**2009**	**2013**	**2019**	**2019**
Vehicles						
Autorickshaw	14				0	0
Motorcycles	65			8	23	18
Cars	4				1	
Minivan	22				1	
Jeep/utility	7	2	14	1	5	2
Pickups	10				3	
Light truck	19			2	5	
Heavy truck	39	12	8		33	2
35-seater buses	13	8	8	8	8	8
Tractor	1	20	16			0
Other	0				1	0
Passengers						
Men	388			118	204	98
Women	252			60	115	63
Children	67			33	27	22
Total passengers	**707**			**211**	**346**	**183**

Sources: DRSP, 2007; Stickland, 2009; Starkey et al., 2013 and current research

Comparing the data from different dates for the middle section, shows a particular increase in traffic volumes between 2013 and 2019, with a rise in the number of motorcycles and heavy trucks. There has also been a decline in tractors, while 35-seater buses have remained stable, at close to 8 trips per day for this section of the road. These buses are highly regulated by the operator associations. There has been a 64% increase in daily passenger numbers between 2013 and 2019. Of the 135 extra passengers a day recorded between these dates there was a rise of 39 bus passengers (19%) and an increase of 96 in non-bus passengers. As only three passengers were recorded as travelling in non-bus vehicles in 2013, the increase was 32-fold. The heavy truck movements are associated with a stone quarry located on the road.

Surprisingly, fewer than two pedestrians per day were recorded in the 2019 surveys. The enumerators were instructed to record pedestrians travelling along the road, and not people making very short journeys within the local village area of the counting station. One possible explanation is that in Nepal, the network of footpaths is often much more direct than the road alignments, so that people walk along paths when travelling, and so they could not be observed on the road. The researchers also note that most people observed walking on the road were within villages or making short journeys between fields and the villages.

3.3.4 Trip making, fares and user satisfaction

The transport users' survey collected data on employment, journey purpose, fares and satisfaction with different modes. Occupation data is shown in Table 10 while journey purpose is given in Table 11. Nearly 70% of users classified their occupation as farmers (which included men and women). Sixteen per cent were shopkeepers or worked in commercial business. Just four per cent were teachers, health and social workers or were at college.

Table 10 Occupations of the 98 users surveyed

Occupation	No.
Farmer	69
Shopkeeper or store worker	8
Commercial business	8
Other	6
Housewife	2
Teacher	2
College student	1
Chief/traditional leader	1
Health/social worker	1
Total	98

Table 11 shows that the main journey purpose was to visit local markets or shops. Other important purposes were going to town, visiting friends or relations, or making health trips. There were only small differences between the travel purposes of men and women, with women having a slightly higher proportion of their trips to health facilities, local shops and the nearby town. The similarity of travel patterns for men and women, including visits to health centres, seems more noteworthy than the differences.

Of the 61 trips to market or local shops, 29 were made in autorickshaws, and of the 29 trips to friends and relations (which tended to be long distance), 22 were made by 35-seater buses. The user satisfaction survey identified the main modes for passengers as autorickshaws, jeeps/pickups, minivans and 35-seater buses. However, there is no mention of motorcycles, which the traffic counts indicate are growing in importance. Most motorcycles in Nepal are used privately and so these may have been 'off the radar' of paying passengers in this location.

As may be expected, the 35-seater bus was the most widely used means of transport, particularly for long distance journeys. Minivans and autorickshaws are principally used for short distance transport on the first section of the road.

Typically, people travelled between one and four times per month. The journey purpose data showed that only one journey was recorded for 'work' and only one person reported travelling to school or college. Without any working commuters and school trips, the overall frequency of travel was relatively low. Some private school buses operate on the first section of the road.

Table 11 Purposes of user journeys in transport services (disaggregated by gender)

Purpose	Number of male user trips[1]	Percentage of male trips	Number of female user trips[1]	Percentage of female trips
	(N = 59)		*(N = 41)*	
Nearby market or shops	34	37	27	40
Visiting friends or relations	18	20	11	16
Town, shopping or bank	14	15	13	19
Health centre	13	14	11	16
Business	6	7	2	3
Wedding or funeral	2	3	0	0
Farming	1	1	1	2
Work	1	1	0	0
Selling produce	1	1	0	0
School or college	0	0	1	2
Religious meeting	0	0	1	2
Other	1	1	0	0
Access to government offices	0	0	0	0
	91	**100%**	**67**	**100%**

[1] *Users were able to specify more than one trip*

Detailed data on trip distances, journey times, fares and freight charges in given in Table 12. There appears little difference between wet and dry season fares. The difference is only significant for autorickshaws. As expected, fares per km fall with increasing distance.

Table 12 Mean values of data from user survey on trip distances, journey times, fares and freight tariffs

		2013 survey[1]	2019 survey		
		35-seater bus *(N=19)*	35-seater bus *(N=134*	Autorickshaw *(N=34)*	Minivan *(N=27)*
Average trip distance	*km*	45.9	33.5	4.7	6.0
Average dry season trips/month	*trips/month*		2.1	3.2	2.3
Average wet season trips/month	*trips/month*		2.6	3.3	2.1
Average dry season fare paid	*NPR*	218	123.9	64.6	53.6
Average wet season fare paid	*NPR*		124.3	64.9	53.6
Dry season fares	*US cents per passenger-km*	**5.1**	**4.6**	**11.1**	**7.6**
Wet season fares	*US cents per passenger-km*		4.7	11.1	7.6
Journey time dry season	*mins*	225	166.4	23.7	34.6
Journey Time wet season	*mins*		170.7	25.2	37.7
Accompanied freight	*kg*	50	36.6	21.8	26.7
Accompanied freight tariff	*NPR*	116.8	5.3	2.7	5.0
Accompanied freight tariff	*US cents per tonne-km*	**55.4**	**3.8**	**37.8**	**35.1**
Unaccompanied freight	*kg*		60.1	104.5	55
Unaccompanied freight tariff	*NPR*		7.45	2.44	2.23
Unaccompanied freight	*US cents per tonne-km*		**2.3**	**12.6**	**9.9**

[1]*Note. Fares for 2013 have been increased by 46% to account for consumer price inflation to 2019*

The comparison with 2013 data shows that both passenger fares, and freight tariffs, appear to have fallen in real terms. There also appears to have been a reduction in bus journey times. Due to the substantial control by the Operators Association, there is a less direct link between road condition and service provision, hence many of these changes may be due to other factors, including competitive pressures from other modes.

Table 13 provides information on user satisfaction with different modes. There is also corresponding satisfaction data relating to 2013. In the current 2019 survey minivans have the highest overall satisfaction. For minivans and 35-seater buses the highest satisfaction comes from the level of fares and charges. Autorickshaws score low on this because of their relatively high passenger fares. The lowest satisfaction comes from factors such as comfort, dust and noise and access for the elderly and vulnerable. For most aspects there is little difference between 2013 and 2019 for the 35-seater bus surveys, apart from dust, noise and access for the vulnerable. It is possible that there has been a recent shift in public opinion, sensitising people to these factors.

Table 13 User satisfaction with different services

	User satisfaction with services by different vehicles *(Average satisfaction scores out of 10)*			
	2013 survey	2019 survey *(N = 100)*		
	All vehicles	Autorickshaws	Minivans	35-seater bus
Passenger fares	5.42	3.49	6.60	6.54
Journey times	5.53	6.71	5.96	5.41
Frequency	6.26	5.94	5.00	5.88
Predictability	5.63	5.51	4.84	5.23
First vehicle	6.37	5.37	4.40	5.23
Small freight service	6.79	5.97	6.44	6.51
Small freight charges	6.58	5.00	6.44	5.80
Medium freight services	6.68	5.57	6.44	6.29
Medium freight charges	6.68	5.00	6.12	5.92
Courier services	5.63	5.86	6.12	6.04
Safety	5.63	4.29	5.48	5.27
Security	6.16	6.14	5.76	5.87
Seat Space	5.79	6.06	6.28	5.58
Seat Type	5.89	4.71	5.96	5.71
Comfort with baggage	5.84	4.43	4.60	4.43
Bumpiness comfort		2.51	2.36	2.86
Dust and Noise	5.00	2.06	1.75	2.65
Access for vulnerable	4.95	2.34	2.20	1.54
Pickup point facilities		3.83	4.28	2.81
Overall average Score	**5.93**	**4.78**	**5.11**	**5.03**

3.3.5 Vehicle operations, fares and costs

A range of detailed data was collected from the operators on their vehicles, operations, costs and revenues. This data is presented in the following tables. Table 14 presents data on the vehicle, the driver, annual travel distance and data relating to the last trip.

It can be seen that the autorickshaws and minivans are quite new, whereas the average age of the 35-seater bus is over 10 years old. Again, the autorickshaws and minivans are mostly owned by the driver. In comparison the 35-seater buses tend to be owned by others who employ the driver. The annual distance travelled for the minivan and 35-seater bus appear relatively low for medium and large commercial vehicles.

