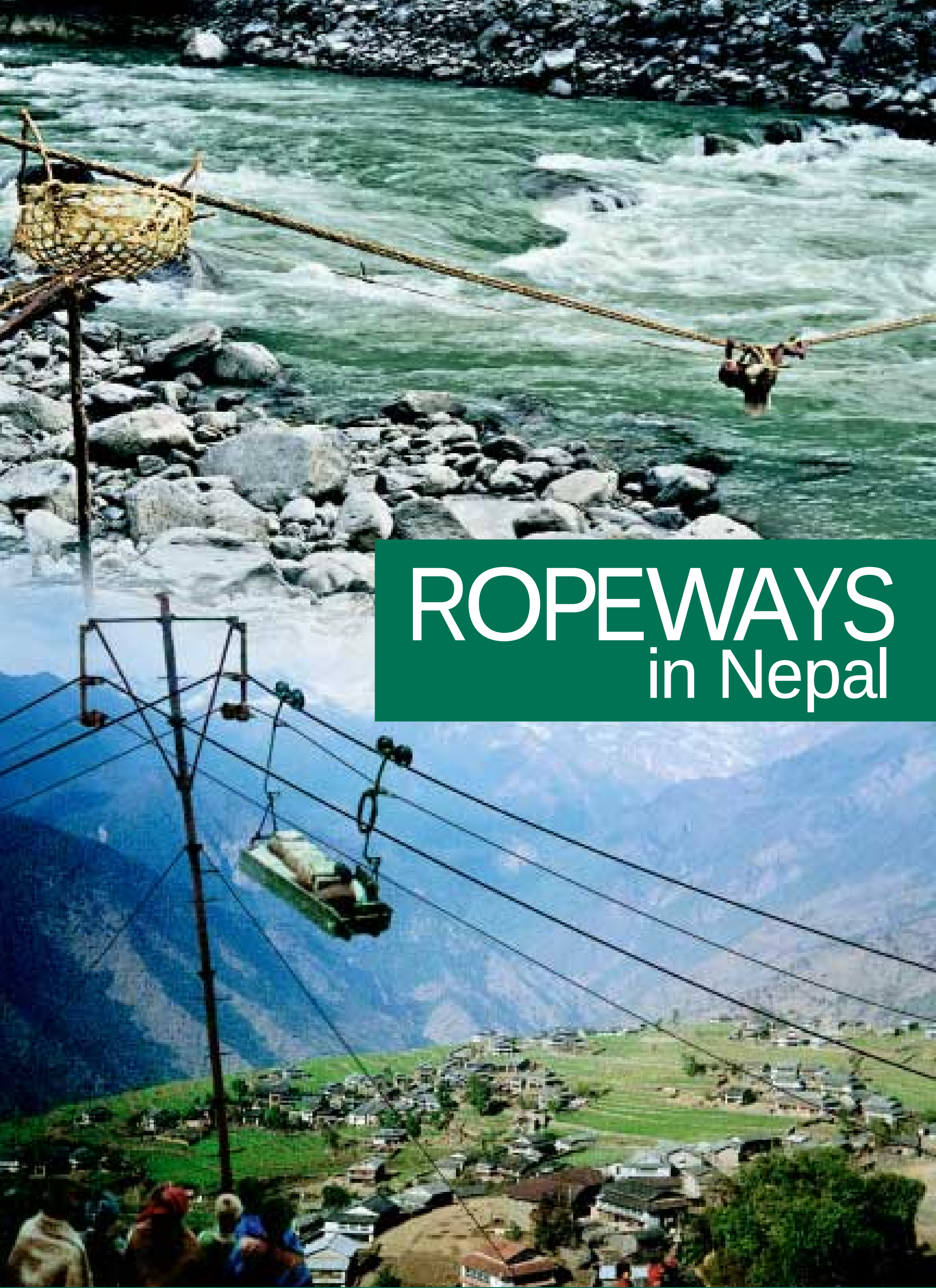

ROPEWAYS in Nepal

Dipak Gyawali ▪ Ajaya Dixit ▪ Madhukar Upadhya

ROPEWAYS
in Nepal

Context, Constraints and Co-evolution

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Cover photo
Crossing the Arun River on a rattan rope taken by Toni Hagen in 1956, and Barpak Ropeway in operation against the background of Barpak village by Bir Bahadur Ghale in 1998.

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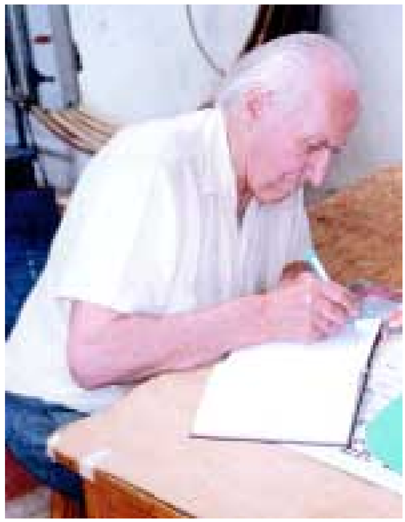
Dedicated to the memory of

Toni Hagen

who made Nepal his *karma bhoomi* and inspired many



1917 – 2003

I am very much impressed,
a real pioneers work.
It is to be hoped this pilot
project will start a large ropeway
development, for the benefit of
the poor people.

I should like to encourage all
people involved to take up this path.
Special thanks to Mr. Madhukar
Upadhya for his pioneers work

24th May 1997 Toni Hagen
Katrin Hagen

(from the visitors' book at the Bhattedanda Milkway, which Toni Hagen is seen signing in the photograph above)

FOREWORD

Some years ago a Thai friend of mine, an economist, was abruptly fired from his job as a newspaper editor in Bangkok. On his way home he met another friend who complained that he was financing the construction of a hotel and didn't have a project manager. The earlier one had resigned in despair at the problems he faced. My friend immediately offered to take on the task. When asked what technical qualifications he had, he replied that he had none but that he had been educated at Cambridge and that a Renaissance man could turn his hand to anything. He was given the job and built a great hotel.

Perhaps the issue of ropeways demands a similar approach, one based on self-confidence and a willingness to accept an unquantifiable challenge. In Nepal, distance from the nearest road is a crucial determinant of development, which suggests that the obvious answer to the need to boost living standard is to build more roads. Yet in a mountainous environment where roads are technically very difficult to build and transaction costs very high, the obvious answer may not be the right one.

Perhaps the first step is essentially conceptual: to think in terms of rural access rather than road construction.

In March 1996, Dipak Gyawali and Ajaya Dixit published a paper arguing that ropeways could complement roads in Nepal. They provided many detailed supporting calculations. But the most honest and perhaps the most crucial element in the paper was the section which admitted that the only real way to discover whether ropeways would work would be to build one and see. It was on that basis that the British Embassy contributed to the funding for the Barpak Ropeway in an endeavour to take the academic debate forward in a practical way. The lessons learned from Barpak form a part of the wider pool of knowledge assembled in this book, which I hope will, in turn, stimulate the building of more ropeways and the learning of more lessons.

L. Barnaby Smith
Former British Ambassador to Nepal

PREFACE

This book is being published after an eight-year gestation period. Going through our respective diaries, we have found amusing notes that chronicle the unforeseen shifts in the course of our research.

It all began in June 1995, when Bhola Shrestha of ITDG-Nepal* asked Dipak Gyawali and Ajaya Dixit if they were interested in carrying out a study on the future of ropeways in Nepal. The idea of writing a book was not even a seed of imagination at that time; that ambition arose much later. Our main objective then was to figure out if ropeways could improve the load factor of small and isolated micro-hydropower plants (MHPs) and thus help them earn enough money to become economically self-sustaining. Most small hydel plants are idle for much of the day and come to life only for a few hours in the evening to provide electric light. In some cases, the daytime productive load is practically zero; in others, attempts have been made to introduce bakeries, furniture factories and other electricity-consuming enterprises. If MHPs were not to be perpetually propped up by life-support subsidies, we concluded, some innovative ideas had to be forthcoming.

One idea we discussed at that meeting was powering small ropeways with electricity generated from MHPs. The emphasis was on the word 'small,' for none of us was thinking in terms of the existing Hetauda-Kathmandu Ropeway or the proposed Surkhet-Jumla Ropeway models. We asked a number of questions: Does it even make sense to think along these lines? Are small ropeways feasible? If so, in what kinds of places? Would porters be displaced and made redundant by this new technology? Would ropeways just end up as yet another white elephant requiring eternal subsidies?

Thus began a long process of discussions, field trips, meetings, debates, investigations, discoveries and, of course, moments of exuberance followed by days of depression. We began by trying to prepare a conceptual analysis of the context for, and viability of, goods-carrying ropeways in Nepal. After visiting an innovative, functioning ropeway like the Milkway in Bhattedanda (see chapter 8), we would feel elated; when we had to walk through ghost towns like Teku Bhansar or Hetauda stations of the moribund Nepal Ropeway, we would come back totally depressed. When Bir Bahadur Ghale, an entrepreneur from Barpak, came to our office to bang on the table and insist that his village be included in our list of potential pilot project areas, our faith in the creative potential of Nepali villagers increased manifold. When Ajaya broke his leg at Rangrung on the way to Barpak and had to be carried back

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* ITDG: Intermediate Technology Development Group, a Schumacher-inspired, Prince Charles-patronised, non-profit NGO advocating people-centric technology development.

to the roadhead at Gorkha Bazaar using 20-minutes stretches of relay portering in a *thunche*, we realised the Herculean odds villagers had to surmount just to survive. 'What will they have to do to build and sustain a technology as sophisticated as a ropeway?' we wondered.

As our study picked up speed, so did a few crucial events that were to have interesting consequences not only for ropeway but also for hydropower development in Nepal. Our investigations were invigorated by the ethos of local capacity building that fed the campaign against the Arun-3 hydroelectric project, which His Majesty's Government of Nepal (HMG/N) and its donors pursued so single-mindedly. The thinking about local ropeways was, to this dissident collegium, an extension of that campaign. By mid-August 1995, the World Bank had pulled out of the Arun-3 project and thereby set into motion a chain of other events hithertofore suppressed. A vacuum had been exposed in the country's power generation scene and there was a need to fill the gap with whatever was available. Alternative projects, including small and medium-scale hydroelectric schemes run by private as well as community efforts, found new openings.

At the start of what would soon be a rapidly changing development terrain, we conducted our study and produced a report for ITDG-Nepal.* To the question 'Do ropeways have any future in Nepal?' our report boldly said, 'Yes!' but only if several conceptual shifts were made. The first was to think of ropeway as short-haul (see Chapter 14 for more about such one- to three-kilometre *gaun-besi* ropeways) rural ropeways providing access to only the most difficult of climbs or the steepest of valleys. The second and more important conceptual shift was to develop ropeways as an industry born out of the marriage of two well-established industries catering to rural Nepal: MHPs and suspension bridges. Both have built up Nepali capacities significantly and both boast successful track records several decades long. Indeed, in a crude way, it can be said that a ropeway is only a suspension bridge with pulleys and gears suspended on towers similar to those for transmission lines and powered by electricity from a MHP. Our report was presented at the Galyang Ropeways Seminar in Syanja on 17-18 April, 1996. The Seminar brought together an interesting mix of individuals who thought unconventionally and had either worked on or studied ropeways. Many of them ended up writing chapters for this book.

Meanwhile, Bikash Pandey, the ITDG-Nepal's chief at the time and one of the principal advocates of the 'alternate' approach to hydropower development left for Berkeley, California, to pursue higher studies and Bhola Shrestha took over as the

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* Gyawali, G. and Dixit, A., 1996: 'Ropeways in Nepal: Conceptual Analysis of Context and Viability', report prepared for ITDG Nepal by G&D Associates Interdisciplinary Analysts, Kathmandu, March.

organisation's chief. Also at this time, Nepal's premier micro-hydro entrepreneur, Akkal Man Nakarmi, was contacted by a Nepali tourism investor to design a cable car to Hattiban in Kathmandu. Akkal Man, in turn, had requested a programme called Swiss Contact to provide the services of a volunteer expert in ropeway systems. Gottfried Rohrer, who ran a ropeway manufacturing company called Lasso Technik Ag and who had recently handed over the company's management to his son-in-law, came to help Akkal Man.

Unfortunately, it turned out that Rohrer's expertise was in goods transport, whereas the tourism investor wanted a passenger-carrying cable car. Although Akkal Man could not use the services of Rohrer, Bir Bahadur Ghale took him to Barpak with the idea of exploring the possibility of constructing a goods carrying ropeway between Rangrung and Barpak. Once in Barpak, Rohrer was appalled to find that there were no toilets. He felt that it would be a long time before one could talk of constructing a passenger ropeway in such a 'primitive' settlement and instead suggested that an 'as-good-as-new' Swiss Army ropeway kept in stock for emergencies could be acquired and installed for as little as three-and-a-half million rupees.

Rohrer's suggestion encouraged both Bhola Shrestha and Bir Bahadur Ghale, who were seeking financing in order to buy a ropeway. Bir Bahadur was already in contact with ITDG-Nepal, which was providing support to the Barpak MHP. He had asked ITDG-Nepal also to help him install a ropeway at Barpak. The ropeway project faced other hurdles too, because rural transport was not in the programme horizon of ITDG-UK and its Nepal office provided support only to electricity end-use programmes. Though such a project was not within the mandate of ITDG-Nepal, Bhola Shrestha agreed to help Bir Bahadur install a ropeway at Barpak in an advisory capacity, arguing that the new technology would use the energy of the MHP during daytime. He suggested that the community of Barpak implement the project when the time came. Later, Bhola helped prepare a proposal for installing a ropeway at Barpak and sent it, along with Dipak and Ajaya's report, to British Ambassador L. Barnaby Smith. This chain of events had both positive and negative consequences: the good side was that a pilot project was successfully undertaken, while the not-so-happy aspects were the unforeseen lessons that had to be learnt the hard way (see chapters 9 and 10).

After reading our report, Barney (as he was popularly known in Kathmandu) called the two of us (Dipak and Ajaya), for discussions. He was convinced of the need to try something innovative if access to Nepal's hill hinterlands was to be speedily developed. He took the plunge, risking his Ambassador's Fund and warning the two of us that he held us 'morally responsible' for talking him into it (see his foreword, which argues why we should take risks in development).

While Bir Bahadur Ghale and Bhola Shrestha were trying to find ways to get a Swiss Army ropeway, they ran into Nepal Yantra Shala's Shyam Raj Pradhan, who was then working with Karl Mueller, a friend of Toni Hagen. When he was told of the plan for Barpak and the three-and-a-half-million-rupee proposal, Mueller asked for the source of this estimate. Told about Gottfried Rohrer, he said, 'In Switzerland, a man of that age does not tell lies'. Mueller ended up approaching the Nepal Swiss Friendship Association, which got Hans Aschmann to carry out the mission of inspecting the ropeline in question.

All these doings reached the ears of Toni Hagen. In the true Swiss style of substantive (rather than procedural) efficiency, he simply landed in Kathmandu in April 1997 with a copy of the shipping documents for a Swiss Army ropeway auctioned for twenty-five thousand Swiss francs (1 Re = 10 SFr). Because the money for the ropeway had already been secured, the problem now was to get the equipment shipped to Barpak in hot haste! The Barpak initiative seemed to enthuse Toni Hagen so much that he suggested importing 10 smaller unused Swiss Army ropeways to Nepal at a total cost of Rs 25 million. Toni Hagen, Bhola Shrestha and Bir Bahadur Ghale had approached Swiss Development Corporation (SDC) for help. The SDC bureaucrats, however, were too reticent to support such a pioneering enterprise.

As a result, we decided that no matter what happened with the Barpak experiment, we had to document the process as a lesson for future Nepali entrepreneurs. That was when we decided that we would bring out a book about this experience and all other experiences till Galyang and afterwards.

The book has fourteen chapters grouped into three parts, many of which were written by those who had gathered in Galyang and a few by others with whom we came into contact later. Part I discusses background issues as well as the policy context. Toni Hagen, excited by the alternative entrepreneurship he saw, contributed a chapter. He shows how Nepal, with its exclusive focus on roads rather than ropeways in low-traffic hilly terrain, took a wrong turn in transportation development. Switzerland, on the other hand, had opted to complement arterial highways with many ropeways branching out from them. He describes how the area near Lake Lucerne, which is similar to Kathmandu Valley, is served by many cable cars and ropeways and points out with regret that Kathmandu has none. He also provided the photograph he took in the Arun Valley in 1956 of a villager crossing the Arun River in a wicker basket sliding along a non-metallic, organic rope. This image is on the cover of our book. The montage photo is of the Barpak Ropeway whose construction he contributed to. The 1956 picture is a traditional Nepali ropeway which later served as an inspiration for improved steel cable *ghirlings* (see Chapter 12). Because of his commitment to ropeways and Nepal's development for half a century, we have dedicated this book to his memory.

In the second chapter, Surendra Lal Shrestha draws upon his many years of experience in the National Planning Commission (NPC) to summarise the role ropeways have played (or not played) in the conceptual horizon of Nepal's development managers. He shows that the institutional gap, which prevented the spread of ropeway technology, stemmed from the bureaucratic proclivity for building roads and only roads and from the failure of local district governments to take up creative initiatives. The third chapter, by Urmila Shimkhada and Drona Upadhyaya, is an attempt to summarise the key findings of all the ropeway studies conducted in the past that they were able to lay their hands on. It may not be exhaustive, but it is our hope that future researchers and entrepreneurs can begin with this book confident that they will not need to search for other endeavours not described in its pages.

The second part consists of nine case studies of various ropeways in Nepal. Before they are discussed, in the fourth chapter Madhukar Upadhya and Kirtan Ram Bhandary introduce the technical aspects of a ropeway. This chapter is aimed at introducing the technicalities of ropeways to potential investors who wish to get a quick grasp of the artefact's basics: for specific details, they can consult specialised writings. This chapter is the outcome of our own attempt to make sense of different terminologies and conflicting details. Like this book itself, it started as an attempt to provide a glossary of technical terms but ended up becoming a full-fledged chapter. Upadhya and Bhandary describe the technology which was introduced to Nepal during the reign of Chandra Shamsher in the 1920s and later in the 1960s by USAID. Our hope with this chapter is that it will obviate the need for potential investors to run from pillar to post and even the Alps, as some of us did in the 1990s, searching for basic information of what building a ropeway entails.

In the fifth chapter, Shyam Sundar Shrestha describes the problems faced by the institution that inherited and maintained the oldest ropeway in Nepal, the Nepal Ropeway. He shows how the lack of policy commitment to replace imported fossil fuel with local hydro energy as well as the absence of attendant institutional support contributed to its slow death. In sharp contrast, Resham Raj Dhakal's chapter describes the cost effectiveness and success of temporary construction ropeways, which obviate the need to build expensive roads that won't be used after a project has been completed. In a similar vein, Ganesh Kumar Singh describes how the cement factory in Hetauda has successfully used ropeways. He explores the importance of a 'maintenance culture' as well as the unique problems faced in integrating ropeway operation with industrial production.