Table 14 Operational data, driver status and last trip for three types of transport services vehicle

		Autorickshaw *(N=9)*	Minivan *(N=5)*	35-seater bus *(N=9)*
Year of manufacture		2018	2019	2008
Current value	*USD*	3,857	14,625	18,000
Vehicles owned by driver		7 (78%)	4 (80%)	2 (22%)
Average age of driver	*years*	31.6	24.6	35.6
Drivers with licence		1 (11%)	4 (80%)	9 (100%)
Fuel		petrol	diesel	diesel
Seats	*No.*	4.5	8	34.5
Annual distance	*km*	19,666	16,800	30,000
Last trip:	*km*	3.8	7.2	70
Last trip: passengers	*No.*	3.1	5	21
Last trip: freight	*kg*	16.7	36	406.3
Last trip : revenue	*USD*	1.79	3.85	37.90

Table 15 provides data on typical fares when operating on fixed routes. It is interesting to note that people with disabilities pay lower fares than normal.

Table 15 Key statistics on fixed route operations for three types of transport services

Fixed route operational characteristics, fares and key statistics							
		Autorickshaw *(N=9)*		Minivan *(N=5)*		35-seater bus *(N=9)*	
Normal trip distance	*km*	5.9		7.9		77	
Normal journey time	*mins*	32		60		367	
% rev. from passengers		72%		82%		86%	
% rev. from freight		12%		11%		9%	
% rev. from own account		17%		7%		5%	
		NPR	***USD cents***	***NPR***	***USD cents***	***NPR***	***USD cents***
Normal passenger fare		75	67.5	88	79.2	254	229
Normal fare per passenger-km		13.2	**11.9**	11.4	**10.3**	3.3	**3.0**
Child fare		0	0	0	0	0	0
With disabilities, fare		*36*	32	58	52	141	127
20 kg sack accompanied freight		34	31	72	65	46	41
20 kg freight per tonne-km		245	**221**	440	**396**	27	**24**
50 kg sack accompanied freight		73	66	120	108	111	100
50 kg freight per tonne-km		259	**234**	314	**283**	29	**26**

Vehicle operating cost data and revenues are given in Table 16. There is considerable uncertainty over vehicle maintenance costs hence these figures should be treated with caution. The analysis suggests that although the 35-seater buses are much more expensive to buy, their relative profitability (compared to the capital costs) is less than for the other vehicles. This may help explain the increasing use of other vehicles such as autorickshaws and minivans.

Table 16 Estimated annual vehicle operating costs and revenues

Estimated annual operating costs and revenues			
	Autorickshaw *(N = 9)* *USD*	**Minivan** *(N = 5)* *USD*	**35-seater bus** *(N = 9)* *USD*
Fuel	2,250	3,150	5,175
Maintenance	540	900	1,350
Tyres	55	153	550
Insurance	100	277	1,037
Registration	15	0	152
Operating Licence	10	16	36
Association	79	389	1,037
Fines	0	0	37
Assistants	0	0	1,301
Total	3,049	4,885	10,674
Revenue	6,528	7,776	15,660
Balance	3,479	2,891	4,986
Calculated net income per month to operator and capital costs	290	241	415

Questions were asked of drivers over the role of associations. The results are shown in Table 17.

Table 17 The roles of the operators' associations

Operator' associations			
	Per cent of drivers answering "Yes"		
	Autorickshaw *(N=9)*	**Minivan** *(N=5)*	**35-seater bus** *(N=9)*
Association member?	89%	100%	100%
Controls order of departure?	22%	80%	100%
Provides support for illness?	89%	100%	100%
Controls fares?	100%	100%	100%
Support in case of crash?	100%	100%	100%
Control over who operates on different routes?	89%	100%	100%
Support in case of police action?	100%	80%	100%
Controls departure times?	44%	80%	100%
Negotiates with officials?	89%	100%	100%

It can be seen that associations operate most control over 35-seater buses, and least control over autorickshaws which tend to be more informal. Nevertheless, even here there is still significant control over who operates on different routes and on departure times.

3.3.6 Drivers' perceptions on the causes of change

Questions were asked of drivers on the key factors causing change to their operations. The results are shown in Table 18. The answers only relate to questions where some drivers answered "yes".

Table 18 Drivers' perceptions on the causes of change

Drivers' perceptions on the causes of change			
	Per cent of drivers answering "Yes"		
	Autorickshaw *(N=9)*	Minivan *(N=5)*	35-seater bus *(N=9)*
More personal motorcycles?	89%	60%	100%
More use of three-wheelers?	44%	40%	67%
More use of jeeps, pickups?	56%	0%	67%
More use of minivans/minibuses?	67%	0%	56%
More people travelling?	44%	20%	0%
More use of 35-seater buses?	33%	0%	22%
Road condition deteriorating?	11%	20%	22%
Fewer people travelling?	0%	20%	22%
Road condition improving?	22%	0%	0%

The increasing use of small vehicles, such as motorcycles, three-wheelers and minivans are major factors affecting the development of rural transport services. Around 20% of drivers operating minivans and 35-seater buses, who travel longer distances, felt that road conditions were getting worse. While for autorickshaws, who also operate in urban and peri-urban areas, there was a small net perception that road conditions were getting better.

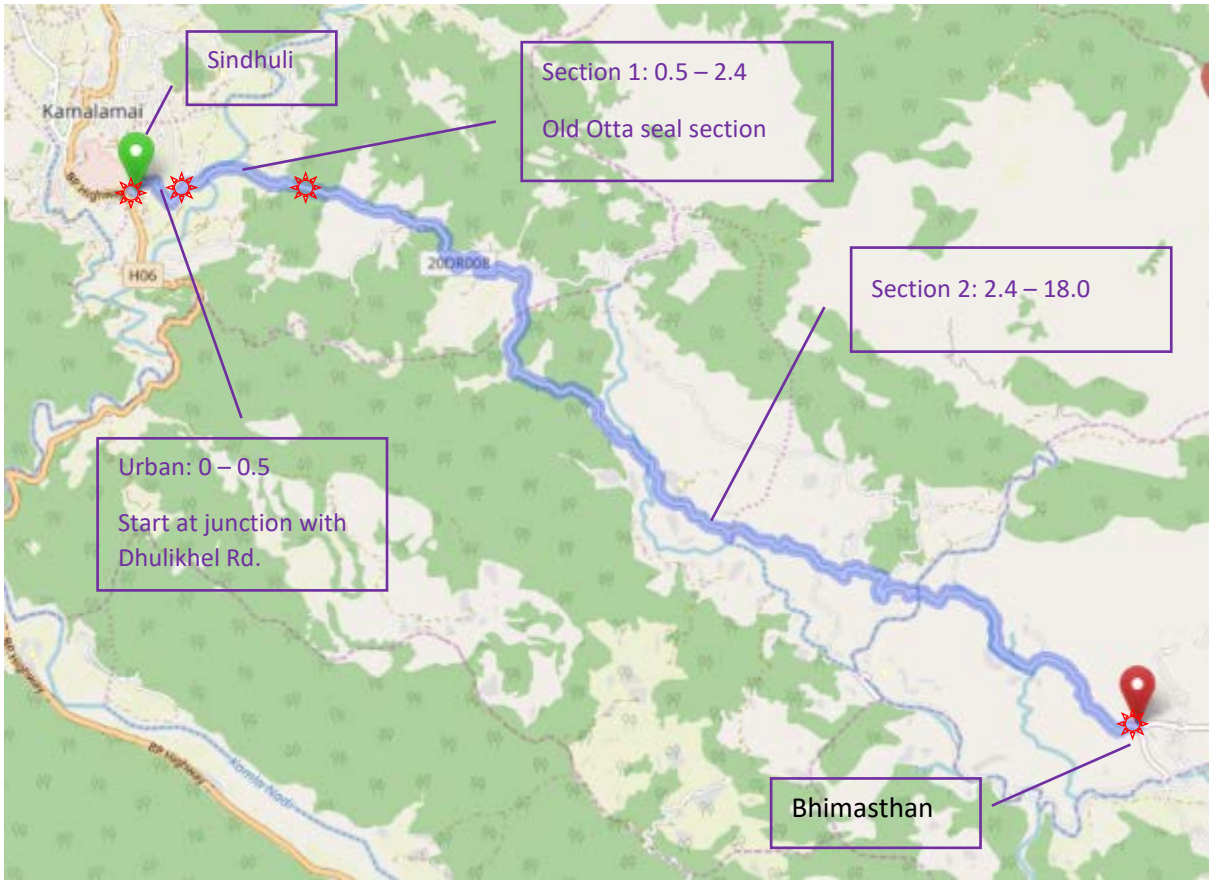
4 Majhitar-Bhimasthan Road

4.1 Road geography, history and condition

4.1.1 History and alignment

The Majhita-Bhimasthan road is 18 km, and was extended to Chakmake at 35 km. Its surface is predominantly earth, with some gravel spot improvements, bituminous Otta seals, cobblestone and stone soling. The road was constructed by DRSP in the 2000s and completed by 2010. The first 0.5 km can be considered urban, and this contains a section of concrete road. For this research, the first section starts at approximately 0.5 km and runs to 2.4 km which was surfaced using an Otta seal. This surface has deteriorated to the level where there is very little surface remaining, but it can be treated differently because there was also a gravel base. The second section to 18 km is of standard DRSP earth construction and includes several sections of cobblestones or stone soling. The road existed before DRSP but was very basic and was not motorable during the wet season. Due to the poor surface condition at that time many vehicles preferred to drive through the dry riverbeds, rather than use the road. The alignment of the road and the sections can be seen in Figure 20.

Figure 20 Road alignment and sections



The road continues to a village called Chakmake at approximately 35 km and is gradually being extended further. The administrative boundaries are from 0 to 14 km (Kamalamai) and 14 – 35 km (Tinpatan).

The first section is in an urban area near to Kamalamai and is maintained by the municipality. This includes a steep concrete section and some stone soling areas, which make the section motorable all year. The section is from 0 km at the junction with BP Highway, to 0.5 km but will not be considered as part of this study due to the urban nature of the section.

Section 1 runs from 0.5 km to 2.4 km. The alignment is winding but mainly flat. This area was sealed using an Otta seal by DRSP, with intermittent cobblestones or stone soling on steep areas (see Figure 21). However, the Otta seal surface has largely disappeared with only small areas still visible. The width is approximately 5 m.

Figure 21 Part of section 1 showing some remaining Otta seal (foreground) and a cobbled slope (behind)

Section 2 is from 2.4 km to 18 km at Bhimasthan. The alignment is winding with some hills. The road on this section is an earth surface, with several sections of cobblestone or stone soling in steep areas to maintain accessibility, as shown in Figure 22.

Figure 22 Different cobblestone sections in 2012 (left) and 2019 (centre) and laying cobblestones in 2009

The road is motorable all year. Width is approximately 4 to 5 m in most places, although the final section just before Bhimasthan has been widened recently to approximately 8 m. The reason for this widening is not apparent and seems to be excessive for the width required on such a road, as can be seen in Figure 23.

Figure 23 Recently widened section of the road close to Bhimasthan

The two main bridges constructed by Japanese aid on this alignment are simple but in good condition, although they seem to have received little maintenance.

Figure 24 One of the Japanese-funded bridges under construction in 2012 and in use in 2019

Figure 25 Two bridges: the right hand one constructed with Japanese-funding in 2012

The road extends to the village of Chakmake, at about 35 km, and is gradually being extended further to other communities. In the future, there is the possibility it will be extended to link to another road on the national network, which could create through traffic. Currently most buses terminate at Chakmake.

4.1.2 Status and condition

Key drainage structures are generally in good condition, although the road is used to channel irrigation water between fields, which appears to be one reason why the Otta seal surface deteriorated so quickly. Side drains are poorly maintained but crossing areas such as streams and rivers are in good repair, and the existing bridges built with Japanese aid are in good condition and function well.

Gabion structures are used extensively as retaining walls (see Figure 26) and for river protection and water course crossings. This is appropriate in the prevailing terrain where soils are often weak and erodible, and it is not always possible to find a solid foundation for structures. DRSP used gabions for drifts to good effect and avoided using culverts wherever possible. This has been a successful approach by DRSP and has helped to maintain the integrity and passability of rural roads.

Figure 26 Retaining walls made with stone gabions

Some culverts which existed before DRSP have been retained and are effective but need monitoring (see Figure 27).

Figure 27 Failed cross-drain culvert on cobblestone bend

The drifts installed by DRSP are in good condition and function well (see Figure 28). In general, the road is in fair to poor condition, but is motorable by four-wheel drive vehicles throughout the wet season.

Figure 28 Concrete drifts on the road

Urban section: This section is in reasonable condition and includes a concrete section on the steep hill between the start of the road and the first river, and extended stone soling/cobblestones, which keep the

road motorable all year. The surface is rough but durable and is used by a variety of different vehicles, including Tempos and motorcycles.

Section 1: This is treated as a separate section as although the sealed surface is largely gone, the base was formed of gravel and as such has more durability than the earth section that follows. Around 2010, when the road was completed, the Otta seal surfacing was seen as successful, but a combination of a lack of maintenance and irrigation activities that encroached onto the road led to its deterioration. Drainage is adequate but not well maintained and some side drains are being used as irrigation ditches (see Figure 29).

Figure 29 Three examples of water flowing onto road

Section 2: This section of the road is in fair condition, although rough, with some isolated areas in poor condition, mainly where drainage has failed and the surface has become muddy. Two examples of this are shown in Figure 30. However, due to the extensive stone soling and cobblestone surface in this section, especially through the hilly areas, there are no impassable areas and the base has retained its stability.

Figure 30 Muddy sections of the road caused by water running onto the road

Extension to Chakmake: The road from Bhimasthan to Chakmake is earthen surface and follows the largely flat river bed. The alignment is not engineered and in some places is variable because it is located within the river bed itself. It is understood that the road remains motorable to buses throughout the wet season, with some short exceptions for extreme events.

Figure 31 Gully erosion threatening parts of the road

4.1.3 Roughness/IRI

The roughness of this road was measured using a smartphone app. However, due to the slow speeds that could be achieved it was not possible to measure IRI for the majority of the road. Most of the road could only be driven at between 10 and 15 km/h, so very few measurements were taken. It can therefore be assumed from the World Bank roughness scale (Gillespie et al, 1986) that the IRI is in excess of 20 m/km.

4.1.4 Maintenance

No major maintenance has been applied on this road since it was completed in 2010. Some spot patching was undertaken approximately three years ago, in order to repair the worst areas and some maintenance of the cobblestone sections in 2019 as shown in Figure 32. There has been some widening and apparent rehabilitation for about 1 km before Bhimasthan.

Figure 32 Male and female stone masons and a female labourer repairing a cobblestone section of the road

Drainage structures are still good, but side drains have deteriorated, mainly through being used for irrigation purposes (see Figure 33). There is minimal risk of landslides on this road, but localised failures in cut areas are possible.

Figure 33 Cross-drain created by farmers wanting irrigation water on other side of the road

Lengthworkers were employed when the road was completed and they were still employed in 2012 (see Figure 34). However, they are no longer present, so routine maintenance is absent.

Figure 34 Lengthworkers in 2012

4.2 Socio-economic and transport context

The Majhitar-Bhimasthan road serves a fertile mixed farming agricultural area with a relatively low population density. The economy is based on farming. Irrigated rice is the main crop, and there is relatively little production of crops for urban markets. It seems ironic that the weekly market at Bhimasthan brings in many vegetables such as cauliflowers, tomatoes and aubergines from the Terai for local purchase, rather than being a marketplace for exporting such products. There are several poultry farms along the road, serving urban communities and some dairy production and marketing. There is some extraction of stones and sand from the rivers. Otherwise, the small number of non-farming enterprises along the road are mainly small retail stores, teashops and bars.

Prior to the road construction, some long-distance buses served the catchment area in the dry season, using dry riverbeds as roads (a practice that continues to this day). With the road construction, the number of daily buses increased to four in each direction, with half of these terminating at the end of the road (Majhitar) and half the operators travelling the long distance to Kathmandu, via the bus stand in the local market town of Sindhulimadhi. The Majhitar junction bus stand that is on the edge of Sindhulimadhi is shown in Figure 35. Autorickshaws and pickups also wait for passengers at this junction.

Figure 35 Bus stand at the start of the road at Majhitar looking from the west (left) and east (right)

The other main transport service vehicles are jeeps/pickups that operate both as hired point-to-point services and route-based services. Unusually for Nepal, their association/cartel seems well connected in Sindhulimadhi, and the bus cartel is unable to remove their competition, despite their active lobbying to suggest that many jeeps/pickups are not correctly licensed to run transport services.

Autorickshaws are the main point-to-point taxi services in Sindhulimadhi and Majhitar, and many have female drivers, as shown in Figure 36. Autorickshaws operate on the urban and peri-urban sections of the road and are gradually extending their range. Few Sindhulimadhi operators travel more than seven kilometres from Majhitar. However, some autorickshaws do travel to Bhimasthan on market days (generally as vehicles hired for the day) and on other days when they are chartered. In addition, in recent years a small number of autorickshaws have been based at Bhimasthan and Chakmake. While they mainly make short distance journeys around these towns, sometimes they carry people and goods all the way to Majhitar.

Figure 36 Female autorickshaw drivers at the Majhitar bus stand (left) and Sindhulimadhi bus stand (right)

4.3 Survey findings

4.3.1 Development along the road corridor

The purpose of the enterprise survey was to record economic activities taking place along the line of the road. Changing numbers of enterprises is a useful outcome indicator for road projects. Previous DRSP surveys had counted enterprises, so there was comparable 'before' data. Enterprise surveys generally ignore the initial urban section of the road, so the 2019 survey started counting at Wallo Rampur village, 3 km from the start of the road at Majhitar. Traditional crop and livestock farms were not included. In total, there were 89 enterprises along the road up to and including Bhimasthan, 41 were run by women, 39 by men and 9 run jointly. In total, 20 different activities were found. Most enterprises (51) were small general stories, teashops and bars (6) and six specialised stores (chemists, hardware, electronics and jewellery).

There were premises for tailors (4), carpenters, blacksmiths and bicycle repairs. In addition, there were eight chicken farms, four meat/dairy shops, three agricultural suppliers and two cold stores.

In 2002, before the road was built, there had been 21 recorded enterprises. This had increased to 40 in 2013, approximately doubling over ten years. The numbers had approximately doubled again in the past six years. While many factors will have influenced the investments and related consumption, it is likely that the road and transport will have been very relevant. In 2013, as in 2019, the gender balance of enterprise ownership was almost equal, with women entrepreneurs being slightly more than men, due to their dominance in storekeeping.

4.3.2 Road infrastructure

Questions were asked from the key informants (Table 19 and Table 20) and the vehicle operators (Table 21) on the adequacy of the road infrastructure and any problems they perceived. The key informants provided opinions on the adequacy of different aspects of infrastructure as well as identifying problematic issues. The vehicle operators identified road infrastructure issues that adversely affected their businesses.