In Chapter 8 Madhukar Upadhya describes the Bhattedanda Milkway. This unique project has had its share of successes as well as institutional failures. The Milkway had just been commissioned when our first meeting at ITDG-Nepal took place and, as is the case with all externally-induced development, those involved in its promotion had little idea of the social consequences of its operation and maintenance. The results, from commissioning success to institutional breakdown to revitalisation, were yet to be lived through. The experience has been recorded and analysed in this chapter. Chapters 9 and 10 document the experience in Barpak from two perspectives. Bir Bahadur Ghale provides the testimony of a Nepali entrepreneur's encounter with ropeways. His account brings forth a grassroots perspective as well as his personal touch of commitment to his village and society. His account was translated into English from Nepali. Bhola Shrestha brings forth the perspective of an engineer who took on the role of a development catalyst. He shows how calculations of technical and economic feasibility do not effortlessly dovetail into institutional feasibility during either construction or operation.

We were impressed with the leadership and charisma of Bir Bahadur Ghale from the moment he showed up unexpectedly in our office as we were preparing the ITDG report. He had somehow got wind of the fact that we were going to recommend prospective sites for a pilot project and had come to lobby for Barpak. We were impressed with his forceful views, and we recommended Barpak as a premier pilot site because of the existing MHP and the strong community base. Several years later, when the Barpak Ropeway was in full swing, we asked his fellow villagers how Bir Bahadur was faring, and the answer was: 'He is busy minting money!' (*U ta note chhapya chhapai chha, sir!*). Then, in May 1999, tragedy struck in the form of both an accident and the washing away of the lower station by a catastrophic flood in the Rangrung River. What is exceptional about Bir Bahadur is his invincibility and indefatigability: a bit wiser after his pilot project experience, he is now engaged in re-establishing the Barpak Ropeway as well as expanding the capacity of his MHP.

Chapter 11 is also an entrepreneur's account, but one by a sophisticated urban scion of a national business house, not by a village entrepreneur. Rajesh Babu Shrestha's account of the difficulties he faced in establishing the popular Manakamana Cable Car shows how a rent-seeking bureaucratic culture discourages Nepal's risk takers from investing their money even when profit stares them in the face. Chapter 12 by Ajaya Dixit and Madhukar Upadhya is an attempt to bring to salience a Nepali transport technology that has remained in the shadows of development discourse. This preliminary examination of *ghirling* shows how the indigenised ropeway served as a common mode of transport in the hills. The challenge is to improve the comfort, safety and reliability of a *ghirling*. The last two chapters of Part III attempt to take stock of where the industry stands. Dale Nafziger, with his long years of work with the United Mission to Nepal (UMN), sounds a cautionary note, but he concludes by saying that visionary individuals need to take calculated risks to provide the evidence that proves or disproves that ropeway technology can be an agent of rural transformation. Finally in Chapter 14 Dipak Gyawali and Ajaya Dixit describe how ropeways can complement roads in rural transportation and discuss the seven sins that need to be avoided if ropeway technology is to grow roots in Nepal.

This book would not have been possible without the immense support we as editors have received from many from the start, during its long gestation period, and right up to the finish. All the participants of the Galyang seminar and the many who agreed to be authors had to put up with the slow process that publishing a book, unlike writing a consultancy report, entails. They have exhibited the patience of angels. Special *sraddha suman* goes to the late Ganesh Bahadur Gurung, a retired Gorkha soldier from Simjung, who was there with his first-aid kit when Ajaya Dixit broke his leg on the way to Barpak. The Gorkha-based staff of Rural Self-reliance Development Center, too, provided help and support at a critical time. The staff of the Bagmati Watershed Project must also be thanked for their enthusiasm and dedication in the construction and maintenance of the Bhattedanda Milkway. The late Gerold Muller need special mention as does Ganesh Pathak, who continues to provide technical support for its maintenance. Chandra Bahadur Dulal and villagers of Bhattedanda and Ikudol have served as inspiration for us; it is their commitment to this alternate mode of transport development that goaded us, as editors, to see the book through. We also thank the Ford Foundation, New Delhi and International Development Research Centre (IDRC), New Delhi for their support to the Nepal Water Conservation Foundation (NWCF). Their institutional support for other water-related research gave us the base that allowed us to pursue doggedly over the years many ideas examine in this book.

The support from people with their hearts in the right places helped us see the book through the critical final stages of editing and publishing. Bikash Pandey, Ratna Sansar Shrestha, Suman Basnet and Bibek Chapagain at Winrock International Nepal were helpful in providing the resources to print the book. We also acknowledge the help provided by Binod Devkota, Bhim Ghotane, Narendra Nyachho, Dayananda Bajracharya, Dinesh Bhuju, Gyani Shakya, Shiva Basnet, Pratibha Manaen, Susan Ghimire, Surendra Pradhan, Pramod Amatya, Maya Nath Bhattarai, Shiva Bisangkhe Ramesh Chaudhary, Aarjan Dixit, Jayendra Rimal, Dhruba Raj Regmi, Murali Gopal Ranjitkar, and David Sowerwine. Monica Hagen, daughter of Toni Hagen, helped us with names and data related to Switzerland when her father was incapacitated and subsequently after he passed away. Kanchan Mani Dixit, Narayan Adhikari, Ganga Shrestha, Geeta Bhomi, Sunita Munankarmi and Chandika Dhital provided crucial support in the production process. We deeply appreciate Perry Thapa for her help. None of those mentioned above, individuals or institutions, are, however, responsible for any error in the book. They are ours, and ours alone.

Dipak Gyawali, Ajaya Dixit and Madhukar Upadhya
Patan Dhoka, Lalitpur, Nepal.
August, 2004

CONTENTS

TABLES

ANNEXES

FIGURES

ACRONYMS

ACAP	Annapurna Conservation Area Project
ADBN	Agriculture Development Bank of Nepal
AECP	Alternative Energy Promotion Centre
AHREP	Andhi Khola Hydro and Rural Electrification Project
ATCHA	Association for Technical Cooperation to the Himalayan Areas
BBLL	Bridge Building at Local Level
BIWMP	Bagmati Integrated Watershed Management Programme
BPC	Butwal Power Company
BRECO	British Engineering Co., Ltd.
BWP	Bagmati Watershed Project
BYS	Balaju Yantra Shala
CB	Community bridge
CEDA	Centre for Economic Development and Administration
CGI	Corrugated Galvanised Iron
CPN	Communist Party of Nepal
DAO	District Administration Office
DC	Dairy Development Corporation
DDC	District Development Committee
DoLIDAR	Department of Local Infrastructure Development and Agriculture Road
DoR	Department of Roads
DWIDP	Department of Water Induced Disaster Prevention
EIA	Environmental Impact Assessment
ESC	Economic Services Centre
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
FAO	Food and Agriculture Organisation
FC	Fibre core
GTZ	German Technical Cooperation, Nepal
HMG/N	His Majesty's Government of Nepal
ICIMOD	International Centre for Integrated Mountain Development
IDA	Interdisciplinary Analysts
INGO	International Non-governmental Organisation
INPS	Integrated Nepal Power System
IOE	Institute of Engineering
IRR	Internal rate of return
ITDG	Intermediate Technology Development Group
IWRC	Independent wire rope core

KAAA BGN	Kadoorie Agricultural Aid Association British Gurkha Nepal
KE	Khawa Engineering
KEVA	Kathmandu Electric Vehicle Alliance
KLDP	Karnali Local Development Programme
KMI	Kathmandu Metal Industries
KMTNC	King Mahendra Trust for Nature Conservation
kW	Kilo Watt
LSTB	Long span trail bridge
MBL	Maximum Breaking Load
MHP	Micro-hydropower Plant
MLD	Ministry of Local Development
MoF	Ministry of Finance
MoFSC	Ministry of Forest and Soil Conservation
MoWT	Ministry of Works and Transport
MP	Members of Parliament
MPPU	Multipurpose power unit
NC	Nepali Congress
NEWAH	Nepal Water for Health
NFFB	Natural force ferry boat
NGDG	Northern Gorkha Development Group
NGO	Non-governmental organisation
NOMPL	Nepal Orind Magnesite P. Ltd.
NPC	National Planning Commission
NR	Nepal Ropeway
NRSL	Nepal Ropeways System Ltd.
NTC	Nepal Transportation Corporation
NWCF	Nepal Water Conservation Foundation
OECD	Organisation for Economic Cooperation and Development
PF	Pressure frame
RADC	Remote Area Development Committee
RCC	Ropeway Construction Committee
RCUP	Resource Conservation and Utilization Project
RMC	Ropeway Management Committee
ROC	Ropeway Operating Committee
RONAST	Royal Nepal Academy of Science and Technology
RUC	Ropeway User's Committee
SBD	Suspension Bridge Division
SinKaLaMa	Sindhupalchok, Kavrepalanchok, Lalitpur and Makawanpur Integrated Rural Development Project
SFFSO	Swiss Federal Flight Security Office
SNF	Solid-not-fat

SNV	Netherlands Volunteer Agency
SBB	Swiss Federal Railways
STOL	Short take off and landing
TBSSP	Trail Bridge Sub-sector Project
TRD	Track rope divide
ULS	Unloading station
UML	United Marxist-Leninist
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development
USOM	United States Organisation Mission
VCS	Vikash Consultancy Services
VDC	Village Development Committee
WSC	Wire strand core

PART I Policy Context

CHAPTER 1

Ropeways and Tourism:
Swiss Experience and Lessons for Nepal

TONI HAGEN

MIXED TRANSPORTATION DEVELOPMENT IN SWITZERLAND

After obtaining independence from colonial rule, most developing countries embarked on a single-focus programme of road building and have continued such programmes today without considering better options and more economic alternatives. Switzerland, on the other hand, modernised its transportation system using a mix of railways, roads and ropeways. Its balanced policy fostered the development of a judicious blend of transport technologies suitable to specific areas in the Swiss Alps and meeting economic requirements. With government support a robust ropeway industry flourished.

In rugged mountainous terrain, the advantages of ropeways over other means of transport are many. First, they are much cheaper to build, operate and maintain than roads. In addition, they cause negligible harm to the environment. They need much less space than motorable roads and there is no need for parking places. In fact, except for the foundations and supporting steel towers, ropeways do not require much construction work on the ground at all. Since very little earth is moved, mountain slopes are not destabilised as they are when road alignments are excavated. While roads are ugly gashes cut into mountain slopes, ropeways do not mar nature's beauty. Ropeways, unlike hill roads, do not trigger landslides, nor are they as vulnerable to floods and cloudbursts. They have no expensive bridges to be periodically rebuilt after they are washed away. Because they can be powered by hydroelectricity—a resource abundant in the mountains if a government promotes local investment in decentralised hydropower plants—ropeways do not pollute the air as motor vehicles do. And, critically important for tourism, ropeways are silent.

The Swiss Alps have historically been a formidable barrier to transport. The building of trails across the mountains to facilitate the transport of pack animals started in the 13th century, when Swiss democracy began, although some trails must have existed much earlier, in Roman times. Hannibal, for example, on his way to conquer Rome from the north, started from Carthage and reached the Alps via Gibraltar. His army and elephants crossed three high mountain passes in what is today Switzerland. In the 18th century some of the ancient transit routes, including the famous Gotthard Horse Coach Road, used by horse-drawn passenger coaches were upgraded to roads. These primitive roads were improved to motorable standards only at the beginning of the 20th century. Even then, the government of the Canton of Grison thought motorcars were too noisy, too dangerous and too polluting and banned them until 1926. At that time, road construction and maintenance was basically the decentralised responsibility of Swiss cantons and municipalities.

It was only in the 1960s, when Switzerland decided to construct a modern national highway system, that the federal government became involved in road building in more ways than just paying subsidies. Among other activities, it set nation-wide standards and specifications, passed laws and regulations to ensure the compatibility of road plans with environmental concerns, issued tenders for private construction companies to do the work and checked the quality and standard of the results. Since then, the federal government has covered up to 90 per cent of the cost of constructing highways, while respective cantons pay the rest. Funding for the national highway system is generated through a special tax on the retail price of gasoline and diesel amounting to over half of that price. From 1961 till 2001 Switzerland spent 60.445 billion Swiss francs (US$ 43.175 billion at today's rate of 1.39 SFr to one US$) to build, maintain and operate a highway grid of 1,673 kilometres; the cost per kilometre was roughly US$ 25.8 million. As of 2001, Switzerland had also built 51,357 kilometres of village roads and 18,115 kilometres of urban roads at the respective costs of US$ 0.36 and US$ 1.2 million per kilometre. Switzerland's road system is probably the densest of any mountain country in the world. Its achievement is the result of full decentralisation and of participation by authorities as well as people at all levels.

Railway construction began in the mid-19th century at the initiative of several private enterprises. In 1847 the Spanisch Brotli Bahn, the first railway in Switzerland, started running from Zurich to Baden. The name derived from the high society of Zurich, for whom the train brought sweets from a well-known bakery in Baden on Sundays. Another important railway of the Gotthard was built in 1869. The total length of track in 1855 was just 210 kilometres, but it was extended to 17,727 kilometres in just 15 years. The Vitznau-Rigi train, the first mountain railway in Europe, was opened in 1871. The Pilatus Railway, which runs from Alpnachstad—a town readily accessible from Lucerne by boat, train or road—to Pilatus Kulm at an elevation of 1,838 metres was opened in 1889. It used steam engines, at first, then converted to electricity in 1937 because the cogwheel system used before that was unable to provide protection against slippage at the extreme gradient of nearly 1:2. Because of the steep angle of carriage, a special system with a vertical toothed gearwheel, together with a transverse boiler for the engine, was devised. Reaching a maximum gradient of 48 per cent, the Pilatus is still the steepest rack railway in the world.

Construction of the Jungfrau-Bahn, whose designation is Jungfraujoch, started in 1896 and was completed in 1912. Attaining a height of 3,300 metres, it is the highest railway in Europe. Most of the line (where the steepest gradient is 1:4) employs a rack system with overhead trolleys, but there is also a short section (of gradient 1:14) which uses an ordinary or adhesive system. A connection between Weggis and Rigi was opened in 1968. To complement these private endeavours, Swiss Federal Railways, SBB, was established in 1902. In order to expand train services to remote and poor areas, SSB merged several major Swiss railway systems which had been nationalised in 1897. These routes produced little or no profit for the private sector and needed cross-subsidisation through government intervention. All tourist railways, as well as some smaller lines and mountain railways, have remained private.

The drive for railway construction reached its peak in 1882, when the Gotthard Transit Route was built through the Alps. This 19-kilometre-long tunnel was the longest in the world until the recent opening of the Channel Tunnel between France and England. It was a masterpiece of tunnel engineering, which used labour-intensive construction techniques rather than the drilling rigs and other heavy equipment available at that time. Furthermore, the alignment of the Gotthard Railway, with its several loops and tunnels on both sides of the Gotthard River was extraordinarily farsighted. The same alignment is still in use today and allows trains of up to 800 tonnes—the heaviest in the world—to be towed by the most powerful electric locomotives in the world at a speed of 80 kilometres per hour. The line climbs from 400 metres at Erstfeld to 1100 metres at the entrance of the tunnel at Goschenen and then descends to 200 metres on the southern side.

For access to the most rugged and remote mountain areas, however, the construction of railways and roads proved to be too difficult and costly. Ropeways, it turned out, were a cheaper and more convenient alternative. They were to play a very important role even before steam and combustion engines were invented or electric power was made available. Motorcars did not ply Switzerland's roads until the 1920s and the boom in road building began only after the end of the Second World War. In contrast, the first boom in ropeways establishment in Switzerland took place in the 19th century; these ropeway routes have only partly been replaced by motorable roads and, in the last few decades, by helicopters. When the potential of Switzerland for tourism was discovered in the middle of the 19th century, ropeways of all kinds and sizes enjoyed an unparalleled boom.

SWISS ROPEWAY SYSTEMS

Ropeway systems exist in different parts of the world and different definitions are found in many different languages. In order to clarify terminology and to prevent misinterpretation or misunderstanding, the definitions in use in Switzerland are elucidated below. There are two main types of ropeway systems:

1. Cable cars, and
2. Aerial ropeways, which, in turn, are further classified into two types:
   a. Circulating mono-rope aerial ropeways, each with a single endless steel rope which carries and drives loads at the same time.
   b. Commuting bi-rope aerial ropeways with one strong steel rope for carrying loads and a second one for providing traction on loads.

Cable cars: These are essentially railway cars that are towed along a rail track on the ground using a steel cable which is powered at a hill station. A car is attached to each end of the cable, and both cars run simultaneously, one up and the other down, crossing each other halfway in between. Simple cable cars have been built in considerable number, not only in tourist areas but also in towns situated in hilly areas. In Lausanne, for example, cable cars carry passengers from the harbour on the lake to the centre of the town, and, in Zurich, from the city centre up to the university quarters. In St. Gallen, a cable car which was run by gravity once operated from the city centre to the elevated parts of the town. Making use of the country's abundant water resources, cars were equipped with tanks which could be filled with water from a nearby brook to make the downhill run. The tide of electrification that swept across Switzerland after 1930 eliminated steam traction from the mountains. Electric motors replaced steam locomotives and gravity because it took too long to fill up tanks and because the passenger carrying capacity had to be increased.

The basic engineering advantage of cable cars on steep terrain is that, unlike roads, which need a long serpentine gradient, tracks can be built straight from the valley bottom to the hilltop. Simple cable cars are by no means obsolete. While it is true that new cable cars are not being built due to the prohibitively high cost of right-of-way clearance, which requires the demolition of existing buildings, very old cable cars are being renewed and upgraded in modern Swiss towns. It is unthinkable to many Swiss people that roads will replace city cable cars.

Aerial ropeways: Aerial ropeways, or sky rails, transport goods and passengers suspended on steel ropes through the air. Six kinds of aerial ropeways are in use in Switzerland:

1. ***Gravity-driven, one-way, mono-rope aerial ropeways:*** These have only one carrying steel rope, which stretches in a single span from an elevated point down to the terminal. There is no pulling rope since gravity acts as the driving force. These ropeways do not have any brakes. These are the simplest and most primitive ropeways and can obviously be used only for downhill cargo transport. Local farmers built them to transport timber and bales of hay. Government permission is not needed to build one though the Swiss Federal Flight Security Office (SFFSO) has to be informed.
2. ***Commuting two-way, bi-rope aerial ropeways:*** These ropeways have a strong steel track rope and a separate traction rope. In this system, tanks are filled with water to artificially increase the force of gravity for the downhill run and then are emptied for the uphill run. The difference in the weights of the two ends of the steel rope lifts the cargo upwards. Many of these systems have now been upgraded and electric motors or combustion engines have been added as power sources.
3. ***Circulating, mono-rope, open-air, multi-seater aerial ropeways (chair lifts):*** This third type of aerial ropeway has chairs or benches with up to four seats, each suspended on a steel rope driven in a loop. The chairs, which are fastened to the rope using a gripping mechanism, may be independently disconnected from the rope and transferred to a separate suspended rail at terminal points for embarking and disembarking. A ride in such an open-air chair lift is a fascinating experience for lovers of nature; it is a smooth and totally silent gliding over a landscape of forests, jungles, rivers, villages, pastureland and rocks. The panoramic view that unfolds as one gains altitude is overwhelmingly spectacular.
4. ***Circulating, mono-rope, mini-cabin aerial ropeways:*** These ropeways are a further development of open-air chair lifts; they provide seats for four to six passengers per cabin. The mini cabins are detachable from the main carrying-cum-driving steel rope and come to an almost complete standstill to make it easy for passengers to get on and off. While an open-air ride is an unmatched delight, mini-cabins are very convenient in winter, in generally cold climates or at higher altitudes.
5. ***Mono-cable tow-lifts, or ground ski lifts:*** These are driven by a continuous steel rope mounted on two large driving wheels with vertical axes, one at the

bottom and the other at the top station of the ski lift. The wheel at the bottom station is powered by electric motors. Skiers standing their own skis hold onto small individual steel ropes fixed to the main rope and are towed upward. Tow-lifts fall between cable cars, in which the load carried is dragged along the ground, and aerial ropeways, in which the load is suspended on cables in the air. If the distance between the lower and the upper terminal is too long, small towers between the main terminal stations support the driving steel rope. With this simple system, skiers can enjoy sliding downhill without tiring themselves by trudging up slopes. Small loads can also be suspended on the driving steel rope and transported up or downhill. Because simple tow lifts are often uncomfortable and have limited capacity, they are gradually being replaced by open-air chair lifts, which have the additional advantage of being usable in the summer.