Table 19 Opinions on the adequacy of road infrastructure from ten key informants

Road attribute	Average score* *Rating out of 10*
Road connections	7.0
Pedestrian access	4.2
Alignment	3.5
Structures	2.2
Surface	1.5
Width	1.5
* 10 = very good. 0 = very bad	

The key informants rated the road width, surface and structures as poor. In fact, for them the only good attribute of the road was that it connected people to Sindhulimadhi and other destinations. They all agreed that the road improvements had had beneficial effects, there were negative views on the current state of the road. As with the Thulo Parsel road survey, the road was found to be too narrow, too rough and too dusty. The general view on road maintenance was that it was inadequate. Interestingly, the key informants (who were not transport operators) did not consider there was any harassment of operators by police or officials. However, the operators reported they were regularly stopped and ended up paying over USD 100 a year in fines and payments, although whether this counts as enforcement or harassment is debateable.

Table 20 Assessments of key road issues by key informants (ranked)

Possible problem issues	Number of respondents answering yes or no *(N = 10)*	
	Yes	No
Road too narrow	10	0
Surface too rough	10	0
Too dusty	8	2
Lack of shelter for pedestrians	6	4
Subject to flooding	5	5
Slippery/Muddy	5	5
Poor alignment	5	5
Pedestrians/cyclists at risk	5	5
Too steep	3	7
Road works obstacles	3	7
Poor junction layout	3	7
Poor driver behaviour	3	7
Traffic too fast	2	8
Harassment from police/officials	0	10

As perhaps expected, Table 21 shows that autorickshaw drivers were most sensitive to road condition adversely affecting their business, similarly drivers of jeeps/utility vehicles were least affected by road condition, and were least worried by slipperiness or the risk of getting stuck. All operators seemed resigned to the problems of discomfort and high journey times and regarded these as the least of their worries.

Table 21 Operators' perceptions of road factors adversely affecting their business

Importance of road problems adversely affecting transport business			
Problem issue	**Autorickshaw** *(n = 9)* *Mean score out of 10*	**Jeep/Pickup** *(n = 5)* *Mean score out of 10*	**35-seater bus** *(n = 9)* *Mean score out of 10*
Risk of vehicle damage	**10.0**	6.2	**9.0**
Road too muddy	9.3	5.5	7.3
Slippery when wet	9.3	4.7	7.7
Road roughness	9.0	6.1	8.1
Dust	8.7	7.0	8.3
High operating costs	8.3	**7.2**	8.0
Risk of getting stuck	8.2	3.4	6.1
Uncomfortable	5.4	6.9	6.3
High travel times	4.3	6.7	6.7
Average Score	8.1	6.0	7.5
* 10 = very serious problem. 0 = not a problem			

Users were asked which type of vehicles were best suited to different conditions, and their responses are summarised in Table 22. The 35-seater buses seemed to be most popular for all the conditions discussed. Jeep, pickups and utilities were mentioned for rough and wet roads, and autorickshaws were favoured by some for smooth roads. As motorcycles are seldom used for public transport, users did not consider them a realistic option for any type of road condition.

Table 22 Users' perceptions of which vehicles were best for different road conditions

	Number of responses *(n = 100)* **Which vehicles best for**		
	Smooth roads	**Rough roads**	**Wet roads**
35-seater bus	70	66	58
Jeep, pick-up or utility	6	31	36
Autorickshaw	16	2	2
Car	5	0	0
Minibus	3	1	0
Truck	0	0	3
Minivan	0	0	1
Paid motorcycle	0	0	0
Total	100	100	100

4.3.3 Traffic and trip making

Table 23 shows the results of two-day traffic counts carried out in December 2019 in the rural area near to Bhimasthan (Count point 1). There was also a two-day count 10 km from Majhitar which is on the outskirts of Sindhulimadhi town (Count point 2). The 2019 count at Bhimasthan has been compared with similar counts carried out for DRSP in previous years.

Table 23 Recent daily traffic counts along the Bhimasthan road compared with earlier studies

	Count point 1 *2 km from Bhimasthan*				Count point 2 *10 km from Majhitar Town*
	2007	2009	2013	2019	2019
Vehicles					
Motorcycles	0	23	68	158	134
Jeeps/Pickups/Utilities	0	1	21	10	39
Tractors	6	1	5	22	12
Autorickshaws	0	0	0	17	2
35-seater bus	8	5	9	7	15
Light truck	0	0	1	2	4
Heavy truck	0	0	3	1	2
Car	0	1	2	0	2
Bicycle	0	0	2	6	0
Minivan	0	0	1	0	0
Other vehicles	0	0	1	1	2
All passengers					
Men			249	479	647
Women			178	142	244
Children			113	50	59
Total passengers			**540**	**671**	**940**
Pedestrians					
Men			64	40	
Women			84	84	
Children			36	72	
Total pedestrians			**184**	**196**	

Sources: DRSP, 2007; Stickland, 2009; Starkey et al., 2013 and current research

The traffic surveys show a clear increase in traffic volumes and passenger movements since completion of the road. Although there have been some fluctuations in some vehicle categories, one clear trend has been the long-term increase in motorcycle volumes since 2009, and the appearance of autorickshaws in recent years. In addition to the small number of autorickshaws that operate along the road from their base in Majhitar (mainly starting their journeys with a specific point-to-point hire), a small number of autorickshaws are now based at Bhimasthan and at Chakmake (the end of the extended road). While these sometimes travel down to Majhitar, most of their trips are less than 5 km point-to-point services around Bhimasthan and Chakmake. Bus numbers have been fairly consistent over the years, at about eight bus movements a day (as confirmed by discussions with the operators). The high number of buses recorded in 2019 near Majhitar was probably due to the school buses that serve this part of the road (see Figure 31).

The number of jeeps/pickups counted near Bhimasthan is considered surprisingly low and perhaps anomalous. It is also possible that the 2013 figure was unusually high. No minivans were recorded in 2019, although some people reported using minivans in the dry season. Minivans seem to be more susceptible to muddy conditions than the lighter autorickshaws. Overall bus passenger numbers and other passengers have increased greatly over the years, partly due to increasing use of jeeps/pickups and autorickshaws. The number of pedestrians around Bhimasthan seems to have been fairly constant in recent years, with no records available before 2013.

Besides the traffic surveys, a range of questions were asked from users and vehicle operators about the change in traffic patterns and the causes behind the changes. Table 24 summarises the perceptions of users. The users thought that pickups/jeeps, buses and autorickshaws had all increased greatly since the road was improved and in the past year. While the traffic counts support increases in the use of jeep and autorickshaw services, bus numbers do not seem to have increased in the past year. The much smaller increase in minivans is also in accordance with traffic counts and other survey information. While it may seem striking that users saw no increase in motorcycles (that are increasing throughout Nepal), this is

because the question related specifically to paid motorcycles (motorcycle taxis). These are not common in Nepal, and that is why their negligible numbers have not increased or decreased.

Table 24 Users' perception of changes in traffic volumes (ranked by overall score)

	Perception of change (scale -10 to +10)			
	Since improvements		Since last year	
	Vehicle nos.	Passengers	Vehicle nos.	Passengers
Jeep, pickup, utility	8.9	9.0	7.5	7.5
35-seater bus	8.9	9.1	7.3	7.6
Autorickshaw	7.4	7.7	6.6	6.6
Truck	4.9	3.5	3.0	2.0
Minivan	4.4	4.1	3.2	2.8
Minibus	3.2	2.9	2.2	1.4
Car	3.5	2.7	1.8	1.4
Paid motorcycle	0.2	0.1	0.0	0.1

4.3.4 Trip making, fares and user satisfaction

The transport users survey collected data on employment, journey purpose, fares and satisfaction with different public transport modes. Occupation data is shown in Table 25 while journey purpose is given in Table 26. About 58% of users surveyed classified their occupation as farmers (which included men and women). Twelve percent considered they were in commercial business and there was a wide range of other occupations including teachers, students and shop workers.

Table 25 The occupations of the users surveyed

Occupation	No.
Farmer	57
Commercial business	12
Teacher	7
Shopkeeper or store worker	4
College student	3
Housewife	2
Government worker	1
Labourer	1
Transport worker	1
Other	12
Total	98

Table 26 shows a wide range of travel purposes, with journeys to town (for shopping, banking or visiting government offices), to local markets and shops, and to health centres. The longer journeys were mainly in buses or jeeps/pickups, although some people travelled the length of the road in trucks, autorickshaws and (in the dry season) minivans. Table 26 shows there are some differences between the travel purposes of men and women, with women having a higher proportion of their trips to health facilities, farming and visiting friends and relatives. As with the Kavre road, the similarity of the travel purposes for men and women is noteworthy.

Table 26 Purposes of user journeys in transport services (disaggregated by gender)

Purpose	Number of male user trips[1]	Percentage of male trips	Number of female user trips[1]	Percentage of female trips
	(N = 60)		*(N = 41)*	
Town, shopping or bank	44	36	27	29
Health centre	19	15	17	18
Local market/shops	14	12	12	13
Work	15	12	10	11
Visiting government offices	13	11	6	6
Visiting friends or relations	7	6	8	9
Business	3	3	3	3
Farming	0	0	3	3
School or college	0	0	1	1
Other	6	5	7	7
Total	**124**	**100%**	**94**	**100%**
[1] Users were able to specify more than one trip				

Table 27 provides data from users of five different vehicle types, with some historic data from the DRSP bus users' survey of 2013 (Starkey et al., 2013). The 2019 data shows a slight reduction in fares for bus users compared with the 2013 data, after adjusting for inflation. There also appears to have been a decrease in journey times.