6. ***Commuting bi-rope, large-cabin aerial ropeways:*** These differ from mini-cabin ropeways in that, instead of a continuous rope, they have a strong steel carrying rope and a separate steel driving rope with one large cabin at each end. One cabin is pulled uphill as the other one moves simultaneously downhill, thereby getting gravity to do part of the work of pulling the load uphill. The cabins used are very large—the size of a city bus. The largest one in use in the Swiss Alps is the ropeway from Zermat to the summit of Rothorn Mountain. Each cabin can hold 150 passengers.

Swiss aerial ropeways have two different purposes: to provide access to remote mountain villages and high pastureland and to foster tourism. Tourist ropeways have much higher capacities and stricter safety regulations than village ropeways. They also have to be licensed by the Swiss federal government or, if they are small, by the canton or municipality in which they are located. The SFFSO enters all ropeways, even the smallest village one, on a topographical cadastral map, which is distributed to all pilots flying in or over Switzerland (Table 1.1). This is because ropeways, if undetected, can be a great hazard for aircraft and helicopters.

TABLE 1.1 Aerial ropeways registered by the SFFSO as of 1997

Ropeway type	Number	Jurisdiction
Major tourist aerial	5 67	Registered and licensed by Swiss federal government
Small cargo and local	244	Registered and licensed by cantons*
Simple cargo aerial	2,057	Registered by municipalities and the SFFSO
Total	**2,868**	

** Some of these are licensed for tourism too.*

HIGH PASTURES, REMOTE MOUNTAIN VILLAGES AND TOURISM

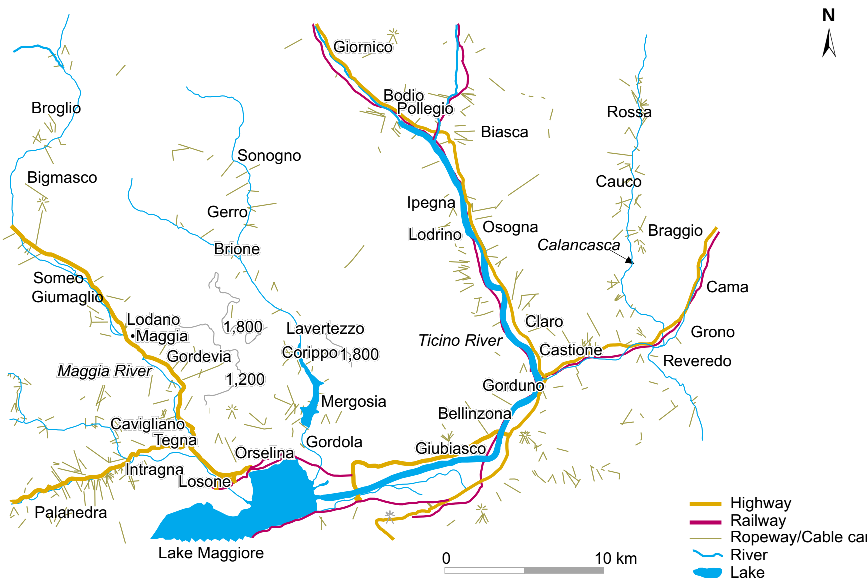
The building of these six types of ropeways in Switzerland started in the 19th century. The early ones were very simple and small, built (except for the steel rope) by local village blacksmiths and other craftsmen. The simplest ropeway was used to transport hay from mountain pastures down to villages so that there would be a stock of animal feed during the winter. These simple ropeways had neither engines nor brakes. The cargo was just suspended on a wheel and the load sped down to the valley, where it stopped at the end of the rope when it hit a bale of hay. Thousands of such very primitive ropeways have been used all over the hills of Switzerland.

The next stage was building simple, two-way ropeways for transporting cargo both uphill and downhill. Simple combustion engines, frequently those of old motorcars, powered these systems, which served primarily to transport cheese produced in mountain pastures during the summer down to villages and roads for marketing. Hundreds of ropeways were used in forests to bring timber down to roads; even today, modern mobile ropeway units serve the same purpose. Improved ropeways also increasingly served to transport passengers. For a long time, ropeways were the only connection between many villages and summer settlements and lowlands and valley roads. Temporary ropeways are used to protect construction works situated on steep mountain slopes above the tree line against avalanches. In the second half of the 20th century, temporary ropeways of all sizes were used while constructing hydroelectric dams and barrages. Some of them have survived and are used today to transport tourists. The oldest aerial ropeway still in operation in Switzerland today dates to 1917.

Building feeder ropeways to gain access to remote mountain villages is by no means an obsolete transport policy. As late as the period between 1991 and 1995, fourteen new ropeways were built in Switzerland, an achievement which suggests that building difficult feeder roads to remote mountain villages is by no means the only or even the most appropriate solution to meeting the need for mountain transport. In addition to building new ropeways, old ones have been upgraded with devices that increase their safety and capacity. Of the 70 ropeways that had been constructed by 1959, fifty were upgraded after twenty to thirty years of operation. Out of the 126 ropeways that were built between 1960 and 1980, twenty-five were upgraded. An additional nineteen ropeways were upgraded between 1990 and 1995.

Even today in a country as rich as Switzerland feeder ropeways are an important means of accessing poor villages in backward cantons. Table 1.2 shows that the four poorest mountain cantons of Switzerland have the largest number of feeder ropeways per inhabitant, or inversely, the fewest inhabitants per ropeway. In contrast, the rich canton of Zurich has just one feeder ropeway for its population of over a million people.

FIGURE 1.1
Ropeway density in the Ticino/Maggia Valley



In the canton of Ticino, many small feeder ropeways operate along the Gotthard Route, which is the main highway through the Alps connecting northern and southern Europe (Figure 1.1).

TABLE 1.2 Small cargo-cum-passenger aerial ropeways licensed by cantons

Canton	No. of aerial ropeways	Canton size (km²)	Population	Inhabitants per ropeway
Uri	53	1,100	36,000	679
Ticino	31	2,800	305,000	9,838
Obwalden	30	490	31,000	1,033
Nidwalden	28	280	37,000	1,321
Berne	27	6,000	942,000	34,889
Valais	24	5,200	270,000	11,250
Grisons	16	7,100	185,000	11,563
Glarus	11	690	39,000	3,545
Vaud	11	3,200	606,000	55,091
St.Gallen	8	2,000	440,000	55,000
Lucerne	6	1,500	340,000	56,667
Argovie	3	1,400	53,000	17,667
Zug	1	250	92,000	92,000
Zurich	1	1,700	1,176,000	1,176,000
Total	**250**	**33,710**	**4,552,000**	**18,208**

One important institution whose skills and institutional capacity regarding the use of ropeways for emergency are highly developed is the Swiss Army, which keeps a large number of mobile aerial cargo ropeways of different lengths and capacities in stock. One of them was brought to Nepal and installed in the village of Barpak in Gorkha District (see chapters 9 and 10). Setting it up took Nepalis about four months but professionals in the Swiss Army could have installed this 300 kilogramme cargo ropeway within 19 hours. Despite such well-maintained governmental capability, ropeways in Switzerland are primarily a private sector enterprise. Tourism did trigger a boom in the construction of mountain railways, cogwheel trains, tow-lifts, open-seat ropeways, mini-cabin ropeways and high-capacity ropeways, but all these were initiated, planned, financed and run entirely by private enterprises.

Hundreds of mountains in Switzerland with beautiful panoramic views are accessible by aerial ropeways and cogwheel railways which were put in place in the 19th and the early decades of the 20th centuries. As of 1995, the Swiss federal government had licensed 567 major tourist aerial ropeways in addition to the numerous cogwheel railways and cable cars. Roughly twenty per cent (or 120) of these tourist ropeways are in the canton of Grisons, which is called the 'vacation corner of Switzerland'. Since Grisons covers an area of 7,100 square kilometres and has a local population of 185,000, there is one major tourist ropeway for every 59 square kilometres and every 1,541 inhabitants.

In 1847, the 1,800-metre Rigi Mountain in Central Switzerland, famous for its panoramic view, was opened from the northern side with the first cogwheel railway in the world. Following its success, a second cogwheel railway was built in 1871 from the south, starting in Vitznau (436 metres) on the bank of Lake Lucerne. In 1868, the first ropeway from Weggis was built on the same lake. Hotels were built on the top of Rigi Mountain, whose reputation as the most beautiful location for mountain resorts in the world is due not only to the extraordinarily beautiful panoramic view but also to the fact that there are no access roads and consequently no motorcars, no noise and no pollution (Table 1.3). In 1937, electric trains replaced steam engines, but when marketing experts recently discovered the potential value of nostalgia, the old steam engine of 1847 was taken out of the National Transport Museum in Lucerne,

TABLE 1.3 Rigi Mountain: some facts

1847	Construction of the world's first cogwheel railway with a steam locomotive
1937	Replacement of the old steam locomotive with electric traction
1996	Still no access road; access only through two cogwheel railways and one aerial ropeway
1997	Reinstallation of old steam locomotives dating to 1847. Nostalgia-inspiring old-fashioned trains a grand success

■ Large cabin aerial ropeway in Central Switzerland. View from Mt. Stanserhorn over the lake of Lucerne.

FIGURE 1.2:
Ropeways around Lake Lucerne (area 500 km²)

restored and, in 1977, put into service for tourist excursions with great success. In that first year alone, with only 150 days of operation, it transported over 45 thousand tourists to the top of Rigi Mountain. The maximum daily visits using the two cogwheel railways and the aerial ropeway together amounted to not less than 5,000 passengers.

Another pioneering effort was the construction of a cogwheel from the town of Interlaken (566 metres) to Jungfraujoch (3,454 metres). To do so, a tunnel had to be built through the northern face of the famous Eiger Mountain up to the glacier plateau. From this point one gets a thrilling view of the high mountains of the Bernese Overland as well as of the 40-kilometre-long Aletsch Glacier, the longest in the Alps. On peak days, there can be up to 8,000 visitors. In the jubilee year, 23,000 people used the system of Jungfrau in one day (Table 1.4).

TABLE 1.4 Tourists transported by the three types of ropeways

Average per day in good years	3,000-4,000
Peak days	5,000
Annually	500,000
Hotels built	13
Hotel beds	551
Beds in youth hostels	150
Annual arrivals in hotels	18,718
Nights spent in hotels per year	35,336
Average duration of stay	About 2 days

The 27-kilometre-long and 18-kilometre-wide Lucerne Lake in the historic heart of Switzerland is one of the main tourist areas in the country. It has developed into the densest tourist area because none of the surrounding mountains and hill resorts has been opened up using roads. The Lucerne area is comparable in size to the Kathmandu Valley, which is about 25 kilometres from Sanga in the east to Thankot in the west, and about 27 kilometres from Shivapuri in the north to Phulchoki or Chandragiri in the south. Its population, however, is much smaller. Lucerne is home to just 600,000 people, while Kathmandu City has over one-and-a-half million and the whole valley is home to approximately two million people. Another difference is that though cogwheel railways, cable cars and major aerial ropeways have opened five mountains and three hill resorts around Lucerne (Figure 1.2), the Kathmandu Valley has no such transport technology. These eight destinations are briefly described below.

- Mt. Pilatus (2,121 metres): The steepest cogwheel railway in the world (with a gradient of 48 per cent) was built in 1889 from Alpnach (436 metres) on the southern side. In 1954, an aerial ropeway with four-seater cabins was installed from Kriens, a village near the town of Lucerne, to Frankmüntegg. The connection between Frankmüntegg and Pilatus was opened in 1956.
- Burgenstock (1,128 metres): One 874-metre-long cable car and one vertical lift to the top of a perpendicular rockwall have been built.
- Stanserhorn (1,898 metres) is served by one cable car in two sections.
- Klewenalp (1,593 metres) has one aerial ropeway.
- Seelisberg (766 metres) has one cable car.
- Stoos (1,275 metres) has one cable cars and one aerial ropeway.
- Fronalpstock (1,922 metres) has one aerial ropeway.
- Rigi Mountain (1,800 metres): This, the most famous mountain in Switzerland, has no access by road but is served by two cogwheel railways and one aerial ropeway, which starts at 400 metres and goes right to the top.

TABLE 1.5 Cogwheel railways, cableways and aerial ropeways in the Lucerne Lake area

	Climb (m)	Cogwheel railways	Cableways	Major ropeways to the top	Lesser local ropeways and chair lifts
Lucerne town	200		3		
Mt. Pilatus	1,700	1		1	2
Burgenstock	450		1		1 (chair lift)
Stanserhorn	1,450		1		
Klevenalp	1,150			1	
Seelisberg	240		1		
Morschach	400		1		
Stoos	1,200		1		
Fronalpstock	700			1	
Mt. Rigi	1,400	2		1	3
Others					10
Total		**3**	**8**	**4**	**16**

In the area surrounding St. Moritz (1,800 metres) in Grisons, which is the top alpine vacation centre for the international jet set, five famous mountains were opened with cable cars and aerial ropeways. There is no access by road. Zermatt (1,616 metres) and the Matterhorn (4,478 metres), a fashionable hill vacation and mountain sports centre respectively, are not accessible by road either. A cogwheel railway provides access to the Gornergrat (3,132 metres) and an aerial ropeway takes passengers from there up to the Stockhorn (3,532 metres). The highest ropeway in the Alps carries tourists from Zermatt to the little Matterhorn (3,884 metres).

There are nine major hill resorts in Switzerland which have either no access by road or do not allow motorcars to enter (Table 1.6). Cable cars provide the only access

TABLE 1.6 Fashionable hill resorts without road connections

Resort	Altitude (m)	Number of tourist beds	Type of access
Bettmeralp	1,950	400	Aerial ropeway
Braunwald	1,400	1,660	Cable car
Murren	1,650	2,000	Cable car
Riederalp	1,950	7,500	Aerial ropeway
Rigi-Kaltbad	1,400	570	Two cogwheel railways, one aerial ropeway
Saas Fee	2,000	7,300	No cars in villages; road and parking outside only
Stoos	1,300	2,300	Cable car and aerial ropeway
Wengen	1,300	3,300	Cogwheel railway
Zermatt	1,620	13,500	Mountain railway with road ending a few kilometres below

to these tourist centres of international repute. Together they have 53,230 beds, almost five times as many as the 11,661 beds in the Kathmandu Valley. Most other reputed tourist centres try to curb private motor traffic as much as possible either by building parking spaces in the periphery and running public bus services free of cost or by prohibiting driving at night. Some tourist areas close to villages use barriers which residents alone can open electronically with a code.

LESSONS FOR NEPAL

Not in terms of the spirit of its people but certainly in terms of its market economy, Nepal is one of the poorest countries in the world. For marginalised hill people in areas difficult to access, simple feeder ropeways seem to be an appropriate means of establishing connections. They are appropriate both technically due to their low maintenance costs and environmentally due to their low vulnerability to landslides and floods. Building ropeways to access remote mountain villages is by no means a backward transport policy for Nepal, as the example of mountainous and land-locked Switzerland has shown. Feeder ropeways are a highly economical alternative; they are not meant to displace feeder roads but to complement them. At the same time, ropeways should not be seen as just a continuation of feeder roads; they should be pursued as an independent component of a mountain-friendly transport policy in inaccessible remote areas as well as in prospective sites for tourist resorts.

Nepal had a successful early start in ropeway building. In 1922, Maharaja Chandra Shamsher started building a 22-kilometre-long cargo ropeway from Dhorshing over the Chisapanigarhi and Chandragiri hills and passing into the Kathmandu Valley.* This deed was every bit as farsighted as the pioneering construction of the Gotthard Railway and its tunnel 150 years ago in Switzerland. In 1964, the United States Agency for International Development (USAID) rightly replaced and extended the old ropeway by a new 42-kilometre-long system from Hetauda. It followed the alignment of the old one, yet had a higher capacity (equivalent to 24 truckloads during its daily operation of eight hours). Institutional problems prevented it from operating at full capacity despite the fact that transporting cargo by ropeway cost half of what using trucks on the Tribhuban Highway did.

With the introduction of foreign development aid to Nepal, policy changed. In early Five-Year Plans, road construction enjoyed high priority. The World Bank and bilateral donors assisted successive governments in their road-building programmes. The theory at that time, which was espoused by the World Bank, was that roads are

* The ropeway, whose construction began in 1922, came into full-fledged operation in 1927 (also see Chapter 5). In 1924, a four-kilometre ropeway from Halchok to Lainchaur was also built.

the backbone of development. The assumption was that development in other areas would automatically follow road construction. This was, of course, a false assumption, like another theory widely propagated by the World Bank, that aid to central governments would trickle-down to poor villages. For some time the World Bank seemed to have learned from its mistakes. In its 'Nepal Country Report of 1976', the Bank wrote that the construction and maintenance of roads in a rugged mountainous country was too costly and other means of transport should be found. Today, however, all the early lessons seem to have been forgotten: road building is booming despite the extremely high cost of maintenance and the damage they cause to fragile mountain environment.

Ropeways have played an important role in Switzerland for over a century. Nepal could learn much not only from its example but also from the examples of other mountain-blessed countries that have promoted the development of ropeways, especially simple freight ropeways, which are by no means the monopoly of Switzerland. In Bangladesh, a Swiss firm had, as of 1997, opened fifty remote villages in the hill district of Chitagong with not less than 60 simple ropeways. In Australia, a World Heritage nature reserve has been opened by a ropeway that crosses very scenic coral reefs, tropical forests, and mountains to end, after a 7.5-kilometre journey, at a fashionable hill resort which has no access road. Malaysia also has a number of scenic tourist ropeways to reach resort centres on mountain tops that are not served by access roads. On all continents, fruit plantations, mining enterprises and many other industries use a great number of ropeways to transport goods.