Table 27 Mean values of data from user survey on trip distances, journey times, fares and freight tariffs

		2013 survey[1]	2019 survey				
		35-seater bus	35-seater bus	Jeep/ Utility	Auto-rickshaw	Truck	Minivan
Observations		21	103	74	51	6	3
Average trip distance	*km*	18.7	18.3	18.4	4.5	17.8	36.3
Average dry season trips/month	*trips/month*		3.4	3.1	3.1	6.2	1.0
Average wet season trips/month	*trips/month*		2.3	2.5	3.1	3.0	1.0
Average dry season fare paid	*NPR*	129	115	168	162	70	300
Average wet season fare paid	*NPR*		118	176	200	83	300
Dry season fares	*US cents per passenger-km*	**6.2**	**5.4**	**8.6**	**40**	**3.7**	**7.5**
Wet season fares	*US cents per passenger-km*		**5.5**	**8.8**	**49**	**4.2**	**7.5**
Journey time dry season	*mins*	113	103	85	22	117	160
Journey time wet season	*mins*	141	121	100	26	137	180
Accompanied freight	*kg*	73	51	53	48	50	
Accompanied freight tariff	*NPR*	77	90	99	102	41	
Accompanied freight tariff	*US cents per tonne-km*	**83**	**81**	**82**	**702**	**36**	
Unaccompanied freight	*kg*	200	284	197	198	200	
Unaccompanied freight tariff	*NPR*	295	192	289	325	175	
Unaccompanied freight	*US cents per tonne-km*	**65**	**69**	**68**	**576**	**38**	
[1]Note. 2013 Fares and tariffs have been multiplied by 1.46 to account for inflation							

As shown in Table 27, truck fares, per passenger-km, are the least expensive, probably because this is relatively uncomfortable and carrying passengers is opportunistic and not a regular transport service. Jeeps/utility vehicles provide faster journeys and charge about 60% more than buses. Autorickshaws are by far the most expensive, at seven times the bus tariffs. This is partly explained by point-to-point operations and shorter trip distances. For the same distance, autorickshaw fares are 3.6 times those in Thulo Parsel. This may be related to the fact that all the autorickshaws on that road operated on the busy lowland

section of that road, with few infrastructural challenges. In contrast, many of the autorickshaws journeys recorded on the Bhimasthan road were on the remoter and rougher upper sections of the road.

There appears little difference between wet and dry season fares. Only autorickshaws and trucks seem to charge higher wet season fares (as was found on the Thulo Parsel road). As expected, for all modes, fares per passenger-km fall with increasing distance.

Compared with the Thulo Parsel road, bus fares per passenger-km are slightly higher. However, by far the biggest difference between the roads is in accompanied and unaccompanied freight tariffs on buses. On the Bhimasthan route these tariffs are 22 and 30 times as expensive on the Thulo Parsel road, when expressed on a per tonne-km basis. There are clearly different charging regimes for small and medium freight loads between the two routes. As is to be expected, the highest freight rates are for the smallest vehicles with short-distance journeys (autorickshaws) which charge about eight times the freight rates of buses.

Table 28 provides information on user satisfaction with the different public transport modes, and for comparison, includes corresponding satisfaction data collected in 2013. The table indicates a small rise in satisfaction with buses between 2013 and 2019, although satisfaction with comfort, safety and security had decreased. It is striking that the overall satisfaction with buses was the lowest of all transport types. Access for vulnerable people was considered poor for all types of vehicle. It should be noted the sample sizes for minivans and trucks are low, but they are included for interest. Satisfaction with minivans will not be discussed, and comparisons will only be noted for trucks on issues that appear straightforward.

Table 28 User satisfaction with different services

	Satisfaction with services by different vehicles *(Average satisfaction scores out of 10)*					
	2013 survey	**2019 survey** *(N = 100)*				
	35-seater bus	**35-seater bus**	**Jeep/pickup**	**Autorickshaw**	**Truck**	**Minivan**
Sample size (N)	*21*	*100*	*74*	*51*	*6*	*3*
Passenger fares	4.92	5.75	5.27	4.72	7.00	7.00
Journey times	6.00	5.30	6.67	6.74	6.50	7.00
Frequency	3.38	5.65	5.88	6.88	4.50	6.00
Predictability	4.46	4.35	5.73	6.77	5.00	6.00
First vehicle access	4.77	5.34	4.54	6.09	7.00	7.00
Small freight service	5.72	5.76	5.26	5.43	7.00	7.00
Small freight charges	4.68	5.42	4.83	4.48	7.00	7.00
Medium freight services	5.56	5.74	4.98	5.37	7.00	7.00
Medium freight charges	6.00	5.29	4.77	4.95	7.00	6.00
Courier services	5.71	6.42	7.09	7.81	6.00	7.75
Safety	4.85	4.08	6.09	5.40	3.50	6.00
Security	6.88	5.04	6.17	5.84	5.50	6.00
Seat space	5.31	5.03	5.73	5.23	1.50	4.00
Seat type	4.54	4.67	5.60	5.16	2.75	6.00
Comfort with baggage	5.50	4.49	4.05	3.17	3.50	4.00
Bumpiness comfort		3.04	3.64	3.23	3.50	2.50
Dust and noise	3.12	3.31	3.58	4.25	4.50	5.00
Access for vulnerable	3.62	3.24	3.98	3.63	5.50	5.00
Pickup point facilities	1.85	4.95	5.56	6.60	5.50	4.00
Overall average score	**4.83**	**4.89**	**5.23**	**5.36**	**5.25**	**5.80**

While Table 28, provides interesting details of people's opinions on many aspects of the transport services, it is too 'high resolution' for simple comparisons. Therefore, certain aspects have been clustered into single issues, and the resulting shorter lists have been ranked to make differences clearer. Journey times, frequency, predictability and first vehicle access have been combined and averaged as 'timeliness'. While these have been clustered into one indicator, it is acknowledged that these are all distinct parameters. In Table 28 it can be seen that people have scored the various parameters differently and, for example, 'journey times' have understandably scored higher than 'frequency' for buses, but not for autorickshaws.

Nevertheless, the aggregated parameters are useful and the four separate freight parameters have been combined and averaged, as have comfort issues (seat type, space and comfort around legs) and ride issues (bumpiness, dust and noise). The results are presented in Table 29.

Table 29 Ranked, simplified user satisfaction with different transport services

Bus (2013) *(N=21)*		Bus (2019) *(N=100)*		Utility *(N=74)*		Autorickshaw *(N=51)*		Truck *(N=6)*		Minivan *(N=3)*	
Security	6.9	Courier	6.4	Courier	7.1	Courier	7.8	**Fares**	**7.0**	Courier	7.8
Courier	5.7	**Fares**	**5.8**	Security	6.2	Timeliness	6.6	Freight	7.0	**Fares**	**7.0**
Freight	5.5	Freight	5.6	Safety	6.1	Security	5.8	Courier	6.0	Freight	6.8
Comfort	5.1	Timeliness	5.2	Timeliness	5.7	Safety	5.4	Timeliness	5.8	Timeliness	6.5
Fares	**4.9**	Security	5.0	**Fares**	**5.3**	Freight	5.1	Security	5.5	Safety	6.0
Safety	4.9	Comfort	4.7	Comfort	5.1	**Fares**	**4.7**	Ride	4.0	Security	6.0
Timeliness	4.7	Safety	4.1	Freight	5.0	Comfort	4.5	Safety	3.5	Comfort	4.7
Ride	3.1	Ride	3.2	Ride	3.6	Ride	3.7	Comfort	2.6	Ride	3.8

From the simplified rankings in Table 29, some similarities and differences between modes become clearer. Sending messages, money and items with the drivers (courier services) are popular with all transport modes, whereas ride quality and comfort are causes of dissatisfaction for all services. Bus fares are more popular than they were in 2013 and are a source of greater satisfaction than the more expensive jeeps/pickups and much better than the expensive autorickshaws. The low fares of trucks seem even better. The safety of buses was considered low in 2013 and had dropped further by 2019. This means they are, perhaps surprisingly, considered less safe than jeeps/pickups or autorickshaws.

4.3.5 Vehicle operations, fares and costs

A range of detailed data was collected from the drivers of autorickshaws, jeeps/pickups and buses about their vehicles, operations, costs and revenues. Table 30 presents data on the vehicle, the driver, the annual distance travelled and data relating to the last trip.

Table 30 Operational data, driver status and last trip for three types of transport services vehicle

		Drivers reporting of their operational characteristics		
		Autorickshaw *(N=9)*	Jeep/pickup *(N=14)*	35-seater bus *(N=9)*
Year of manufacture		2017	2017	2010
Current value	*USD*	4,600	17,182	18,844
Vehicles owned by driver		6 (75%)	3 (21%)	2 (29%)
Average age of driver	*years*	36	29	34
Drivers with licence		4 (67%)	14 (100%)	9 (100%)
Fuel		petrol	diesel	diesel
Seats	*no*	3	8.8	33
Annual distance	*km*	25,000	41,650	28,000
Last trip:	*km*	26	45	93
Last trip: passengers	*no.*	4.7	6	36
Last trip: freight	*kg*	15	700	988
Last trip : revenue	*USD*	10.5	26.8	111

As might be expected, the buses are quite old and the autorickshaws are relatively new. The annual distances travelled by autorickshaws and buses is similar, and seems high for autorickshaws, suggesting that the rural autorickshaws do less waiting around than their urban colleagues. The buses have low annual distances as they do just one trip a day. In contrast, the relatively new jeeps/pickups average over 100 km a day, suggesting they often make more than one return trip a day, and/or travel on to Kathmandu.

Table 31 provides data provided by the transport operators on their operating patterns, revenue streams and tariffs for passengers and freight. As might be expected, the jeeps/pickups make over half their income from carrying freight. Autorickshaws make 18% of their income from carrying goods and charge high rates for this service. While the buses are considered important by people for carrying goods, buses only gain 5% of their revenue from freight charges. As would be expected, the cheapest form of the three main forms of passenger transport is the bus, and the pickups charge a premium (35%) and the autorickshaws provide the most expensive transport (50% more than buses, per passenger-km). All forms of transport give significant discounts (about half price) for children and people with disabilities. As is quite common in rural surveys, the fares claimed to be paid by the users are higher than the fares claimed to be charged by the operators, for all forms of transport. This can sometimes be explained by drivers increasing their personal incomes, or by differences per passenger-km between short journeys and longer distances. On the Bhimasthan road, the difference between the fares reported by autorickshaw users (USDc 40 per passenger-km) is much higher than those reported by their operators (USDc 7.2 per passenger-km). This is likely to be due to point-to-point operations, where the operator charges one or two people for a full passenger load.

Table 31 Data and key statistics on fixed route operations for three types of transport services

Driver reporting of fixed route operational characteristics, fares and key statistics						
	Autorickshaw *(N=9)*		**Jeep/pickup** *(N=14)*		**35-seater bus** *(N=9)*	
Normal trip distance *km*	29		38		95	
Normal journey time *mins*	126		201		275	
% rev. from passengers	73%		35%		90%	
% rev. from freight	18%		53%		5%	
% rev. from own account	9%		13%		6%	
	NPR	***USD cents***	***NPR***	***USD cents***	***NPR***	***USD cents***
Normal passenger fare	242	214	277	245	365	323
Normal fare per passenger-km	8.1	**7.2**	7.4	**6.5**	5.4	**4.8**
Child fare	154		135		135	
With disabilities, fare	143		153		180	
20 kg sack accompanied freight	73		36		43	
20 kg freight per tonne-km	126	**112**	55	**49**	23	**20**
50 kg sack accompanied freight	124		101		90	
50 kg freight per tonne-km	86	**76**	52	**46**	19	**17**

Vehicle operating cost data and revenues are given in Table 32. There is generally considerable uncertainty over vehicle operating and maintenance costs in the informal transport sector, hence these figures should be treated with caution. The buses provide the highest income, but the relative profitability of buses and jeeps/pickups is quite similar, as despite the pickups having much lower payloads, they operate longer hours and charge a premium on tariffs. Also, the cost of a new jeep/pickup is similar to the value of an old bus, as shown in Table 30.

Comparing the estimated operating cost and revenue data from the different roads studied, net incomes for buses on the Thulo Parsel road were estimated at USD 415 per month compared with USD 1288 on the Bhimasthan road. Net incomes for autorickshaws were estimated to be USD 290 for the Thulo Parsel road compared with USD 556 for the Bhimasthan road. It is not immediately clear what is allowing the extra incomes from the Bhimasthan road, but there appears less within-mode competition relative to transport demand and less association influence on the Bhimasthan road.

Table 32 Estimated annual vehicle operating costs and revenues

Estimated annual operating costs and revenues			
	Autorickshaw *(N=9)* *USD*	**Jeep/pickup** *(N=14)* *USD*	**35-seater bus** *(N=9)* *USD*
Fuel	3,345	6,478	7,650
Maintenance	195	822	690
Tyres	65	925	629
Insurance	86	332	458
Registration	162	673	323
Operating licence	33	32	65
Association	0	87	23
Fines	189	691	132
Assistants	0	0	500
Total	4,076	10,039	10,468
Revenue	10,746	23,016	25,920
Balance	6,671	12,977	15,452
Calculated net income per month to operator and capital costs	556	1,081	1,288

Questions were asked of drivers over the role of transport associations. The results are shown in Table 33. Interestingly only 38% of Bhimasthan bus drivers were members of an association compared with 100% in Thulo Parsel. This seems because the bus association in Sindhuli is primarily for owners and not for drivers, and most buses are driven by hired drivers. Similarly, there was low association membership among jeep/pickup drivers (21%), who were predominantly hired personnel. Although most autorickshaws were owned by their drivers, none of the drivers was a member of an association. This is in contrast to the survey on the Thulo Parsel road where 89% of autorickshaw drivers were members of a transport association. In most of Nepal, bus associations are powerful, but they seem less so in Sindhuli. According to a key informant interview with the head of the association organising the buses on the Bhimasthan road, the owners of jeeps/pickups have greater influence over the authorities in Sindhuli. This was given as an explanation for the increasing use of jeeps/pickups for transport services, even though many remain registered as private vehicles (that are now allowed to carry passengers for reward).

Table 33 Roles of the operators' associations

Operator' associations			
	Proportion of drivers answering "Yes"		
	Autorickshaw *(N=9)*	**Jeep/pickup** *(N=14)*	**35-seater bus** *(N=9)*
Association member?	0%	21%	38%
Controls order of departure?	0%	7%	43%
Provides support for illness?	0%	0%	0%
Controls fares?	0%	7%	43%
Support in case of crash?	0%	0%	43%
Control over who operates on different routes?	0%	7%	43%
Support in case of police action?	0%	14%	43%
Controls departure times?	0%	7%	43%
Negotiates with officials?	0%	7%	43%

Information was collected on the extent to which drivers were stopped by police and officials. The results are shown in Table 34. This seems to be a much more important issue for Bhimasthan compared with Thulo

Parsel. The incidence of being stopped is higher in Bhimasthan and correspondingly the payments and fines reported were much higher, as was shown in Table 32. The jeeps/pickups paid the most at about USD 700 a year which may be because many were private vehicles but were operating as transport services. The drivers of autorickshaws appeared to be stopped almost every other day, and for one third of the stops it appeared to them to be for 'no reason'. Their payments accounted for about 5% of their operating costs, but still left them with a reasonable revenue. Bus drivers were stopped most (21 times a month) but made the lowest payments, representing just 1.3% of their operating costs.

Table 34 Drivers' responses to questions on being stopped by police and officials

Answers on being stopped by police or officials	Autorickshaw *(N=9)*	Jeep/pickup *(N=14)*	35-seater bus *(N=9)*
Regularly stopped? *Percent of drivers answering "Yes"*	100%	86%	75%
Times per month	14	7	21
Monthly fines *NPR*	1750	6400	1220
Reasons for being stopped *(percentage of respondents saying 'yes')*			
Stopping in wrong place	56%	7%	25%
Licence/Tax/Insurance	22%	21%	38%
Overloading people	33%	0%	38%
Speeding	22%	0%	38%
Traffic signs	11%	0%	25%
'No reason'	33%	0%	0%
Overloading freight	22%	7%	0%
Faulty lights	11%	0%	13%
Wrong equipment	11%	0%	0%
Other reasons	11%	57%	13%

4.3.6 Drivers' perceptions on the causes of change

Data was collected from drivers on their perception of the causes of change of supply and demand within the local transport market. The responses are summarised in Table 35. The drivers seemed to be aware that competition from other transport modes, including the use of personal motorcycles, was adversely affecting their business. There was a general consensus that market demand was increasing. Autorickshaw operators were particularly optimistic about greater transport demand, while bus drivers were less convinced. Although drivers had complained about the quality of the road affecting their business (as shown in Table 21), nevertheless they were relatively optimistic about road condition improving and more people travelling. The slight optimism about improving road conditions on the Bhimasthan road was in sharp contrast to the perceptions on the Thulo Parsel road. On the Thulo Parsel route, no bus drivers felt the road condition was improving and none of them felt there were more people travelling. In contrast, on the Bhimasthan route, 71% of bus drivers felt the road was improving and 63% of bus drivers felt there were more people travelling.

Table 35 Drivers' perceptions on the causes of change to transport supply and demand

Drivers' perceptions on the causes of change (ranked by overall responses)	Per cent of drivers answering 'Yes'		
	Autorickshaw	Jeep/pickup	35-seater bus
More personal motorcycles?	89%	93%	75%
More use of jeeps, pickups?	56%	93%	100%
More use of three-wheelers?	100%	50%	88%
More use of 35-seater buses?	56%	93%	88%
More people travelling?	100%	50%	63%
Road condition improving?	33%	62%	71%
More use of minivans/minibuses?	11%	64%	38%
Fewer people travelling?	0%	21%	25%
Road condition deteriorating?	0%	7%	25%

5 Discussion of emerging issues

5.1 Road provision and transport services supply

The two DRSP roads studied in Nepal had sections of completely new alignments allowing motorised traffic to reach some villages that had previously only been accessible by footpaths and mule trails. Other alignments along their length replaced poor seasonal tracks or riverbeds and allowed transport services to operate all through the year for the first time. The road provision was basic: they were quite narrow, earth roads with cobble stones or stone soling on steep or vulnerable sections. The stone sections were rough, but reliable, and served to avoid slippery gradients.