The development of transport in Nepal has been quite different: major highways are built and even repaired by foreign contractors. If national contractors are involved, they are mostly Kathmandu-based. Even to construct remote feeder roads in the districts, central agencies such as the Department of Roads (DoR) or the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) are involved. It is not local governments but contractors from Kathmandu that benefit. An excellent model of involving local people and authorities in the construction of environmentally friendly roads was, however, developed in the 1980s in Nepal: green roads. These roads, which were first implemented in the Tinau Watershed (later Palpa Development) Project and then in the Dhading District Development Project, operate on the principle of 'food-for-work' or income generating activities for self-organised rural groups. They not only make remote rural areas accessible, but also help alleviate poverty.

Despite the success of green roads, they are not the complete answer to transportation problems in the hills of the Himalaya. Given the formidable challenge of seeing that these roads do not deteriorate after a short time (rendering driving through the desecrated scenic beauty a painful experience and resulting in a public relations disaster for tourism promotion), green roads need to be complemented with an active programme of ropeway building.

Nepal has great potential for opening up its poor hinterlands to international tourists, yet roads are the only way with which mountains have been opened to seekers of a unique panoramic view. Nagarkot, Phulchoki, Hattiban and Shivapuri in the Kathmandu Valley as well as Sarangkot and Naudanda near Pokhara are all accessible by road only. The roads are in notoriously bad shape, parking places are few and tourists are engulfed by clouds of dust and polluted air. The construction of roads without attention to protecting the environment ruins beautiful scenery. If Nepal had hired experts in destroying unique tourist sites and mountain scenes, they could not have done better.

Ropeways for tourists are not just a means to get from one place to another. Nor, for that matter is a road, but a gentle ride to the top of the mountains in a comfortable cabin or open chairs is a unique thrill. A ropeway carrier glides as slowly and gently as a helicopter but without the ear-splitting noise. Travelling on ropeways would be still more thrilling when Kathmandu is covered with dense fog and even aircrafts are not allowed to take-off. Rising smoothly out of and above the fog and smog, the ride would offer a breathtaking experience and a panoramic view of the Himalayan mountains.

In the Kathmandu Valley, aerial ropeways could start at the outskirts of town, at the Ring Road encircling Kathmandu. The annoying drive on bad roads with their dust and traffic congestion could be avoided and tourists could glide over picturesque villages and beautiful rice fields where hardworking yet content farmers work. These ropeways could also promote treks of one or two days in the beautiful hills around the outer rim of the Kathmandu Valley. The great potential for establishing hotels in the Kathmandu Valley has so far been unexploited, but Nepal, like Switzerland, has spectacular aerial ropeway rides to offer.

The most incredible ride in the Alps is that on an aerial ropeway on Mont Blanc, France, whose awe-inspiring scenery certainly rivals that in Nepal. The 34-kilometre ropeway crosses the whole Mont Blanc range, which has the highest peak in the Alps (4,807 metres). The ropeway starts from Chamonix (1,100 metres) and proceeds via Aiguille du Midi (3,842 metres) over the Glacier de Geant and the Col du Geant (3,171 metres) into the Italian mountain resort of Entreves (1,306 metres). If Thak Khola were opened section-wise by a similar ropeway, the glide from Pokhara over Ghorepani, with its beautiful Gurung villages, down to Tatopani and on through the world's deepest gorge to Jomsom with peaks on either side, would be simply overwhelming. No other country in the world can offer the unique experience of silently gliding over the 8000-metre-high range of the Himalaya. Trekkers could to choose to ride on the ropeway across the steepest and most tiresome sections of the trek, while trekking along other portions. This would allow them much more flexibility in making choices about the length, duration and stress of a trek.

Why did the individuals responsible for tourist development in Nepal make such harmful and irreversible mistakes as building roads to the panoramic mountains around Kathmandu and Pokhara? Why do they continue to make these same mistakes today? Why are roads preferred for opening high mountain valleys such as Thak Khola when aerial ropeways would be cheaper to build and maintain since they would be much less vulnerable to natural disasters like floods and landslides? Why is Nepal dominated by regimes that are obsessed with a road mania?

Part of the answer is certainly the fact that, for big donors, whether international or bilateral, modern road construction is good business: up to 90 per cent of the money invested returns to the donor. An example is the high-tech project implemented to stabilise the landslide on the Jiri Road at a cost of over eight million SFr. Another main reason for the unfortunate prevalence of a wrong notion about transport development is that none of those responsible have so far taken pains to study alpine hill tourism beginning with its fundamentals and to learn from that study. Instead, they only visit incestuous international tourist conferences with hackneyed themes in places like Berlin, London or Paris, where the same people make the same statements again and again, reinforcing their own and each other's views. They may thus make themselves happy, but they do not make any contribution to proper tourism development or to the happiness of the marginalised poor in the Himalaya.

CHAPTER 2

State Promotion of Ropeways:

Moving from Stagnation to Change in Nepal's Policy Environment

SURENDRA LAL SHRESTHA

Nepal's scenic terrain is a transporter's nightmare. Its hills and mountains, which comprise about two-thirds of the country's area, are criss-crossed by rivers that flow through gorges, churn in rapids and create waterfalls. The steep slopes and valleys associated with river formation severely hamper the movement of people and goods from one location to another. Many of Nepal's mountainous districts are still inaccessible by road; they are classified as *'durgam kshetra'* or 'remote areas'. Given how weak the country's economy is, roads serving these areas will not be constructed for quite some time. More than half of the country's population still lives in the mountains and hills (Table 2.1). Though this ratio is expected to decline in the years ahead as more people migrate to the Tarai and to urban areas, those that remain behind will still need a transportation system of some sort.

Because hill settlements are scattered and comprise just a few hamlets with a dozen or so households each, the task of providing transportation services is daunting.

TABLE 2.1 Populations and their political representation by geographical region

Geographical region	Population		Parliament members	District Development Committee members
	1991	2001		
a) Mountains	1,443,130 (7.8)	1,690,263 (7.3)	28 (13.6)	176 (14.9)
b) Hills	8,419,891 (45.5)	10,271,506 (44.2)	89 (43.4)	663 (56.3)
Total (a+b)	9,863,021 (53.3)	11,961,769 (51.5)	117 (57.0)	839 (71.2)
c) Tarai	8,628,079 (46.7)	11,252,912 (48.5)	88 (43.0)	340 (28.8)
Grand total	**18,491,100 (100)**	**23,214,681 (100)**	**205 (100)**	**1,179 (100)**

The numbers in parenthesis are percentages.

Source: CBS, 1991 and 2001 and Election Commission, 2001

If one considers that Nepal has 2,418 village development committees (VDCs) in the hills, each with nine wards, which may, in turn, include several scattered hamlets, it is clear that the cost of developing transportation facilities is prohibitively expensive. Nevertheless, it is the state's responsibility to meet the aspirations of the people who live in remote areas to be better provided with modern services, including transportation, which makes access to all other services possible. If local economies are to improve and poverty is to be alleviated, then local communities must be provided with access to markets. Modes of transport that are cost effective and suited to specific areas are essential, and government policies must facilitate their realisation if the national goals of social and economic upliftment are to be fulfilled. In Nepal, roads, though much needed, are not universally feasible; in their stead, ropeways, if properly planned, can facilitate access to even the remotest of hill hamlets.

TRANSPORT SECTOR IN NATIONAL PLANS

When the Rana regime was overthrown in 1951, Nepal's entire transport system consisted of 376 kilometres of motorable roads, one airport, 100 kilometres of narrow-gauged railway line connecting Janakpur with Jayanagar in India and Raxaul with Amlekhgunj, and 22 kilometres of mono-cable ropeway that transported cargo from Dhorshing to Matatirtha in Kathmandu. Today, Nepal has more than fifteen thousand kilometres of motorable roads aligned north-south as well as east-west to connect various parts of the country. Forty-three airports have been built and Kathmandu's international airport handles wide-bodied jets.

In contrast, growth in other modes of transport has been negligible. The extent of ropeway development for instance, has been limited to the institution of a now defunct 42-kilometre bi-cable cargo line from Hetauda to Kathmandu, a three-kilometre ropeway in Bhattedanda and a three-kilometre passenger cable car line to Manakamana. From 100 kilometres, the length of railway line dropped to 53 kilometres when the Raxaul-Amlekhgunj line fell into disuse. Also during those fifty years an electric trolley bus system was installed to operate along the 13-kilometre stretch between Tripureswar in Kathmandu, and Surya Binayak in Bhaktapur. Inland navigation in Nepal is limited to ferries and dugout canoes which are used only along certain stretches of the Kosi, Narayani and Karnali rivers. None of these transport systems are mentioned in the transport sector of Nepal's National Five-Year Plans. The achievements of the transport sector over the last five decades are shown in Table 2.2.

When Nepal first promulgated centralised development planning as its state policy in 1956, attention was turned toward improving transportation facilities. As Table 2.3 shows, the First National Plan allocated the bulk of the government's resources to the transport sector and accorded the implementation of its activities top priority.

TABLE 2.2 Fifty years of transport infrastructure development

Transport infrastructure	Unit	Year 1951	1956	1961	1971	1981	1991	2001
Roads	km	376	624	1,711	2,730	5,270	8,328	15,458*
Earthen	km	288	365	1,010	1,474	2,229	3,064	7,185
All-weather		88	256	701	1,256	3,041	5,264	8,273
Gravel	km	83	122	Na	435	719	2,181	3,696
Blacktop	km	5	137	Na	821	2,322	3,083	4,577
Air strips	No.	1	5	12	21	39	43	43
All-weather	No.	-	1	1	4	4	4	4
Fair-weather	No.	1	4	11	11	14	15	15
STOL	No.	-	-	-	6	21	24	24
Ropeway	km.	26+	26+	26+	42++	42++	42++	6.03+++
Railway	km.	99.4	99.4	99.4	52.0	52.0	52.0	52.0
Trolley	km.	-	-	-	12.5	12.5	12.5	12.5
Foot trail	km.	NA	NA	NA	Na	10,000	15,000	15,000**
Suspension bridge	No.	30	30	55	65	143	408	955

* Collected by DoR for first eight months.

** *This figure is estimated based on the trail map prepared by* the Trail Improvement Programme.

\+ A: Dhorshing-Matatirtha (22 km) and B: Halchok-Lainchaur (4 km).

++ C: A is replaced and extended by Hetauda-Kathmandu (42 km), B ceased to operate.

+++ Manakamana-Kurintar (3.02 km) and Jhankridanda-Bhattedanda (3.01 km). C ceased to operate but physical system has not been dismantled and theoretically can be restarted. The list does not include industrial and construction ropeways. The industrial ropeways are at cement factories in Hetauda (see Chapter 7) and Udaipur. Another industrial ropeway to transport magnesite did not function (see Chapter 3).

Sources: Periodic plans and progress reports of NPC Nepal: Economic Survey FY 2001/02, Ministry of Finance 2002, Nepal; Department of Roads; Suspension Bridge Division, Main Trail Bridge Statistics, 1997 Nepal

TABLE 2.3 Public sector outlay on different development sectors under periodic plans (1956-2002) Rs x 10^6

National Five-Year Plans 1956-2002		Total outlay for the period	Transport and communication		Agriculture and related sectors		Social and others	
			Allocation	Per cent	Allocation	Per cent	Allocation	Per cent
First	(1956-61)	330	124	37.60	94	28.60	11	33.80
Second	(1962-65)	600	143.5	23.90	97	16.20	359	59.90
Third	(1965-70)	1,740	875	50.30	377	21.70	487	28.00
Fourth	(1970-75)	2,750	1,050	38.20	663	24.10	1,037	37.70
Fifth	(1975-80)	7,540	1,990	26.40	2278	30.20	3,272	43.50
Sixth	(1980-85)	21,750	4,230	19.40	6,600	30.40	10,920	50.20
Seventh	(1985-90)	29,000	5,132	17.70	8,976	30.60	14,992	51.70
Eighth	(1992-97)	113,479	20,030	17.70	29,193	25.70	64,256	55.60
Ninth	(1997-02)	189,580	33,340	17.60	51,284	27.00	104,856	55.30
Tenth*	(2002-07)	264,000	41,130	15.60	63,260	24.00	169,440	60.40

* As reflected in the Tenth Plan Approach Paper, NPC/ HMG/N, 2002

Source: National Planning Commission, HMG/Nepal, First to Tenth, National Development Plans Nepal

The Third Five-Year Plan allocated the highest proportion of public sector resources (50 per cent) to developing transport and communication infrastructure. Since then the share of budgetary allocation has declined steadily. With the exception of the Seventh Five-Year Plan, which earmarked a relatively high proportion—29 per cent—other plans allocated less than a fifth of their budgets to the transport sector. The Ninth Five-Year Plan, for example, budgeted only 17 per cent and the Tenth Five-Year Plan about 16 per cent. The actual expenditure on developing various modes of transport from the Fifth Five-Year Plan period through the first three years of the Ninth Five-Year Plan period is presented in Table 2.4.

Within the transport sector, the highest priority—between 73 and 83 per cent of total expenditures—has been consistently given to developing roads. Civil aviation has taken up the next largest share, constituting between 11 and 18 per cent. The expenditure on all other modes of transport was less than one per cent of the total amount. Ropeways, which are included under 'other modes,' have received little attention. After the restoration of multi-party democracy in 1990, during a 'plan holiday' period (1991-1992), about 20 per cent was spent on the transport sector. Expenditure on 'other modes' of transport was only about 0.5 per cent.

In the 1950s, Nepal had virtually no modern transport facilities, and the little there was, was limited to Kathmandu and a few other cities. As transport infrastructure (particularly road and civil aviation) has expanded over the past five decades, so has the import of petroleum-based fuel. Unfortunately, ropeways and electric railways, which could have been operated using locally-generated hydropower, received little

TABLE 2.4 Expenditure incurred in the development of transport infrastructure from 1975 to 2000 (Rs $x10^6$)

Transport sector	Fifth Plan 1975-1980	Sixth Plan 1980-1985	Seventh Plan 1985-1990	Gap years 1991-1992	Eighth Plan 1992-1997	Ninth Plan* 1997-2000
Roads	1,830.30	2,774.70	4,799.30	3,434.90	15,379.70	14,400.30+
	(83.00)	(76.70)	(75.40)	(78.77)	(75.06)	(89.13)
Bridges	108.60	250.00	400.80	287.10	1,693.80	
	(5.95)	(6.90)	(6.30)	(6.56)	(8.27)	-
Civil aviation	253.10	589.80	1,120.40	615.30	3,230.40	1,756.00
	(11.55)	(16.30)	(17.60)	(14.11)	(15.76)	(10.87)
Others	-	2.90	43.70	23.20	187.50	
		(0.08)	(0.69)	(0.53)	(0.92)	-
Total	**2,192.00**	**3,617.40**	**6,365.00**	**4,360.50**	**20,491.50**	**16,156.30**
Development expenditure	8,852.40	22,092.50	48,345.50	32,492.30	111,919.80	90,767.00
Per cent share	**24.76**	**16.37**	**13.17**	**13.42**	**18.31**	**17.80**

Numbers in parentheses are percentages *Source: Economic Survey, Ministry of Finance, 1998/99*

* First three years expenditure only + Includes bridges

priority. Furthermore, existing 'other modes' deteriorated due to the lack of government support and poor operation and maintenance. During the Ninth Five-Year Plan period, three ropeways, one each in Bhattedanda, Barpak and Kurintar, were built. The Manakamana Ropeway was built by the private sector; it is the only people carrier operating in the country. The government wrote off the services of the Nepal Ropeway (NR) in the last year of the Ninth Five-Year Plan period. A few months later the electrically-operated trolley bus between Bhaktapur and Kathmandu also stopped running. It was revived in October 2003 and now operates along a three-kilometre section between Tripureswar and Koteswar.

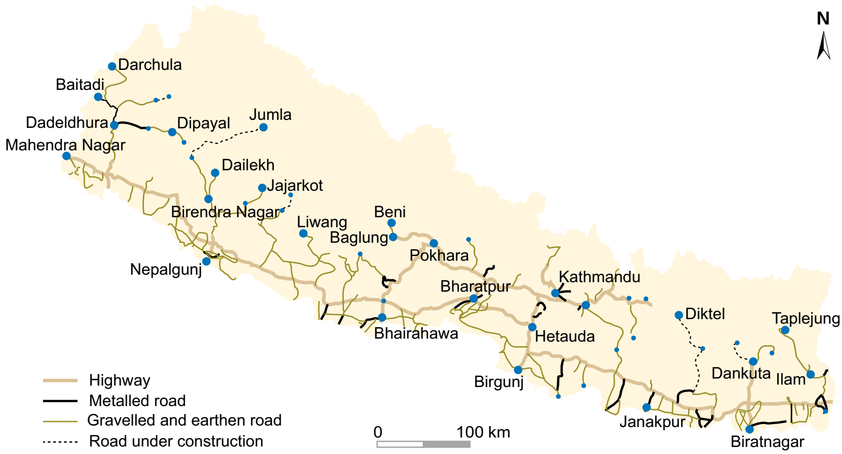
The completion of the Birgunj-Hetauda section of the Tribhuban Highway created competition for the Raxaul-Amlekhgunj Railway, which gradually fell into disuse. Road transport has, among other benefits, the advantage of enabling trucks to deliver consignments to the doors of dealers. Due to the additional loading and unloading costs that shipment by rail entails, the railway could not compete.

In the list of demands for development projects that local representatives put forward, roads are often at the top: local populations clearly aspire to improve access to their villages. Despite the dramatic extension of roads accomplished by the Five-Year Plans, many rural areas are still without access. The present level of growth in road construction, however, cannot meet the existing and latent demand for improved access, and civil aviation will provide too little support. Besides, though both these modes of transport ease the movement of people and materials, the country's poverty makes the problem of finding adequate resources a major hurdle.

One major challenge is the maintenance of completed roads. Another is improving their economic viability. Because the volume of traffic is low—less than 200 to 300 vehicles per day—most hill roads are economically unproductive; their under-utilisation makes them a liability rather than an asset. To make a road productive, movement on it must be increased; to do that a road must meet the demands of not only rural communities but also of other sectors of the economy. For example, the development of a feeder road system connected with a network of farm roads could help increase the area of influence of a highway and thereby promote its economic viability. Though being able to afford the cost of maintenance and rehabilitation is a challenge, more traffic would generate more revenue and thereby meet a greater proportion of maintenance costs.

This concept has gained acceptance and a programme of constructing feeder and district roads has been implemented since 1990. As a consequence, the total length of feeder and district roads increased by 10 and 34 per cent respectively from 1990 to 1998. The ratio of national highways to feeder/district roads was 1:1.95 in 1990, but rose to 1:2.91 in 1998, as shown in Table 2.5. Fifty-one feeder roads now

FIGURE 2.1
Road network in Nepal



Source: DoR (1995)

TABLE 2.5 **Development of roads by type after 1990 (km)**

Type of roads	Year 1990	Year 2000
Highway	2,111	2,974
Feeder	1,822	1,820
District	2,299	9,060
Urban	1,098	2,051
Total	**7,330**	**15,905***

* According to the Economic Survey (2004) the total length of roads in Nepal is 16,042 kilometres.

Source: DoR Nepal Road Statistics, NRS, 2000

connect different highways in the kingdom (DoR, 1995). Major road networks are shown in Figure 2.1.

Despite the promise of a feeder road system, limitations exist. If road systems branching out from main highways are insufficiently developed, feeder roads cannot generate enough traffic to be self-sustaining. Because the alignments of village roads are set according to political pressures rather than economic rationality, they are often inappropriately laid, insufficiently travelled and cost ineffective. In addition, the construction of these roads has not been environmentally friendly.

Green road technology has been adopted very recently as a major innovation in Himalayan road building. Green roads are built without using heavy equipment or blasting. Instead, they use labour-intensive methods to widen a road over a four-year periods: after a track is opened, trees and other vegetation are planted and retention walls are built at strategic points. Cut material is used for filling rather than being dumping over the side. The objective is to stabilise slopes naturally. Green roads include the Tansen-Arghakhanchi and the Arya Bhanjyang-Rampur roads in Palpa District, the Dhading-Malekhu Road in Dhading District and the Galyan-Chapakot Road in Syanja District. Some green roads have been implemented with donor assistance. The German government built two: the 52-kilometre Besi-Salyantar-Sanetar and the 24-kilometre Bhimdhunga-Lamidanda roads in Dhading District (GTZ, 1991). The Swiss have helped in Palpa. These roads have met the transport needs of hinterland areas although the green approach to road building places limitations on the type of vehicles which can be used and the loads they can carry. Low-cost green roads are ideally open to traffic only in the dry season and heavy loads are debarred. Failure to impose these regulations results in an astronomic rise in maintenance costs.

In the Ninth Five-Year Plan period, HMG/N created the DoLIDAR under the Ministry of Local Development (MLD) in order to promote rural roads and thereby agriculture development. Linking rural agriculture roads to feeder roads, district roads and national highways are expected to increase the density of traffic on existing roads.

In the past, the national transportation development policy did not take into consideration all modes of transport. Instead, it was biased towards promoting road and air transportation systems. The implementation of green roads combined with local ropeway development would be an exciting new approach. In addition, the development of ropeways can be planned to complement roads and airports and thereby reduce the cost of developing the overall transport infrastructure. A ropeway is a viable alternative to a road if one compares their financial and environmental costs. Ropeways can make use of roads or even airfields and helipads which have already been constructed in remote areas. Ropeways (simple, short, valley-bottom-to-ridge-top type) can promote agriculture, forestry, dairy farming, mining, cottage and small-scale industry and local tourism.

As a result of an institutional gap, the ropeway as an alternative mode of transportation was not pursued in Nepal in the past. There is no separate department with responsibility for developing ropeways and railways, and the unit in the Ministry of Works and Transport (MoWT) which was assigned this task was ineffective in putting forth any programmes to develop these alternatives. The potential for ropeways is high, though it must be borne in mind that a ropeway transport system would require a very different approach from that used in the past. The following sections discuss why the past approaches led nowhere and what a new planning approach might look like.

NATIONAL PLANS AND POLICIES FOR ROPEWAY

Since ropeway transport can make a positive contribution to rural economies, previous national development plans, particularly those from the Fifth Five-Year Plan onwards, incorporated policies and programmes for improving and extending the existing ropeway services. With grant assistance from the US government, the old 22-kilometre-long, low-capacity mono-cable system operating between Dhorshing and Kathmandu was replaced and extended during the Second Five-Year Plan period with a 42-kilometre-long bi-cable ropeway operating between Hetauda and Kathmandu. The ropeway was owned by HMG/N and operated by NR under the parastatal Nepal Transport Corporation (NTC). No other ropeway lines were introduced although some repair and maintenance as well as rehabilitation work was undertaken.

The Sixth Five-Year Plan proposed developing gravity ropeways in the hills and mountains in order to transport daily necessities. The plan also aimed to initiate arrangements for constructing the Surkhet-Dailekh section of the proposed Surkhet-Jumla Ropeway. Restoring the original carrying capacity of the NR was also mentioned. Although six million rupees was allocated for ropeway development, nothing except the strengthening of the NR happened. The Surkhet-Dailekh Ropeway could not be constructed for two reasons: there was neither a reliable supply of electricity nor any donor assistance.

The Seventh Five-Year Plan also included a programme for developing ropeways and specified policies for building gravity ropeways. This programme aimed to involve private entrepreneurs in ropeway development. However, no tangible achievement was made during this plan period either, other than that some money was spent on the routine maintenance of the NR.

The Eighth Five-Year Plan, which came with the restoration of multi-party democracy, included a programme for developing ropeways under the sub-sector ‘other modes of transport’. The Plan’s ropeway development policy stated that existing ropeways would be consolidated and operated at full capacity, that the private sector would be encouraged to develop short-haul ropeways for promoting tourism and that the public would be mobilised in developing gravity ropeways. The Plan’s objective was to develop a ropeway system in line with the overall objectives and policies of the transport sector. Programmes such as the construction of the Surkhet-Jumla Ropeway, the installation of gravity ropeways on an experimental basis and the consolidation and renovation of the NR were included. For these purposes the Plan allocated 158 million rupees. A study of Surkhet-Jumla Ropeway was carried out but it did not go beyond that. Some investments in renovating the NR, which was still operating then, were made, but the installation of gravity ropeways was not initiated.

The Ninth Five-Year Plan included a policy for developing ropeway transport systems which would support tourism with private sector involvement. The Plan was committed to a twenty year National Transport Master Plan that included a cable car/ropeway development programme. It stated that actions would be initiated to privatise the NR so that it could be operated more effectively. During the first three years of the planning period, the NR was repaired and maintained. At the same time, a high-level committee in the MoWT was constituted to see to its privatisation. An environmental impact assessment (EIA) study of the Birethanti-Jomsom Cable Car Ropeway was approved and the three-kilometre-long Manakamana Cable Car was completed by the private sector. The government also granted permission to the private sector to construct and operate a cable car in Sworgadwari, Pyuthan District. Nevertheless, no substantial achievements were made regarding these pronouncements.

The approach paper of the Tenth Five-Year Plan (2002-2007) states that policies for developing ropeway transportation will be adopted. The Plan aims to encourage private entrepreneurs to construct and operate cable car/ropeways in places with importance for tourist and local economies where road access is lacking. The Plan mentions that priority for cable car/ropeway development would be accorded to those areas where the cost of constructing and operating roads would be comparatively high.

In sum, though policies and modest-scale programmes were incorporated in Nepal's Five-Year Plans, ropeway development has remained stagnant over the last four decades. Its potential to become an important segment of the country's transport system has not been realised.

POLITICAL PARTIES AND THEIR THINKING ON ROPEWAYS

The restoration of multi-party democracy in 1990 brought political parties espousing various ideologies into the mainstream; and it is enlightening to compare the commitments articulated by various political parties regarding ropeways. Since 1990, the country has held three general elections (in 1991, 1995 and 1999). A fourth one, a mid-term poll, was to be held in November 2002 but was postponed due to the Maoist insurgency. In the last twelve years, all major political parties—the Nepali Congress (NC), the Communist Party of Nepal United Marxist-Leninist (CPN/UML), the Rashtriya Prajatantra Party (RPP) and the Nepal Sadbhavana Party (NSP)—have had a stint in the government singly or in various coalitions. Since 1991, political parties have suffered internal polarisation and some have even split. The CPN (United Marxist Leninist), for example split into the CPN (UML) and the CPN (Marxist-Leninist), which went their separate ways but re-united with a smaller dissident faction still remaining separate. The RPP separated into the Thapa and Chand factions but the rift has since outwardly healed. The split of the Nepali Congress party still exists; Girija Prasad Koirala and Sher Bahadur Deuba lead the two factions. The NSP has also split into two factions.

All political parties agree that progress in transportation is essential for the country's overall development and all emphasise this need in their respective manifestos. However, only a few political parties call for the improvement and extension of existing ropeways. In its manifesto of 1991, the CPN (UML) committed itself to extending ropeway service with the electrification of hill settlements. Four years later, in its election manifesto of 1995, it claimed that 'the existing operation of railway, ropeway and trolley bus services will be improved, renovated and extended'. While the NC mentioned nothing specific about the development of ropeways in its election manifesto of 1991, it did promise to develop electric-powered transport services such as trolley buses and railways in feasible locations. This commitment was also reiterated in the party's manifesto of 1995. The manifesto of the Nepal Majdoor Kisan Party (NMKP) mentioned its commitment to developing ropeway transport in remote parts of the country where the construction of roads could take time. The RPP did not mention ropeway development at all.

National-level political parties seem to feel that ropeway development is necessary and, at least in theory, accord priority to its development using electric power obtained from locally available hydropower resources in the hills. The reality, however, is different. No political party in power has translated commitments on paper into action. In fact, when the operation of the trolley bus ceased, no political party—neither those in power nor those on the opposition bench—showed any concern.

The political instability characterising the post-1990 framework is one of the primary reasons the condition of existing ropeways has deteriorated and the development of this mode of transport has failed to progress. Another factor has been the lack of pressure from district-level functionaries. For example, District Development Committees (DDCs) have never put forward proposals for developing ropeways; they have been more concerned about building roads and bridges. In addition, the majority of hill people and communities have not seen the benefits that could accrue from ropeways: they have not been shown examples of successful ropeways that could ease their problems in terms of transporting goods. Local communities, concerned agencies and entrepreneurs are unaware of the success of Manakamana Cable Car and the Bhattedanda Ropeway. The Barpak Ropeway was also successfully operated for fourteen months before its hauling cable snapped. Though it may take time, promoting mass awareness about the benefits of ropeways must be pursued with zeal.

CONCLUSION

Communities in the hills and mountains of Nepal must be provided with easy and affordable transport systems that provide them access to the larger market. Ropeways should become one more component of broad-based rural transport systems comprising trails, suspension bridges and unmetalled and green roads. Short haulage ropeways can complement rural transport systems by meeting local transport needs at affordable costs. Ropeways are end-use opportunities which can improve the performance of MHPs.

In fact, the spread of decentralised micro-hydropower to remote areas provides a suitable environment for developing ropeways as well as for reducing the use of imported petroleum fuels. Ropeways have fewer detrimental impacts on local environments than roads do. Ropeway development not only supports hydropower but it can also be linked to the development of suspension bridges.

In this connection, it is instructive to examine the place and an implementation of suspension bridges in Nepal's Five-Year Plans . Although building bridges to cross deep river gorges started in the First Five-Year Plan itself, this programme was pursued vigorously with specific targets from the Second Five-Year Plan onwards. From a target of 30 bridges then, it reached a target of 400 in the Ninth Five-Year Plan. The central Suspension Bridge Division (SBD) constructed 495 suspension bridges between 1964 and 1999 while the decentralised Bridge Building at the Local Level (BBLL) programme constructed 644 suspension bridges between 1989 and 2000 (Joshi *et al*., 2003). Besides BBLL and SBD, many other agencies are also involved in building suspension bridges. As of 2001, a total of 2,487 trail bridges had been constructed in 61 districts across the country (Helvetas, 2001). The cost per metre of span for a community bridge (CB) and for a long-span trail bridge (LSTB) were about Rs 13,500 and Rs 27,000 respectively. The material costs of a LSTB, including the steel cable and components, were about 40 per cent of the total costs, whereas for CB they constituted 38 per cent. Transportation and construction costs for LSTB was 48 per cent of the total costs, whereas for a CB it was just 23 per cent. Technical engineering support cost two and four per cent of the respective totals. Labour during installation, both skilled and unskilled, constitutes about 35 per cent of the cost of a CB (Helvetas, 2002).

The government must begin promoting ropeways with at least as much emphasis as it has placed on suspension bridges and MHPs. To support the development of micro-hydropower programmes, for example, institutional arrangements such as the Alternative Energy Promotion Centre (AEPC) and the UNDP's Rural Energy Development Programme (REDP) exist. Pilot projects with institutional innovations can provide useful insights, but at the same time, the establishment of an appropriate agency that can help private entrepreneurs and community groups to invest in ropeway development must follow. Local governments must play an important role in the initiatives; they must take a leading role in incorporating ropeways into their development plans as well as act as pressure groups on the national government.

Initiatives must be supported by appropriate policies, rules and regulations, subsidy regimes, tax incentives and credit financing, all of which will encourage Nepali and foreign investors to install ropeways. Equally important are institutional arrangements that provide support to potential entrepreneurs. The creation of infrastructure such as suspension bridges, transmission lines or micro-hydro as well as survey and engineering capabilities need to be part of any package promoting ropeways. To this end, the following suggestions about a different approach to planning rural transport in Nepal are made:

1. The government should include ropeway transport as one of its priority areas for investment. Projects that have regional or national importance must be included in Five-Year Plan documents themselves.
2. Short haulage or other types of ropeways that cater to rural communities must be accorded priority.
3. An appropriate institution that supports ropeway development needs to be established.
4. Both the private and public sector need to be involved in ropeway development.
5. Incentive packages need to clearly spell out rules and regulations that facilitate investment. If needed, donor support must be sought.

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The Study of Ropeways:
A Review of Past Efforts

URMILA SHIMKHADA AND DRONA UPADHYAYA

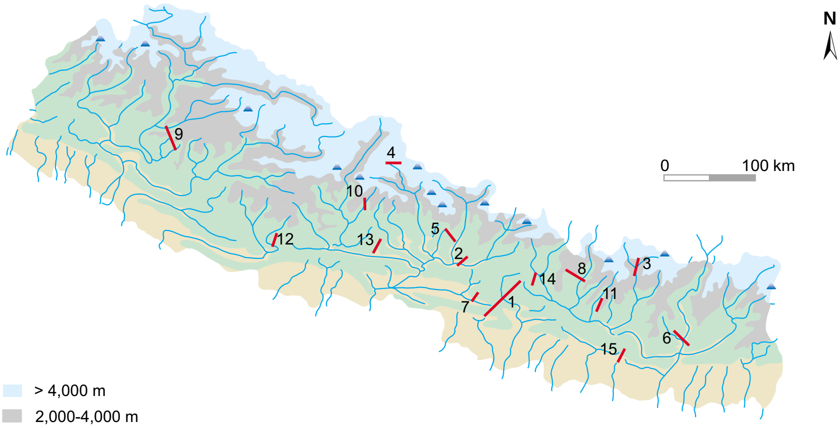
This chapter summarises the many studies on ropeways that have been conducted in Nepal since the 1970s. Many reports are difficult to locate and some cannot be traced at all. Of the studies available to us, the majority focused on long-distance passenger cable cars; very few focused on short systems for transporting goods. The studies of the Bhattedanda and Manakamana ropeways are not included in this review as they are the subject of separate chapters of this book.

This chapter is not meant to be an exhaustive compendium; instead, what it examines are the assumptions that past studies made. By summarising the key data of the analyses in this chapter we hope that it will help those interested in promoting ropeway systems to understand the context within which the planning of earlier ropeway ventures in Nepal took place. The locations of the projects described in the reports reviewed are shown in Figure 3.1.

HISTORICAL DHORSHING-MATATIRTHA ROPEWAY[1]

The English writer-traveller Perceval Landon came to Nepal during the reign of Chandra Shamsher and left a fascinating account of road and ropeway building in Nepal. His observations are reproduced below, as they seem instructive for today's development planners in Nepal. While constructing the Raxaul-Bhainse-Dhorshing Road, English engineer R. S. Underhill wrestled with the same problems that face Nepali planners today. They include the impracticality of constructing roads on steep stretches of mountain terrain, local superstition, the need for developing hydropower to power ropeways and other development reforms. Landon's account also provides

FIGURE 3.1
Location of ropeways studied



- > 4,000 m
- 2,000-4,000 m
- 500-2,000 m
- < 500 m
- Rivers
- Mountain
- Ropeway studied

1. Hetauda-Kathmandu
2. Manakamana
3. Namche Bazar (Bhote Kosi-Namche)
4. Muktinath
5. Barpak
6. Chatara-Bhojpur
7. Hetauda Cement Factory
8. Nepal Orind Magnesite
9. Dangargaun-Kalikot Jubitha
10. Sikha Valley (Sikha, Paudar, Kibang villages)
11. Khimti
12. Jhimruk
13. Andhikhola
14. Bhattedanda
15. Udayapur Cement Factory

Not all ropeways shown here have been reviewed because some of the reports were not available. The length of the blue line is only symbolic and not to scale.

enlightening insights into Chandra Shamsher's views on balancing strategic national security (maintaining Nepal's isolation) with the benefit of cheap rice for the Kathmandu Valley that an access road would provide.* Landon (1928) writes,

> *'After Bhimphedi the road crosses the two passes Sisagarhi and Chandragiri, the steepness and roughness of which have been referred to more than once.** Any improvement of this road to correspond with the lower sections was found to be possible only at an immensely heavy outlay, and the Government did not leave out of account the fact that the severity of the track-and it is not in most places-was a traditional method of making access to the Valley from India less easy than*

* According to Landon (1928), 'Messrs. Martin and Co. of Calcutta surveyed these two sections in the winter of 1924 and have submitted a tender for the construction of a light railway from the frontier to Bichako. No decision has been made as yet as to the advisability of connecting up the Indian system with these advanced posts in Nepal. In the present attitude of Nepal Government the railway would not be allowed to penetrate the country farther than Suparitar. It is understood that the Maharaja himself is inclined to favour the scheme under proper safeguards, and it certainly would have the effect of largely reducing the cost of the freight of Nepal's exported mineral wealth and her imported rice. In connection with the proposal to construct this railway the Maharaja has always associated its advisability with the need for reducing the high rate of rice, the main sustenance of the inhabitants of the Valley of Katmandu. But Nepal thinks of other things than its material wealth'.

** *Mr. Underhill in his report of 1922 says that at both Bhimphedi and Thankot 'the roads terminate abruptly at mountains which rise up like walls for some 900 metres so steeply that it is impracticable to make any cart road over them.'*

*it might otherwise be. After long consideration the Government decided that if possible an aerial ropeway should be constructed so as to facilitate the transit of goods over these passes to and from Kathmandu, without in any way opening up for passenger traffic the new avenue into the capital. The Maharaja took up the question as far back as 1904. It was not at first considered a satisfactory expedient; and it was, perhaps, the very great improvement in this manner of transport which had been effected by the Italians during the Great War that induced the Maharaja to return to his original proposal. At this moment the ropeway is an accomplished fact between Kathmandu and Bhimphedi.*** The magnitude of this work, which is estimated to be about £100,000, will be seen from the details, which Mr. R. S. Underhill, the engineer in charge, has been kind enough to give me.*

The Nepal Ropeway is 14 miles long as the crow flies, running from Dhursing near the head of the cart road which connects it with British India, to Kisipidi in the Valley of Nepal. It passes over mountains 4,500 feet higher than Dhursing, and its terminal at Kisipidi is 930 feet higher than that place.

It carries general merchandise in average loads of 5 cwt., at the rate of 8 tons per hour in either direction, and the heaviest individual load permissible is 10 cwt.

The Ropeway comprises seven sections, each being a complete unit in itself, driven by an electric motor. By the addition of further sections the Ropeway could be extended indefinitely.