Transport services had responded rapidly and all-season bus services were established soon after construction, they have maintained their all-season daily services and in some cases expanded. The 35-seater buses, with relatively short chassis, are well suited to rough mountainous roads with some steep gradients and sharp bends. They have high clearance and so can cope with muddy sections (although difficult passenger access is a side effect of their high clearance, as illustrated in Figure 37). They are equipped with roof racks that can carry freight, which is important as mixed passenger and freight transport is a requirement for rural transport services. There are safety concerns with heavy loads and sometimes passengers on the roofs, given the mountainous and unstable terrain, but the roads do not allow high speeds (low speeds favour safety). Their capacity allows reasonable economies of scale when it comes to passenger and freight tariffs.

Bus fares on both roads, in terms of USDc per passenger-km have decreased since 2013. The reasons for the reduction in bus fares are likely to be complex. Bus drivers on both roads reported demand for buses is decreasing due to people's use of motorcycles (in particular), and greater use by passengers of jeeps, autorickshaws and minivans. However, compared to 2013, bus passenger numbers appear to have risen. The number of buses operating on both the Kavre road and the Sindhuli road have been quite constant since 2007, with four buses daily in each direction on each road. Most other vehicles have increased, with motorcycles now increasing rapidly from a low base (no motorcycles recorded on either road in 2007. On the busy section of the Kavre road there were 65 motorcycles a day, but only 18 on the least used part of the road. On the Sindhuli road, there were over 130 a day on all sections of the road. The use of four-wheel tractors had been common for freight movements in 2007 and 2009, but now it seems that pickups and trucks of various sizes meet most of the freight demand on both roads.

5.2 Rural Transport Premium (RTP)

The fares on the buses are relatively low for transport on LVRRs, and there was little reported difference between the fares in the rainy season and the dry season. On the Kavre and Sindhuli roads, the operators said they charged about USDc 3 and 4.8 per passenger-kilometre, respectively, while users suggested it was more like USDc 5.7 and 5.2 per passenger-km. Such discrepancies are common, particularly where the fares are regulated and/or the drivers are not the owners, which was generally the case on the roads studied. The difference could also be due to the interviewed passengers generally traveling shorter distances than the further destinations that are proportionally cheaper. Table 36 shows the average fares paid per passenger-km for the different vehicle options, as reported by the users interviewed.

Table 36 Average fares in USDc per passenger-km on the Sindhuli road and two sections of the Kavre road

Road	Section	Autorickshaw *USDc*	Jeep/Utility *USDc*	Minivan *USDc*	Bus/Midibus *USDc*
Kavre (Nepal)	*Remote*	-	3.7		5.7
Kavre (Nepal)	*Busy*	11.6		7.6	5.7
Sindhuli (Nepal)	*Remote*	39.9	8.7	-	5.2
Note: most fares relate to the whole road including the remoter sections. On the Kavre Road, some transport types were only available on the busier sections towards the end of the road, and these are presented in a separate row					

Table 37 Standard bus fares for various long-distance routes in Nepal in December 2019

Tanzania			
Origin	**Destination**	**Distance** *km*	**Fare** *NPR*
Kathmandu	Pokhara	200	500
Kathmandu	Butwal	259	519
Kathmandu	Illam	676	1,348
Kathmandu	Jhapa	610	1,172
Kathmandu	Krishnanagar	349	686
Kathmandu	Janakpur	375	736
Kathmandu	Biratnanagar	541	1,043
Kathmandu	Tamghas	376	840
Kathmandu	Ghorahi	434	846
Kathmandu	Nepalgunj	531	1,025
Average fare per passenger km *(NPR)*			**2.04**
Average fare per passenger km *(USDc)*			**1.80**
Note in December 2019. USD1 = NPR 113			

Table 37 shows that long distance bus fares in Nepal are about USDc 1.8 per passenger-km, and this provides the denominator for the RTP, which is the cost of rural transport compared with national buses, as was explained in Section 1.4.2. The calculated RTP values based on Table 36 and Table 37 are presented in Table 38.

Table 38 Rural Transport Premium (RTP) values for transport services in 2019 and 2013

Road	Section	Autorickshaw 2019	Jeep/Utility 2019	Minivan 2019	35-seater bus 2019	35-seater bus 2013
Kavre	*Remote*	-	2.1		3.2	5.1
Kavre	*Busy*	6.4		4.2	3.2	5.1
Sindhuli	*Remote*	22.2	4.8	-	2.9	5.7
Note: The Rural Transport Premium is the calculated from the average fares per passenger-km paid on the rural roads divided by average fares per passenger-km for long-distance buses. The denominator, the long-distance bus fare, was USDc 1.80						

The RTPs for 35-seater buses of 2-9 and 3.2 are not unusual for vehicles with medium capacity operating on rough roads. It would probably be lower if larger buses were used, and higher for if jeeps or pickups were the main transport vehicles. The RTP for jeeps/pickups on the Kavre road was unusually low, at 2.1, suggesting that these were vehicles being used by owners who were supplementing their main income by receiving money for lifts. The RTP for jeeps/pickups on the Sindhuli road was 4.8 and is more in line with similar transport services in other countries. The RTP for autorickshaws is much higher at 6.4 on the busy section of the Kavre road and 22 on the remote section of the Sindhuli road. As discussed in Section 4.3.5, the autorickshaws are mainly acting as point-to-point transport services, with one or two users paying as much as if there were four or five users. On the busy section of the Kavre road with high transport demand, the autorickshaws are competing with minivans, which helps to keep their fares down. On the remote section of the Sindhuli road, the autorickshaws have a small isolated transport market, rough road conditions and no competition other than the scheduled buses. The reported RTP of 22 is high, but RTP values over 10 are not uncommon for small point-to-point services such as autorickshaws or motorcycle taxis where there is no clear competition.

5.3 Transport demand

Transport demand varies greatly with location along the roads. On the Kavre road, 183 people a day travelled on the last (and most remote) section of the road, 346 on the middle section of the road and 707 people a day travelled on the busy first section of the road. It appears that the first section of this road has developed the classic ascending spiral of transport supply and demand, assisted greatly by its proximity to the market town of Tamaghat. For this reason, there are additional bus services travelling from Bhoredovan to Tamaghat and onwards to Kathmandu. There were also 20 minivans and a similar number of autorickshaws serving the short 9.5 km route between Bhoredovan and Tamaghat.

On the Sindhuli road, there were also more passenger movements closer to the urban end of the road, with 940 passengers a day recorded 10 km from the Majhitar junction. However, there were also many passengers travelling on the remote rural section of the road near Bhimasthan (671 passengers a day). This has increased from 540 passengers a day in 2013. Autorickshaw drivers believe there is increasing demand for their services, and some are now based on the remote rural section of this road, and have busy and profitable operations providing transport along the road and at the large villages of Bhirmastan and Chakmake. The proportion of passengers who are women has dropped slightly, from about 33% to 25%.

5.4 Enterprise development

The survey of enterprises (excluding basic farming) on the Kavre road reflects the busy nature of the first section of the road, with 65 different enterprises along this section of the road (excluding the urban and immediate peri-urban areas). On the middle and upper sections of the road there were only about 14 enterprises each in a comparable length of road. While the numbers of enterprises all along the road had increased greatly since 2013, the greatest growth was in the first section of the road. This has an increasing diversified economy that appears to be stimulating transport demand. In the higher, remoter sections of the road, the economy is mainly based on semi-subsistence agriculture, with only a gradual increase in daily transport demand.

On the Sindhuli road, there had also been important increases in business activities along the road. There are now 89 enterprises (mainly retail but also several workshops and chicken farms). This has increased from 21 in 2002, and 40 in 2013, indicating that enterprises had doubled in the first ten years, and more than doubled again in the past six years. The number of male and female run enterprises remains similar.

5.5 Road condition and maintenance

5.5.1 Operator opinions

Road condition affects all transport services but in different ways. The roads studied are both rough, all-season roads passable all the year by buses and jeeps. However, they have some critical muddy points that can be problematic for low-clearance vehicles in the rainy season. The operators all complained of excessive dust in the dry season. This is an unfortunate feature of earth roads, although it does seem to be particularly bad in some parts of Nepal (Workman, 2017). The operators of smaller vehicles (autorickshaws and minivans with low clearance) were worried by deep mud that could make the road impassable to them, and so they did not normally operate on muddy sections. Mud was less of a concern for the bus operators, and for them it was wet slippery slopes that had the biggest impact on their operations. DRSP had been aware of this issue and both roads studied had been built with stone surfaces on potentially slippery gradients. These had endured for ten or more years on some sections. While none of the transport types favoured rough roads, the rough stone surfaces were preferable to deep mud or slippery gradients.

5.5.2 Lengthworkers

When the roads were built, DRSP trained and resourced lengthworkers to carry out regular routine maintenance. The lengthworkers were employed by the local district administration. With human labour (male or female) and simple tools such as shovels, picks and wheelbarrows, many potential problems can be solved before the road starts to deteriorate. In particular, keeping water off the road by keeping side-drains clear and removing minor earth falls is relatively easy and cheap, and avoids the earth road from rapidly deteriorating due to water erosion or mud. The local road authorities failed to supervise and pay the lengthworkers, leading to the breakdown of what had been a simple and effective system of proactive maintenance. Reactive maintenance is generally much more expensive, and often involves heavy machinery, that is expensive (although popular with the public and those responsible for contracting).