Each section comprises a single endless wire rope 7/8' thick and of 29 tons strength, which passes round a horizontal wheel 10 feet in diameter at each end of the section. An electric motor drives one of these wheels through suitable gearing, and thus causes the rope to travel continuously at 4 ¼ miles per hour. The loads are hung from clips on this rope at regular intervals 240 yards apart, and travel with the rope; loads going up to Kisipidi on one side, and travelling down to Dhursing on the other.

The rope is supported by sheaves running on ball bearings carried on cross-arms at the top of 106 steel trestles, which vary in height from 12 feet to 100 feet, to suit the configuration of the ground. The largest span between two trestles is 1,300 yards.

At the end of each section the clips automatically disengage from the wire rope, run along an overhead rail through the station, and then

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*** *The Ropeway was supplied by Messrs. Keymer, Son and Co., of London, with Messrs. R. Pearson and A. J. Knight as Consulting Engineers.*

engage with the rope of the next section; so that a load can travel continuously from end to end of the Ropeway.

The power required to drive the Ropeway when fully loaded is about 80 horse power.

The trestle foundations were commenced early in 1922. Railway strikes in India hindered deliveries of materials, so that trestle erection was not started until March 1923. The first 3½ miles, comprising three sections of the steepest part of the line, have recently run a full load test satisfactorily, and the whole Ropeway is expected to be completed by midsummer 1925. Weather conditions permit of erection work being carried on for six months of the year only.

(Signed) R. R. Underhill.

Landon mentions that some difficulty was experienced by the engineer in constructing the supports for the ropeway. It was believed that the opening was to be celebrated by the immolation of children at the foot of the ropeway's trestles, and in some cases he found villages emptied as he approached them.[2] Landon further writes:

For travellers the route from India to Kathmandu consists of a cart road for fifty-one and a half miles from the frontier to Bhimphedi; a mere track eighteen miles long over two steep and very difficult passes from Bhimphedi to Thankot, and thence by a fairly good cart road through the Valley from Thankot to Kathmandu, a distance of about seven miles.

The electricity needs of the capital-and incidentally of the ropeway-are supplied by a fine installation near Pharping. This project was completed in 1911. The difficulties of the work may be understood from the statement of Mr. Bernard Pantet, the engineer in charge of the works, that eight and a half millions of cubic feet had to be removed and the Kali stream diverted. In the excavation of the reservoir a good deal of especially troublesome rock had to be cleared. The reservoir holds five hundred and twenty-eight thousand seven hundred and eighty-three cubic feet of water. The main pipe line is two thousand five hundred and thirty-eight feet in length, and the pressure of water at the power-house end is two hundred and eighty-eight pounds per square inch. The transmission line is seven miles in length, and it twice crosses the Bagmati by spans of nine hundred and six hundred feet respectively.

It is interesting to note that the power rate has been kept at a figure which London men may envy-two annas per unit. It need hardly be added that the supply of electricity at Kathmandu has suggested and been the means of carrying through a large number of the reforms of the past fifteen years.

CEDA'S CHATARA-BHOJPUR ROPEWAY STUDY[3]

The main objective of CEDA's feasibility study was to examine transport requirements between Chatara and Bhojpur and to assess the demand for a ropeway. The study, which was conducted in 1972 for the MoWT, used questionnaires to derive preliminary investigation results and cost estimates. Questionnaires were administered to five different categories of informants—households, businessmen, people on the trail, people's representatives and government officials—living and working on the proposed route. Based on the information collected, estimates were made of the income and expenditure of the people, annual trade, volume of traffic and destination of travel, as well as the need for future investments at the local level. The total demand for the transport of goods by ropeways was categorised as import demand, export demand and generated demand; it was presumed all would grow when the ropeway was completed (Table 3.1).

TABLE 3.1 Demand for the transport of goods between Chatara and Bhojpur (mt)

Demand	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Import	3,762	3,892	4,026	4,163	4,307	4,455	4,608	4,786	7,950	5,120	5,290	5,464
Export	353	369	385	401	419	437	457	479	501	526	552	579
Generated	0	0	25	28	31	35	39	45	51	62	75	89
Total	**4,115**	**4,261**	**4,436**	**4,592**	**4,757**	**4,927**	**5,104**	**5,310**	**8,502**	**5,708**	**5,917**	**6,132**

It was assumed the proposed ropeway would operate seven hours a day and 275 days a year. A mono-cable system with a hauling capacity of four tonnes per hour and a carrying capacity of 150 to 200 kilogrammes per trip was recommended. Using operation and maintenance costs based on those of the NR, the total benefit from the ropeway was estimated to be Rs 728 per tonne. The study did not include benefits likely to be generated from exports because they could not be ascertained. The net benefit and the total present worth of the ropeway were calculated using eight per cent and ten per cent rates of return. The total worth of the proposed ropeway at a discount factor of eight per cent was Rs 17.4 million and at a discount factor of ten per cent, Rs 15.2 million (Table 3.2). The study recommended that investment be made if the cost of ropeway installation was less than these values for a given rate of return. It did not specify whether the investment was to be private or public. The study found that import and export demand was increasing each year and was expected to increase in the future as well. The demand likely to be generated as a result of the ropeway's operation was said to be insignificant.

When the study was done, there was no modern transport network connected to these areas. The nearest point, Chatara, was at least a one-day walk from the

TABLE 3.2	Net benefit and present worth of the Chatara-Bhojpur Ropeway (Rs x10^3)					
					Present worth	
Year	Demand	Benefit	O and M	Net benefit	8 per cent	10 per cent
1974	4,051	2,949	1,500	1,449	1,341	1,317
1975	4,191	3,051	1,500	1,551	1,329	1,281
1976	4,338	3,158	1,500	1,658	1,316	1,245
1977	4,490	3,269	1,500	1,769	1,300	1,208
1978	4,647	3,383	1,500	1,883	1,282	1,169
1979	4,831	3,517	1,500	2,017	1,270	1,139
1980	5,001	3,641	1,500	2,141	1,248	1,098
1981	5,182	3,772	1,500	2,272	1,226	1,058
1982	5,364	3,905	1,500	2,405	1,202	1,019
1983	5,553	4,043	1,500	2,543	1,177	979
1984	5,553	4,043	1,500	2,543	1,090	890
1985	5,553	4,043	1,500	2,543	1,009	811
1986	5,553	4,043	1,500	2,543	935	737
1987	5,553	4,043	1,500	2,543	486	669
1988	5,553	4,043	1,500	2,543	801	608

road head at Dharan. The report suggested that the Chatara-Bhojpur Ropeway would serve the transport needs of many places in the eastern hills.

ESCAP'S KATHMANDU-HETAUDA CORRIDOR STUDY[4]

The 31st Session of the Economic and Social Commission for Asia and the Pacific (ESCAP), held in New Delhi from 26 February to 7 March, 1975, promised further action on a project related to the conversion and extension of the rail link between India and Nepal. A joint roving team of ropeway, railway and highway experts had completed a preliminary survey in 1971. This survey included a pre-investment study for converting the railway line between Raxaul and Birgunj from narrow to meter gauge. It also completed comparative studies to assess the techno-economic viabilities of three possible modes of transport: railway, ropeway and highway. The study evaluated the transport requirements of the Raxaul-Kathmandu corridor as well as the most suitable mode of transportation for the expected growth in traffic. It suggested an optimal combination of different modes of transport. The survey identified three possible types of transportation systems for the Raxaul-Kathmandu corridor. They were, in order of decreasing order of preference, a ropeway, an extension of the proposed Raxaul-Hetauda meter gauge railway to Kathmandu, and a road. In assessing the three alternatives the following factors regarding existing transportation facilities were considered.

The NR carried a maximum of 38,883 tonnes in 1972/73 compared to its design capacity of 152,000 tonnes per year (Table 3.3). Even with delays, several stoppages,

TABLE 3.3	Forecast of goods to be transported along the Hetauda-Kathmandu corridor (mt)				
Year	**Up**	**Down**	**Year**	**Up**	**Down**
1975/76	250,000	70,000	1988/89	458,771	370,555
1976/77	260,000	72,800	1989/90	475,422	375,218
1977/78	270,400	75,712	1990/91	492,739	380,066
1978/79	281,216	78,470	1991/92	510,748	385,109
1979/80	292,465	81,890	1992/93	529,478	390,353
1980/81	304,164	85,166	1993/94	548,957	395,807
1981/82	316,331	88,572	1994/95	569,215	401,480
1982/83	328,984	92,115	1995/96	590,284	407,379
1983/84	342,144	95,800	1996/97	612,195	413,514
1984/85	398,129	350,632	1997/98	634,983	419,895
1985/86	412,563	357,617	1998/99	658,682	426,531
1986/87	427,366	361,762	1999/00	683,330	433,432
1987/88	442,761	366,072			

Up: Hetauda to Kathmandu
Down: Kathmandu to Hetauda

breakdowns and so on, the ropeway should have been able to carry at least 62,160 tonnes per year. But due to organisational and technical difficulties in its operation as well as to the poor shape of its carriers, frequent derailments and grip defects, the ropeway was under-utilised. Its sub-optimal use led to high operational costs.

The cost of road transport between Hetauda and Kathmandu was calculated at Rs 158.79 per tonne, which was almost one-and-a-half times higher than even the highest costs per tonne incurred by the NR.

The study assumed that agriculture, industry and community development activities would increase significantly in the years ahead. At that time, HMG/N had plans to establish a cement factory in Hetauda and a lead and zinc factory in Rasuwa; because of the increased cargo load their establishment would entail, it was assumed that demand for transport would rise rapidly. The forecast was for a dramatic increase in traffic after 1984-85 (Table 3.4).

The report proposed that a new ropeway be built between Hetauda and Kathmandu to replace the existing one. The system was to have six hundred carriers

TABLE 3.4	Hetauda-Kathmandu Ropeway traffic and operating costs 1970-1975		
Year	**Operating cost (Rs × 10^3)$^+$**	**Goods carried (t)**	**Cost/t (Rs)**
1970/71	2,238	33,123	67.26
1971/72	2,423	33,190	73.00
1972/73	4,151*	38,883	106.76
1973/74	4,006*	37,642	106.42
1974/75	3,530*	29,356	120.25

$^+$ includes depreciation
* includes rehabilitation expenditure

with a payload capacity of 2.5 tonnes and to run at ten kilometres per hour with an operating speed of 60-second intervals between carriers. The annual hauling capacity was to be 294,000 tonnes and its total cost was estimated to be about US$ 37.8 million. Building a 95-kilometre railway line with tunnelling through the Mahabharat mountains was found to be technically possible but expensive. The initial investment was projected to be about US$ 126.4 million and the annual interest, even at the rate of 10 per cent, about US$ 12.6 million, or a third of the cost of the entire new ropeway proposed. Its capacity was to be 500,000 tonnes each way per year.

Developing a railway link between Hetauda and Kathmandu was deemed economically unfeasible for at least 15 years. The study suggested that another investigation be made 20 years later (circa 1989/90) to explore whether or not a railway link would be needed to handle traffic if it increased drastically more than was anticipated. The study also calculated the spillover load to be carried by trucks. Since the proposed ropeway would have a practical annual hauling capacity of 205,800 tonnes (i.e. 70 per cent of its 294,000-tonne capacity), it would be a little short of the expected load of 225,000 tonnes by 1989/90. To handle the additional 19,200 tonnes would require the daily movement of nine trucks.

The report also provided suggestions for upgrading the Hetauda-Kathmandu Ropeway. It identified the following two reasons for the low output of the ropeway:

1 The shortage of carriers caused low output per hour of operation. The average number of carriers despatched per hour was 29.5 (i.e. 74 per cent of the designed 40 carriers per hour) in 1974/75, while in 1975/76 it was only 28.
2 The high shutdown rate resulted in a short operating time each day. About 67 per cent of all shutdown time in 1974/75 was due to technical problems, while the lack of goods accounted for another 16 per cent and the overflow of goods in the warehouse for 13 per cent.

The report recommended increasing the capacity of the warehouses in Hetauda and Kathmandu to 4,000 cubic metres so that at least two days of cargo could be accommodated and there would be enough time to rectify faults. In addition, the study recommended building a repair workshop to carry out regular maintenance such as restoring worn-out grooves and shafts and fixing the damaged bearings of carrier running wheels and the rope suspension wheels. The workshop was to be equipped with a lathe, a milling machine, a boring machine, an electric grinder, a welding machine and manual instruments to fix worn-out grip devices, station rails, damaged carriers and forklifts, car obstacles and so on.

The study also explored the possibility of installing a five tonne container ropeway. It seemed theoretically possible to construct a heavy ropeway to transport goods directly from Raxaul to Kathmandu using the five tonne containers of the Indian Railways, but this proposal was not recommended for reasons of safety and design. The study noted some technical difficulties involved in carrying heavy loads, such as the need for a two-track rope system with running wheels to disperse the loads and for two separate ropes carrying two carriers to transport a single heavy load. The final recommendations of the study were as follows:

- Installing a new ropeway system with an individual carrier capacity of 2.5 tonnes each on the section between Hetauda and Kathmandu.
- Constructing a ropeway-cum-railway terminal at Hetauda within a single complex with the shortest possible transit distance between ropeway and railway to expedite the transhipment of goods from rail to ropeway and *vice versa*.
- Enacting legislation, if necessary, to ensure that all government cargo which could be transported by ropeway was in fact transported by ropeway.
- Carrying out training programmes for staff in the operation of the proposed rail and ropeways.
- Undertaking a detailed survey of the railway line from Hetauda to Kathmandu and a feasibility study of a new alternative highway a few years before the ropeway reached its saturation point in the same corridor in order to choose the best mode, from the techno-economic point of view, for meeting the growing demand.

UNIDO/ESC'S BHIMPHEDI-THANKOT STUDY[5]

In 1992, Economic Services Centre (ESC) conducted another study to assess the feasibility of establishing a cable car system in the Bhimphedi-Thankot sector of the existing NR. The study focused on the number of passengers travelling in and out of Kathmandu and Hetauda. The annual flow of vehicles travelling in and out of Kathmandu in 1992 is given in Table 3.5.

The total number of passengers travelling by bus into or out of Kathmandu was estimated to be about 15,125 per day. It was assumed that 80 per cent of them (i.e.

TABLE 3.5 Flow of vehicles into and out of Kathmandu in 1992

Annual	Night bus	Day bus	Govt. bus	Private vehicle	Project vehicle	Truck/tanker
Incoming	33,068	11,170	5,397	12,603	6,868	75,979
Outgoing	33,509	13,000	5,432	19,907	7,604	72,732

12,100) travelled to or from the eastern sector. Thus, the potential passengers using the proposed cable car was estimated at around 12,100 persons per day.

The study mentioned that if adequate facilities such as restaurants, hotels, resort complexes, recreation centres, national parks and open museums were provided, the cable car would set a trend in the tourism industry. Initiating the project seemed to be a difficult proposition, however, because it was capital intensive, the places it served were isolated and the route was long. Table 3.6 gives insight into the financial viability of the project.

TABLE 3.6 Financial viability of the Hetauda-Kathmandu Cable Car project

Financial viability	Capacity utilisation (per cent)			
	70	80	90	100
Current ratio	14.48	13.92	13.47	13.10
Return on equity	5.13	9.75	14.95	20.16
Return on investment	11.65	13.02	14.16	15.29
Profit as per cent of sales	5.90	11.21	17.20	23.20

STUDY FOR PRIVATISING NR[6]

A pre-feasibility study was initiated in 1986 to improve the capacity of the Hetauda-Kathmandu Ropeway and to find ways of handing it over to the private sector for operation. Multi-Disciplinary Consultants (MDC) completed the study in 1987. The objectives of the study were to find technical ways to enhance the NR's operational efficiency, to prepare a proposal for increasing its capacity to 100 tonnes per hour and to formulate conditions for leasing out ropeway operations. The study's main findings were as follows.

- Although more than 6,134 kilometres of roads were built across the country between 1951 and 1985, road planners did not give due attention to north-south linkages because of the difficult terrain they would have encountered.
- Road traffic between Kathmandu and Hetauda or via Hetauda to other destinations was dominated by cargo. Studies at various locations along the Kathmandu-Birgunj corridor carried out at different times found that trucks destined for Kathmandu were overloaded, whereas those returning were either empty or only partially loaded.
- In 1987, the daily traffic in each direction was about 209 trucks. The total cargo import to Kathmandu was about 2,585 tonnes daily.
- An origin/destination traffic survey carried out at Naubise in 1985 showed that nearly 95 per cent of the total traffic to and from Kathmandu

originated at destinations beyond Mugling. The study revealed that about 30 per cent of the total traffic that passed through Naubise had Birgunj/ Raxaul as their destination.

- The study indicated that Hetauda was the central point of traffic movement. Nearly 60 per cent of the total vehicles using Hetauda as a transit to and from Kathmandu were destined for either Birgunj/Raxaul or for Hetauda/Amlekhgunj.
- After 1986, with the commissioning of the Hetauda Cement Factory, the movement of cargo between Hetauda and Kathmandu increased. The total cargo movement from Hetauda increased to nearly 63.5 per cent of the total cargo movement to Kathmandu. Traffic between Kathmandu and the eastern part of the country constituted only 11.5 per cent of the total.
- The study considered the possibility of extending the existing road network. The rehabilitation of Kanti Rajpath, which was aligned via Bhattedanda, could have had an adverse impact on the NR, but the study predicted this could not be likely within the next 10 years.
- The study also analysed the status of the NR and found that it had incurred annual losses of Rs 2,564,000, Rs 3,041,000, Rs 3,439,000 and Rs 3,025,000 respectively in each fiscal year from 1982/83 to 1985/86.

The Board of Directors of NTC, which governed the NR, consisted of members of both government and semi-government organisations. The government believed that the board represented the users of the NR. National Trading Limited (NTL) and Agriculture Input Corporation (AIC), which had a monopoly on importing cement and fertilisers into Nepal, were represented on the board. Surprisingly, neither agency provided any business to the Ropeway. Instead, they used their own trucks or arranged for private companies to transport their cargo. Not only the board but also the ropeway management committee was apathetic towards its commercial operation.

The study estimated that Rs 9.8 million would be required to rehabilitate the existing system. The total cost included the improvement of the ropeway system (Rs 5.9 million), the electric supply and communication system (Rs 2.7 million), the material handling system (Rs 0.5 million), and office facilities (Rs 0.4 million), as well as pre-operational expenses (Rs 0.3 million). The financial analysis showed that the tariff rate per tonne would decline from Rs 225 to 180 if the working capacity were increased from 60 to 80 per cent. Assuming that the system would function at a capacity between 60 and 70 per cent, the report argued, tariff structure would settle around Rs 200 per tonne.

The study proposed four institutional modes for privatising the Hetauda-Kathmandu Ropeway: (a) making it a semi-public enterprise, (b) turning over management control, (c) selling out, or (d) leasing. The study presented the terms and conditions for leasing the NR and conducted a pre-feasibility assessment of the upgrading of the existing system to 100 tonnes per hour by changing its speed, carrier spacing and payload. It was found that the load on the existing system could be doubled but only by implementing major changes. As a result, this option was considered unfeasible.

The study suggested that a detailed study on the possibility of extending the system to Birgunj, Hetauda Cement Factory, Himal Cement Factory and other feasible locations be carried out.

MoWT'S KHAIRENI-MANAKAMANA CABLE CAR STUDY[7]

In 1988, in line with its plans to promote electricity-based transportation and to diversify tourism development, HMG/N carried out a study to establish a cable car system between Khaireni and Manakamana. The main objective of the study was to understand the socio-economic and technical feasibility of a cable car system designed primarily to handle passengers

Since information from secondary sources was unavailable or inadequate, the study was based on primary data collected from the field. The estimated cost of the electro-mechanical components was based on an existing ropeway in Nainital, India and on the Orind Magnesite Ropeway, Lamosangu, at the prevailing market prices.

Since the study was carried out during the slack season, peak traffic estimates were based on local information. The study estimated that during the peak traffic months (November-March) 1,100 people visited the temple on slack days (Sunday-Thursday) and 2,100 on peak days (Friday and Saturday). During the slack months, the average number of people visiting the temple on a slack day was 89 and on a peak day, 352. The weighted average annual traffic was estimated to be about 207,000 (Table 3.7).

The study included a traffic growth forecast based on interviews with lodge and hotel owners and on the experience of Nainital Cable Car. It analysed the increase

TABLE 3.7 Number of people visiting Manakamana as estimated in 1988

Days	Unit	November-March	April-October	Total
Friday-Saturday	per day	2,100	352	
Sunday-Thursday	per day	1,100	89	
Weighted average	per day	1,386	164	
Weighted average	per month	41,580	5,084	
Total visitors	per year	166,320	40,672	206,992

in the population and the number of business establishments in the capital and projected that the base year number of travellers would double after the first year of operation. Then future traffic was expected to increase by 15 per cent per year for the first three years, by ten per cent for the following three years, by five per cent in the next three years and that it would stabilise at 3.5 per cent thereafter. In this manner the traffic was expected to reach 1,231,600 in the twentieth year after the ropeway was installed.

The study suspected that, due to the reduction in travel time, people would return the same day, thereby threatening the viability of hotels and lodges. At the same time, increased number of travellers would, it predicted, result in greater sales of foodstuff and thereby compensate for the loss. Employment opportunities at hotels and lodges would increase to handle the traffic, and, in turn, average household incomes would rise.

The study warned of increased pressure on forests due to increased firewood consumption. Doubling consumption, the study argued, would lead to deforestation and soil erosion and an increase in the incidence of landslides. The study presented measures to mitigate this negative impact. The study did not predict any negative impacts in the social sector due to the influx of visitors. Referring to other studies, it suggested that having more tourists would bring positive changes to the social setting of Manakamana.

The study proposed using a bi-cable circulating system with 15 detachable cabins for passengers. The system as envisioned would need 40 personnel to run it and about 411 kW of power, which would be available from the 11-kW national grid sub-station at Abu Khaireni. The cost of the project was expected to be about Rs 30 million, of which mechanical parts would constitute Rs 17 million and electrical and civil works nine million rupees. The rest of the money would be required to purchase land and other necessities.

The study determined that the optimal fare was Rs 20 and that setting fares any higher would result in an uneconomic flow of traffic. It showed that the project, with an internal rate of return (IRR) of 20.2 per cent, a payback period of 20 years and a break-even point of 89.9 per cent for the first year, would be financially viable. The report also made the following recommendations:

- The cable car could be used for cargo service by making some alterations. The problem of rendering porters unemployed could be compensated for by increasing opportunities for their employment within the ropeway establishment itself.
- Manakamana should be developed into an attractive tourist spot.

- Alternative sources of energy such as electricity and kerosene should be introduced together with improved cook stoves and forestry development programmes in order to offset any adverse impact that increased firewood consumption might cause.
- Priority should be given to private investors, who would be interested as the venture required modest investment and promised high financial payoffs. A management committee consisting of people's representatives from local villages, local governmental and non-governmental organisations, schools, temples and local communities should be responsible for availing facilities such as drinking water and sanitation.

UNIDO/ESC'S KHAIRENI-MANAKAMANA CABLE CAR COMPLEX STUDY[8]

Four years after the 1988 study, HMG/N commissioned another study of a proposed cable car system between Khaireni and Manakamana with a carrying capacity of 370 persons per hour. This study, which was carried out by Economic Services Centre (ESC) for South Asian Trading Co., Pvt. Ltd, examined the technical and financial feasibility of the system by assessing passenger volume and construction costs. It used the same estimates of the number of people visiting the shrine as the 1988 study did. It is worth noting that no independent assessment was made despite the fact that thousands of pilgrims visited Manakamana in 1992 and their number was increasing. The increment was consistent with the high rate of population growth in the Kathmandu Valley. November through March (Mangsir to Fagun) were identified as peak months while April to October (Chaitra to Kartik) were slack. Similarly, Fridays and Saturdays were categorised as peak days while the rest of the week was slack. Estimates of the growth in traffic are shown in Table 3.8.

TABLE 3.8 Expected growth in the number of passengers to Manakamana

Year	Number of passengers	Year	Number of passengers
1991/92	602,243	2001/02	1,001,906
1992/93	662,467	2002/03	1,036,973
1993/94	728,714	2003/04	1,073,267
1994/95	765,150	2004/05	1,110,831
1995/96	803,407	2005/06	1,149,711
1996/97	843,578	2006/07	1,189,950
1997/98	873,103	2007/08	1,231,599
1998/99	903,661	2008/09	1,274,705
1999/00	935,290	2009/10	1,319,319
2000/01	968,025		

The study assumed that in the initial years of operation the cable car would see tremendous growth in the number of passengers. From the experiences of India, where there had been substantial growth in the number of passenger in the initial years, the study projected that growth would stabilise after 1996/97.

This study suggested that a mono-cable circulatory cable car system be used in order to take advantage of its reliability and cost effectiveness. A reversible system, in contrast, was labelled inefficient. The report concluded that, from the market point of view, the proposal was feasible. It also summarised the financial viability of the project (Table 3.9).

TABLE 3.9 Financial viability of the proposed Khaireni-Manakamana ropeway

Financial viability	Capacity utilisation (per cent)				
	60	70	80	90	100
Debt servicing ratio	2.40	1.81	2.23	2.72	3.28
Current ratio	5.04	4.82	2.64	4.38	4.38
Return on equity	9.47	21.26	34.28	47.29	31.33
Return on investment	13.37	17.64	26.17	30.44	17.88
Profit as per cent of sales	7.99	18.04	29.11	40.17	36.60

UNDP/WORLD BANK'S REMOTE AREA ACCESS STUDY[9]

This study, carried out in the late 1980s, was guided by a macro-level focus: it examined long distance ropeways crossing districts rather than short ones. It formed part of a UNDP's look at the development requirements of remote hill districts of Nepal. Despite its bias, the report does highlight the importance of shorter-than-two-kilometre ropeways as a strategic element of high-altitude outposts such as telecommunications, defense radar and meteorological stations.

The first part of the study, which was conducted over about 17 months in 1975-76, analysed light-duty, general-purpose ropeways. The second part, which was completed in 1990, investigated multi-purpose ropeways that transported goods and passengers. The 1976 study, which was carried out by BPC Hydro Consult, recommended that light-duty ropeways be installed in three corridors in the Karnali-Bheri region. It focused on low-cost and simple technology, which could be built locally at competitive costs with existing modes of transportation, including mules and human porters. The study also explored the possibility of installing hydroelectric plants to operate ropeways.

Daniel Creissels of the French Ropeway Consultancy carried out the second study and identified ropeway technology as very appropriate for remote communities. His report is divided into four parts: (1) a review of different ropeway technologies, (2) detailed descriptions of multi-purpose ropeways and of mono-cable ropeways for transporting goods, and (3) the characteristics and cost of light-duty ropeways. The last part of the second report essentially reproduced the study completed in 1975-76.

The 1990 study examined the needs, constraints, advantages and disadvantages of various ropeway technologies and recommended that a double mono-cable ropeway, a type well-suited for transporting passengers as well as goods, be built in the Mid-Western Development Region. After investigating three routes, the study concluded that the alignment from Dangargaon and Dallu to Tilla Valley in Jumla District was the most promising.

A double mono-cable ropeway has many advantages. During operation and braking, it is stable in winds up to 100 kilometres per hour and can transport reasonably heavy loads. There are no restrictions on the distance from the ropeway to the ground, so it is possible to cover long spans with few towers. The cost of constructing and operating such a ropeway is moderate and for a negligible extra cost, carriers can be designed to be detachable when the ropeway is stopped. This feature increases the standby capacity and makes transferring carriers from one section to another possible.

The study did not analyse the location-specific socio-economic conditions of the proposed ropeway. It did not, for instance, discuss goods or passenger flow. According to the MoWT, no further action has been taken on the project. An article about this study, published in the *Gorkhapatra* on August 17, 1996, mentioned that high-level bureaucrats within the MoWT believed that the project was not viable.

ROPEWAY IN NAMCHE BAZAAR[10]

After it was first invited to build the Milkway in Bhattedanda, Gantner Ltd., an Austrian ropeway and winch manufacturing company, seemed interested in ropeway development in Nepal. Karl Prenull and Gunther Stenico from PINN, an institution of the University of Innsbruck, Faculty of International Business Studies, came to Nepal in 1994 under an agreement between PINN and Gantner Ltd. They prepared a feasibility study for a ropeway project in Namche Bazaar in Solukhumbu District as part of their thesis for PINN. They spent two months in Nepal, including two weeks in Namche Bazaar. The main objective of their study was to assess the social and economic feasibility of establishing a ropeway to solve transportation problems in Namche and to determine if such a ropeway could generate income for local people.

Namche, an affluent village of about 800 people, is a cultural and trading centre which can be reached by an eight- to-ten day hike from Jiri in Dolakha District. There are also regular flights from Kathmandu to Lukla, which is a one- or two-day trek away. Namche has several government offices, lodges and shops. As it lies on the main trekking route to the Everest region, about 12 thousand tourists visit Namche every year. Its Saturday market (*haat* bazaar) attracts people interested in both buying and selling goods from many surrounding villages, even from as far away as Jiri.

The demand in Namche area consists of the need to transport three categories of goods: timber, merchandise and tourists' luggage. Porters usually carry about 387,000 kilogrammes of timber a year from Joresalle, outside Sagarmatha National Park. An individual load ranges from 30 to 90 kilogrammes. Snow and rain regularly hamper the transportation of timber, and odd-sized pieces are difficult to carry uphill. Another 472,000 kilogrammes of merchandise, including food, kerosene and utensils, are imported from places as far away as Jiri using porters, yaks and, when there is a shortage of porters, even helicopters. Individuals or trekking groups are the main customers for porters and yaks. In 1994, porters charged Rs 250 a day to carry an average of about 50 kilogrammes and, in total, they carried more than 213,000 kilogrammes of baggage belonging to tourists. A ropeway, the study estimated, would transport about 778,000 kilogrammes of cargo with an annual turnover of US$ 40,000. Based on the seasonal pattern of tourists and other transportable commodities, the authors proposed that a ropeway with a payload of 300 kilogrammes make two runs per hour.

The study found that a ropeway system would, given the difficulties in building roads, be an appropriate solution to the transport problems in Namche area. Its argument is valid for almost all hilly regions in the country. A Kathmandu-based company, Nepal Ropeways System Ltd. (NRSL), planned to install the proposed ropeway after the study. The lower terminal of the ropeway was to be near the confluence of the Bhote Kosi and the Dudh Kosi rivers near Joresalle at an elevation of 2,804 metres, and the upper terminal was proposed to be at Namche at an elevation of 3400 metres. The length of the ropeway was estimated to be about 2.5 kilometres. The 600 kW Thame Hydropower Plant was to provide the required power. Gantner Ltd. would provide the winch and accessories, while NRSL would purchase towers and cables in the local market or import them from India.

The system would require three semi-skilled operators to carry out regular repair and maintenance; the manufacturer would provide the training and an engineer from NRSL would carry out periodic maintenance. The authors argued that establishing a management board with members elected by the users would be the most desirable way of managing its operation. People in general and shop and lodge owners in particular were in favour of the ropeway, especially considering the fact that building a road would take years, if not decades. They also appreciated the fact that a ropeway would make the cost of merchandise cheaper and more stable. The existing modes of transport, in contrast, were prone to cost fluctuations depending on the season and the type of goods transported.

The proposed ropeway was expected to have positive social and economic benefits and no major adverse environmental impacts. It would decrease the amount of work for porters only marginally. The local people felt that if the ropeway did cause any unemployment, it would be for the good as most villagers wanted to work for trekking agencies and showed little inclination to cultivate their own land. Porters also felt that it would be a relief not to have to carry loads up the steep stretch between Joresalle and Namche and that with the time saved they could do two shifts on the easier stretch of the trek.

The report compared the costs of different modes of transportation from Surkhet to Jumla. The investment needed to develop a ropeway was estimated to be about half that needed to construct a road but about 11 times costlier than developing an STOL field. The maintenance of these systems was also compared. According to the study, maintaining a ropeway would be 20 times cheaper than maintaining a road. Without considering investment, transportation costs per tonne were almost half as much per tonne by road than by ropeway, while air transport was one-and-a-half times costlier than ropeway transport. Mules, it was discovered, charged about the same as a ropeway would.

ROPEWAY IN THE SIKHA VALLEY[11]

In 1963, Jiro Kawakita, a Japanese anthropologist, first visited the village of Sikha in Myagdi District to conduct field-based research. Kawakita proposed installing a simple ropeway to improve the socio-economic and cultural lives of the people of Sikha. The Association for Technical Cooperation to the Himalayan Areas (ATCHA) implemented a ropeway project in 1974 after 11 years of preparation.

In 1971, a two-way ropeway with a span of less than 500 metres was tried but did not succeed. Three ropeways with high tensions were installed in the villages of Sikha, Pauder and Kibang in 1975. The three separate spans, which ranged in length from 1,000 to 1,300 metres, were built at a cost of about Rs 35,000. Single-line cables connecting forested ridge tops with villages at lower elevations were stretched across the valley. They were used to transport fuel and fodder from the forest to the villages by hanging loads on small hooks with rollers. Gravity brought the load down. This simple device was a convenient way to reduce drudgery and offered villagers of Sikha many benefits, but none were economic in the standard sense.

Building these ropeways posed many difficulties. One problem was related to transporting ropeway materials from Pokhara to Sikha. About 400 volunteers from three villages made transportation possible, and the local people were actively involved at every stage of the project.

Panday (1995) reviewed this gravity ropeway in September 1995 to assess its impact. His study showed that although the ropeway did not have significant negative impact, the disintegration of the forest management system, in particular that of the regulatory arrangements for the collection of firewood, had resulted in heavy deforestation close to the ropeway's upper terminal. The report suggested that the operation of the ropeway had to be linked with other developmental activities, like forest management, if it was to be successful.

On the more positive side, the study indicated that the ropeway had helped to reduce the physical burden of women and to increase the enrolment of children in school. The changes were due to the fact that the ropeway transported a considerable amount of fodder and fuel. It was estimated that by using a ropeway, half an hour was saved per load of fodder or firewood. The report mentioned the limitations of the ropeways as:

- A single bundle had to be loaded, reloaded and even re-bundled many times.
- It was accessible only by villagers living on the ridges where the ropeway was located.
- Since the system had no braking device, timber splintered upon impact at the landing point.

The review suggested that a comprehensive plan for maximising benefits be formulated. A ropeway could be a positive infrastructural development if it was linked with other rural development programmes. Without such integration, the overall unintended consequences of a ropeway would be negative although the ropeway per se would not have brought them about. Rather it would accelerate a malaise already present in the community.

LAMOSANGU'S *BIKASE CHIHAN*

Although no written report was available, a ropeway across the Sun Kosi River near Lamosangu today stands forlorn, a *bikase chihan* (development graveyard). Nepal Orind Magnesite P. Ltd. (NOMPL) operated a magnesite mine in Kharidhunga, Dolakha District, and a processing plant in Lamosangu, Sindhupalchok District. The company aimed to use a ropeway to transport raw magnesite from its mines to its processing plant. The Damodar Ropeways Construction Company based in India completed the feasibility study and constructed the goods-transporting ropeway with a mono-cable gravity-cum-motor-powered system imported from Switzerland. Its other components were imported from India.

The theoretical capacity of the carriers was 0.54 tonnes per carrier load, but in 1974/75 it carried only 0.51 tonnes per carrier because of the size and shape of the goods. The ropeway was installed because it was cheaper to transport the raw materials by ropeway than by truck, which cost Rs 170 per tonne. The ropeway did not operate at its full capacity because when it was tested after installation, the technical flaws which were identified never corrected. The contractor never formally handed over the ropeway to NOMPL. The total cost of the ropeway was estimated to be about Rs 80 million, but the actual cost escalated because the dollar appreciated during the construction period. A dispute between NOMPL and the contractor contributed to its demise, as did the substantial financial problems of the company.

IN SUMMARY

Many feasibility studies on ropeways were carried out in the past to explore the possibility of using different types of ropeways for various purposes. Many agencies provided support for these studies, but, unfortunately, they remained mere academic exercises. Two ropeways to carry goods, Bhattedanda and Barpak, and a passenger carrier, Manakamana, were actually built but were not the result of any of the feasibility study efforts described in this chapter.[12] Although the studies reviewed show that the demand for ropeway construction is high in remote areas of Nepal, the country's policy makers did not give serious attention to their findings and recommendations.

Ropeways are also mentioned in an ICIMOD study,[13] which, while not specifically undertaken to discuss ropeways, presents a comparative cost chart among different modes of transportation for the corridor between Surkhet and Jumla (Table 3.10). The assumptions that have gone into the calculations are not clear, and the study highlights the problems of comparing different systems without including a consideration of the heavy capital investments in modes like airfields and roads.

TABLE 3.10 Comparative costs of different modes of transportation between Surkhet and Jumla

Mode of transportation	Investment (Rs x 10^6)	Maintenance cost per year (Rs)	Transportation cost per t* (Rs)
Road (169 km)	1,205	104 million (57,000-66,000/km)	3,579-4,997 (Dailekh-Jumla)
Ropeway (39 km)	659	4.4 million	6,589-8,466 (Dangargaun-Kalikot-Jubitha)
Air field (STOL)	60	0.6 million	8,667-11,143 (Surkhet-Jumla)
Mule (per km)	0.2	10,000	6,141-7,190
River (60 km)	4.987	NA	885-1,138

* This is excluding investment cost

The Ninth Five-Year Plan, which came to an end in 2002, mentioned ropeways briefly and encouraged private sector involvement in their development. The plan mentioned that the process of privatising the NR would be initiated. But no progress in this direction was made. In the fiscal year 2001/02 the national budget did not allocate any money for ropeway development, nor did it make any provision for the NR. On the contrary, in December 2001, HMG/N made a decision to close down NTC, the organisation responsible for managing the ropeway. Government planners do not seem to have seriously studied the reports they commissioned. Despite the visible success that ventures like the Bhattedanda Milkway and the Manakamana Cable Car showed, the transport bureaucracy and the major donors that support it do not view ropeways as a means of connecting remote areas to the market. Maybe ropeway activists and the communities they galvanise, as well as the private sector, will show more creativity in the days ahead.