5.5.3 Irrigation and drainage

One of the main jobs of lengthworkers was to clear minor landslips from the side drains. Without such clearance, water tends to flow onto the road (as shown in Figure 29 and Figure 30). This can lead to mud on the earth sections, and the potential to weaken the base of the stone sections. In Nepal there is an

additional problem caused by farms wishing to irrigate their crops and/or dispose of excess irrigation water. Some farmers make channels to allow irrigation water from one side of the road to pass to the other side. On an earth road this creates a muddy channel that tends to deepen and widen with each heavy vehicle that passes. On stone sections farmers can even dismantle the cobblestones to create a channel for irrigation water (as shown in Figure 33). Unless this is addressed, the action of passing heavy traffic will gradually displace the remaining cobblestones, creating further problems on that section of the road. Lengthworkers would be able to identify and report or address such issues. When it was active, DRSP would address such issues through local consultations and seek appropriate solutions. Where there were large irrigation systems, they provided an engineered drift or culvert to allow water to cross the road without causing damage. This included recognising the needs of the farmers, despite the clear conflict of interests. On some parts of the roads studied, DRSP had made provision for irrigation cross channels at the time of road construction. Clearly, the issues of irrigation water and channels are complex and need community cooperation and understanding if the road is not to deteriorate, to the detriment of transport services and their users. It should be noted that the local roads offices are now starting to install additional cross drainage on the roads, although this does not appear to be directly linked to the irrigation problem.

5.6 Road engineering, labour-based construction and heavy machinery

It seems remarkable that the well-engineered earth roads developed by DRSP using labour-based technologies have lasted so long in the mountain sections in an environment of heavy monsoon rains and frequent landslides. Some of the cobbled surfaces seem in perfect condition, ten years after they were laid down. This is in marked contrast to the 'bulldozer' roads seen throughout the hilly regions of Nepal, some of which were visible as ephemeral offshoots from the two roads studied. These 'bulldozer' roads are made by hiring heavy machinery to create 'roads' to nearby villages. These are seldom engineered and generally suffer from severe erosion during the first rainy season. Some become unusable to traffic in less than a year and few last as long as three years. Despite the erosive power of the monsoons, DRSP roads have endured for more than a decade, due to meticulous planning and simple engineering.

However, the DRSP roads are narrow, which was reported to be an issue for both transport operators and transport users. Narrow roads on steep mountain sides can appear frightening, particularly as there are no crash barriers to stop vehicles going over the edge. They also make it difficult for vehicles to pass on some parts of the road (as shown in Figure 14). As a result, the road operators and authorities wish for sections of the road to be widened. While this could be achieved through labour-based methods, keeping to engineering principles, the tendency has been for the authorities to hire heavy machinery to undertake the work. On both roads, this has led to problems, and is likely to lead to greater problems in the future, due to the lack of slope stabilisation and bioengineering. On the Kavre road, the most difficult section is now the deep mud and poor drainage at the start of the second section (as shown in Figure 15). This problem appears to have been caused by the heavy machinery that was used to widen the road, creating a softer surface and altering the drainage pattern. The heavy trucks (16 a day in each direction) make matters worse, creating ruts that trap the water further. More heavy machinery has been brought in to remove the soft mud. This is only a temporary solution as the engineering problem has not been solved. Transport services are therefore disrupted, and unless there are engineering solutions to the drainage issue, the cycle will continue, and the road may cease to be 'all-season' for transport services.

Transport services operators and users would like the government to upgrade the whole road to a 'blacktop' (bituminous) standard. Some see the introduction of heavy machinery and widening as the first step towards this. However, with many competing needs for improved roads, the upgrades hoped for may not come soon, and an all-season narrow road may become a wider but seasonal road for transport services.

5.7 Transport comfort, convenience and accessibility

The user survey on the Kavre road confirmed that the people in that catchment area really appreciate buses, as the most suitable vehicles for all road conditions. However, they are far from perfect, with an overall rating of 'OK', slightly down on the similar survey carried out in 2013. While there is greater satisfaction for the bus fares (that are lower), there is less satisfaction with the levels of noise and dust, and

access for vulnerable people is now considered ‘bad’. The first step to board the buses is very high, and the handrails are not particularly convenient. While high clearance is needed for the road, one solution could be a fold-down extra step, that would benefit all users.

Figure 37 High bus step and difficult access on 35-seater bus on the Majhitar-Bhimasthan road

On the Kavre road, minivans were rated quite similarly to buses, but autorickshaws were not as popular, partly due to their high fares. However, they scored well on their strong points of high frequency and quick journey times. On the Sindhuli road, buses were the least popular form of transport, including for safety. Buses generally are perceived as safe and cheap vehicles, so to see them being ranked below autorickshaws, and jeeps/pickups is surprising. Only trucks were considered more dangerous.

6 Conclusions and recommendations

The roads studied in Nepal show how the provision of all-season basic earth roads that are narrow but well-engineered can lead to the development of enduring, reliable and popular transport services, notably those provided by buses. Buses can cope with rough roads and patches of mud, but slippery gradients can pose problems. The DRSP provided a solution to this through the labour-based construction of cobblestones and stone soling surfaces on critical slopes. These stone surfaces are rough but permit all-season transport and protect the road from getting muddy and eroded.

The longevity of the original DRSP investments was partly down to planning and engineering, but also was due to a simple and low-cost system of lengthworkers. These women and men had simple but important manual tasks. Most importantly they protected the road investments from water damage due to blocked drains and/or irrigation water that had intentionally, or unintentionally, been allowed to flow onto the road. This system has since broken down, and the road and its transport services are suffering as a result. This was seen on the Sindhuli road where a new muddy 'black spot' appeared to have been created quite recently by a side drain that had been blocked by a small earth slip. It is therefore recommended that the local road authorities restart some form of length worker involvement. This could be based on the previous system or it could be an innovative system based on entrepreneurs or community cooperation. Such a system will benefit the transport services and also the road authority itself, as it will reduce the need for more expensive interventions.

The use of cobblestones and stone soling by DRSP has proved durable and highly effective. It also led to significant sums of money being paid to disadvantaged rural people. This was shown to have had a positive impact on individuals and communities (Stickland, 2009). However, it was not adopted widely in Nepal as cobblestones were not popular with road users or road providers, for various reasons. Cobblestones were rough and people preferred smooth or concrete surfaces. Villagers and transport operators wanted smooth, 'black-top' bituminous surfaces, assuming these would be renewed if they deteriorated. Labour-based operations were perceived as old-fashioned, hard work to organise and with no financial 'benefits' to those commissioning the work. In contrast, hiring contractors for earthworks and bituminous surfaces was modern, quick, easy and often resulted in 'kickbacks' to the commissioning officials (Starkey et al., 2013). Both roads surveyed showed the durability of cobblestones and the short lives of Otta seals and other bituminous surfaces. The case for the continued use of cobblestones should be made through positive publicity. This will not be easy, as the public and transport services providers want 'blacktop' surfaces, as do politicians and the road authorities. The case will have to be made that in hilly areas, cobblestones are better for transport services and users than the lack of all-season road access.

The dangers of trying to widen well-engineered roads with heavy machinery, used by operators without sound understanding of engineering principles, have been observed in this study. The machinery can achieve the road widening but may create critical problems for transport services in terms of drainage, mud and future landslides. The fault is not in the machinery itself but in the way road authorities contract and supervise such works. The original labour-based work involved much on-site supervision to achieve their sustainable results. Due to their power and speed of work, machinery operatives require even more supervision to ensure the results are beneficial. In Nepal, with increasing decentralisation placing a strain on highly-trained human resources, there appears to be an urgent need for appropriate levels of engineers to allow appropriate on-site supervision, with capacity building to ensure the lessons are learned from past experiences (positive and negative).

Nepal has had a long tradition of long-distance, rural bus services that allow rural people to make journeys along the road to the nearest market town, and also travel longer distances to cities as required. This pattern appears successful and is being maintained by the powerful bus cartels. However, on the Sindhuli road, bus cartels appear to be less influential, and this has allowed the growth of jeeps/pickups as transport services. On other rural bus routes in Nepal, jeeps/pickups that appeared to compete with the buses tended to catch fire overnight (which was assumed to be due to the actions of bus operators, as a warning). From the perspectives of the users, a wide range of complementary transport services is preferable, and the shorter journey times and higher frequency of pickups is appreciated, despite the higher fares.

There are changes being seen in rural transport services, with greater use of motorcycles for personal transport (a trend set to accelerate). There are also the smaller, more expensive but more frequent short distance services including those provided by minivans and autorickshaws. These smaller transport types were not seen on the studied roads when they were first built, or in the 2013 surveys. While there is inevitably some competition between bus operators, they have different transport niches and tend to operate in peri-urban areas where there is high transport demand. Interestingly, autorickshaws are increasingly used on the remoter sections of LVRRs, providing convenient (but expensive) local transport services in a way that buses could never achieve.

It is recommended that complementary transport services of different types be encouraged on rural roads where there is sufficient transport demand to justify them. There should not be regulatory disincentives against such vehicles, even though the bus cartels (and possibly even jeep/pickup associations) may try to exert pressure against their expanded use.

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