NOTES

1 See, Landon, P., 1928: *Nepal*, Asian Educational Services, New Delhi. The book was reprinted by Asian Education Services, New Delhi in 1993.

2 It is not known whether Underhill or Landon are describing sacrifices that take place when new equipment is commissioned. Even today, cars, aircrafts and computers do receive goat and chicken sacrifices during Dashain festivals. In extreme cases it is rumoured that human sacrifice (*narabali*) used to take place during the Rana rule and earlier.

3 CEDA, 1972: *Feasibility Study of Chatara-Bhojpur Ropeway*, Centre for Economic Development and Administration, Kathmandu.

4 Economic and Social Commission for Asia and the Pacific,1976

5 UNIDO/ESC, 1992: *Vienna, Austria Project No. DP/NEP/90/002*, United Nations Industrial Development Organisation and Economic Services Centre, Kathmandu.

6 MDC, 1987: *Pre-feasibility Study for Privatisation and Improvement of Capacity to 100 t/hr*, Multi Disciplinary Consultants for HMG's Ministry of Works and Transport, Kathmandu.

7 MoWT, 1988: *Study of Khaireni-Manakamana Cable Car*, Ministry of Works and Transport, Kathmandu.

8 *Ibid.* UNIDO.

9 UNDP/WB, 1990: *Remote Area Access Study*, UNDP Project NEP/86/016, Final Report, Vol. IV, UNDP and World Bank.

10 Prenull, K. and Stenico G., 1994: *Feasibility Study for a Ropeway Project in Namche Bazaar in Sankhuwasabha District*, Faculty of International Business Studies, University of Innsbruck, Austria.

11 Panday, K. K., 1995: *Impacts of the Ropelines on the People and Resources in Sikha Valley*, Kathmandu.

12 None of the earlier studies on Manakamana was used in the construction of the present system. Bhattedanda was an offshoot of a watershed management project and Barpak was built through a private entrepreneur's perseverance.

13 ICIMOD, (undated): *Sustainable Approaches to the Construction of Roads and other Infrastructure in the Hindu Kush Himalaya*, Occasional Paper No. 24.

PART II Case Studies

CHAPTER 4

Understanding the Technicalities of Ropeways

MADHUKAR UPADHYA AND KIRTAN RAM BHANDARY

A ropeway is a mode of transport in which special types of carriers are suspended from, or simply attached to, an overhead rope to facilitate the transfer of materials, goods or passengers, from one point to another. The rope runs the entire length over which the ropeway operates, which typically ranges from a few hundred metres to several kilometres. The rope is stretched between, and supported at, the end-point stations using anchors. When the distance between two stations is large, intermediate towers are used to support the rope. Longer ropeways are comprised of small sections joined together by divide stations. A divide station has the means to transfer carriers from one section to the next.

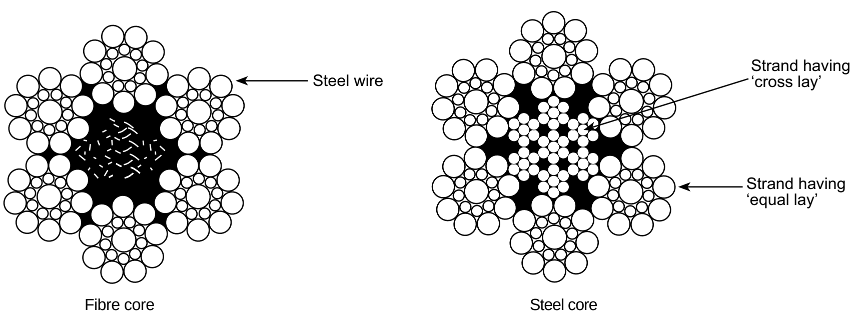
The capacity of a ropeway is measured by the load it can carry per hour and depends upon factors such as the speed of travel, the number of carriers and their capacity. The number of carriers varies: a simple system may have only a single carrier, while a complex system could have several carriers placed at regular intervals along the line. The basic components of a ropeway are a cable(s), carrier(s), and supporting structures.

COMPONENTS OF A ROPEWAY

Rope: The rope or cable of a ropeway fulfils two functions: it bears the suspended load and hauls it along. Depending upon the design, a cable can do one or both of these functions. A rope is made up of several strands of steel wires spun together. At the centre of the rope, and of each strand in it, is a core which supports the wires and strands respectively, keeping them in the correct position and minimising friction between them. A stand may contain a single 'king wire'. In a rope the core may be a strand (a wire-strand core) a second smaller rope (an independent wire-rope core), or a fibre core. A steel-core rope is less flexible but stronger than a fibre-core rope of the same size. The greater strength of a steel-core rope allows the rope to retain its shape under high surface pressures, which ensures that the load is evenly distributed among the wires. Rope with a fibre-core is generally used as a hauling cable.

Ropes can also be classified according to the way in which the wires and strands are laid (Figure 4.1). In an 'equal lay' rope, all the wires in a strand are wound with the same helix angle. Wires lie either along the crown of an underlying wire or in a valley between two underlying wires. This construction requires that wires of different layers be of different sizes and that the smaller wires be closer to the core. In a 'cross-lay' rope the wires in all layers are the same size and a different helix angle or length of lay must be used for each layer. This arrangement results in stress being concentrated at the points where the wires of different layers cross each other.

FIGURE 4.1:
Constructions of ropes



Ropes can be further classified based on the methods used to wind the strands together; there are two common ways: 'lang-lay' and 'ordinary-lay' (Figure 4.2). In a lang-lay rope, the direction of the lays of the outer layer of wires is the same as the direction of the lays of the strands within the rope. In an ordinary-lay rope the outer layer of wires is laid in the opposite direction of the lay of the inner strands. Because the outer wires are exposed for a longer time in the lang-lay arrangement, a better and more uniform wearing surface is provided. A lang-lay rope is also slightly more flexible than an ordinary lay rope but, at the same time, more susceptible to untwisting and kinking. This makes a lang-lay rope hard to handle and limits its application to situations in which it can be fixed permanently at each end to prevent its untwisting.

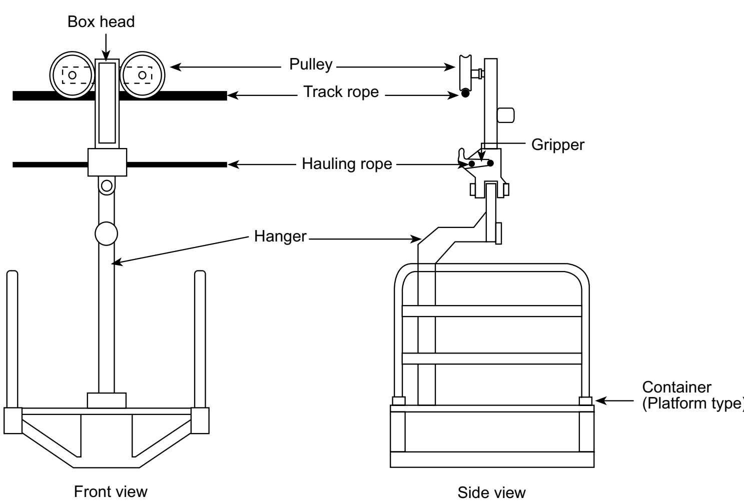
Ropes are specified according to their diameter, number of strands, number of wires in each strand, type of core, arrangement of wires in the strand, and direction

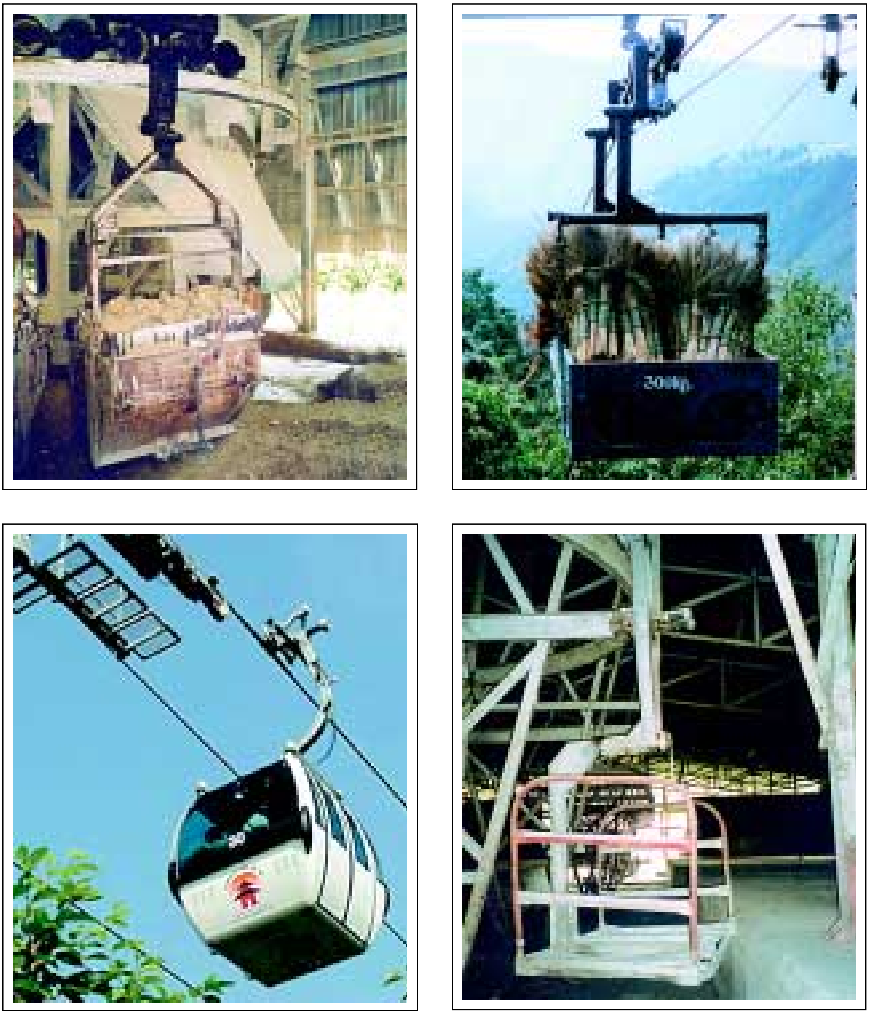
FIGURE 4.2:
Lays of ropes

of rope lay. For example, a rope of a given diameter may be specified by numbers such as 6 x 19 and 9/9/1. The first number (6) denotes the number of strands in the rope. The second number (19) denotes the total number of wires in each strand. The second set of numbers describes the configuration of each strand: the first number indicates the number of wires in the outer layer (9) followed by the number of wires in the inner second layer (9) and the number of wires in the core (1).

Ropeway carrier: A ropeway carrier consists of a carriage and a container (Figure 4.3). The carriage is made up of a box head and a hanger. The box head attaches the container to the hauling rope by means of a clip or wheels that run over the supporting rope in a bi-cable system and/or over the station shunt rail in other ropeway systems. The container may be a bucket, a tray or a passenger cabin and is suspended from the carriage by means of a hanger which, in general, is curved so that the carrier is able to pass by support stations and towers (trestles) without hitting them.

FIGURE 4.3:
Ropeway carrier (schematic)

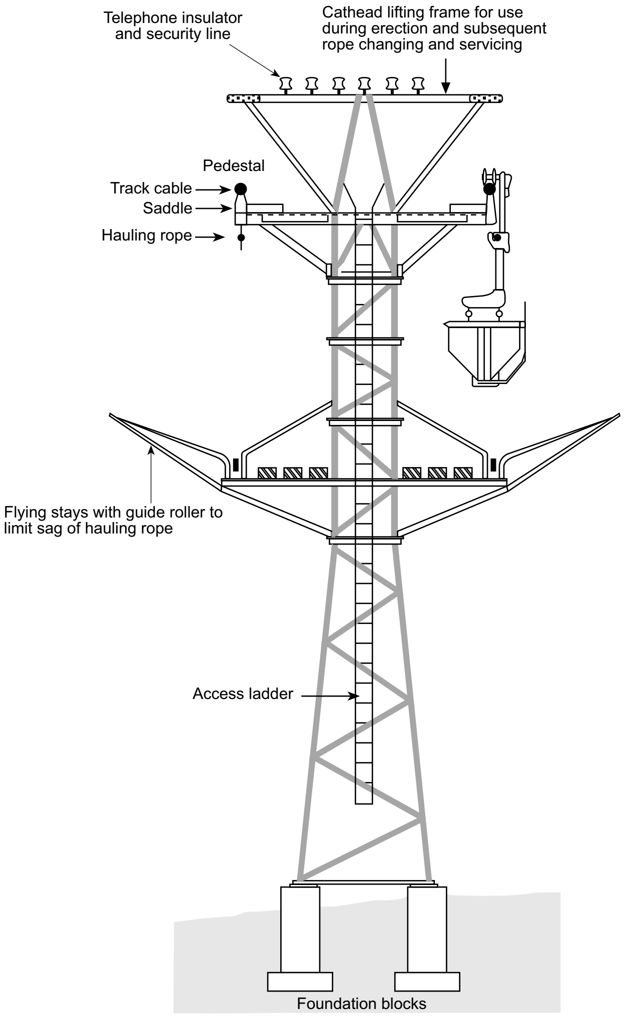




■ Different types of carriers (clockwise from top left: Hetauda Cement Factory, Bhattedanda, NR, Manakamana Cable Car)

Towers or trestles are supporting structures. Depending upon the type of ropeway and its use, they are made of wood, steel, or concrete (Figure 4.4). Towers are provided with a saddle and rollers. Rollers are small wheels used to support the hauling rope in a bi-cable system or the main rope in a mono-cable system. Rollers are generally grouped into a battery so that its radius becomes the bending radius of the rope and thus reduces the bending stress on the rope. A saddle or shoe is used to support the track rope on the tower in a bi-cable ropeway. Because it has a convex surface and is free to rotate, a saddle reduces the angle of approach and departure of a carrier as it passes over a tower. This results in smoother operations and less stress on the rope.

FIGURE 4.4:
Ropeway's tower with accessories



A bi-cable tower has saddles as well as a roller battery, while a mono-cable tower has only a roller battery to support the hauling-carrying rope (Figures 4.5 and 4.6).

Wooden towers can be used in a ropeway which transports materials in a construction project. This type of ropeway is dismantled after construction is complete. Concrete towers are generally used for small ropeways, while steel towers, because they are reusable, are commonly used in all types of ropeways. Steel towers also provide the flexibility to make towers of any size by using steel frames of pole or lattice type. Large towers are built using lattice frames which are transported to the location and assembled.

Tension stations: Tension stations placed at appropriate points along a ropeway line are used to limit the length and maintain the tension of the track cable. The cable is provided with the required tension using track tension equipment or by anchoring it to the ground.

Drive station: A drive station contains the drive system of a ropeway, which includes a motor drive mechanism and a driving sheave. It also has equipment to maintain the tension of the rope. Suspending counter-weights from a tower or in a pit or a combination of both usually achieves this.

Return station: This station at the end of the line contains a return sheave, from which carriers move back towards the drive station. Equipment to maintain the tension of the hauling cable may be placed in this station as well.

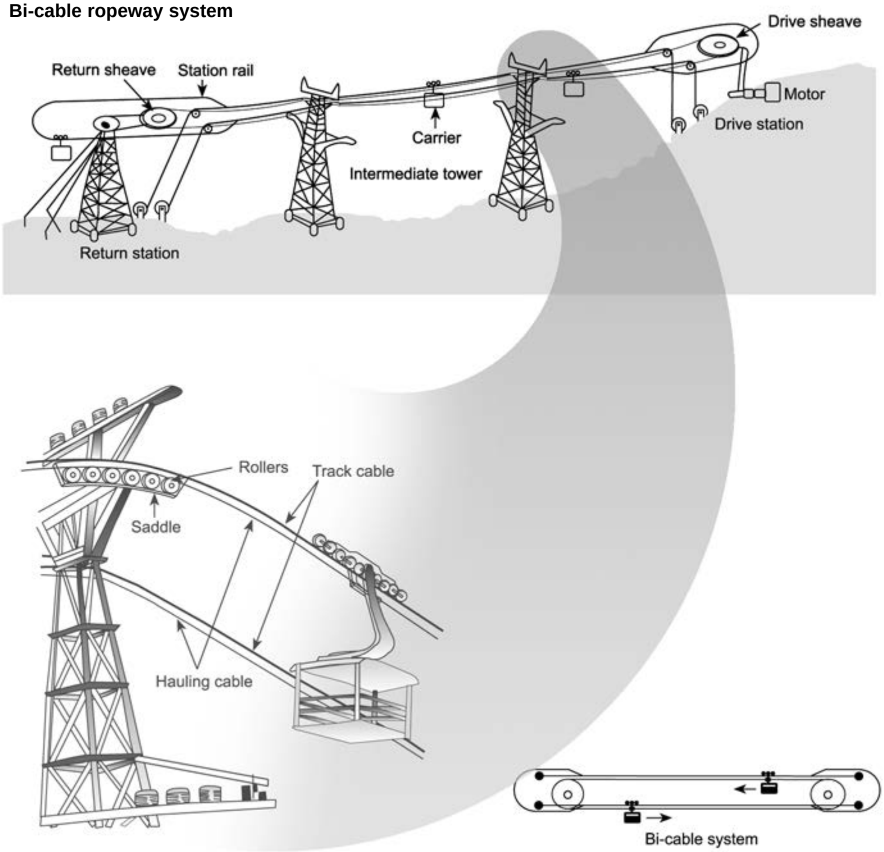
Divide stations: These intermediate stations are used in long ropeways to limit the length and tension of the rope. They divide a ropeway into smaller segments, each of which functions as a separate ropeway. These stations are also provided with fixed rails so that carriers can be transferred from one segment to the next, either manually or automatically.

***Sheaves*:** Sheaves are wheels of large diameter found at both ends of the line and in the stations. The hauling rope passes around them. A driving sheave is powered either by an engine or an electric motor connected to the sheave with a suitable drive mechanism. At the other end of the line there is a return sheave which is not powered but is free to rotate. It responds to floating counter-weights, which maintain the tension in the rope. The rotation of the driving sheave and the difference in tension between the lines at the incoming and outgoing ends causes the rope to move.

TYPES OF ROPEWAYS

Two major types of ropeways systems are used: bi-cable and mono-cable systems. A bi-cable system uses two ropes. The first is a load-carrying rope which is fixed at the stations at both ends and stays stationary. This rope is also called a track rope, track cable, or skyline. Carriers are suspended from the track rope by wheels which glide over it. The second rope is a hauling rope whose ends are joined to make a loop. The loop is mounted on the sheaves at the stations. The carriages, which are suspended from the track rope, are attached to the hauling rope at fixed intervals using grips. At the drive station, a motor powers the drive sheave. When the sheave rotates, the hauling rope moves in a circle and so do the carriages. When a carriage enters the station its grips are detached from the hauling rope and it moves onto the station rail (see Figure 4.5).

FIGURE 4.5:
Bi-cable ropeway system

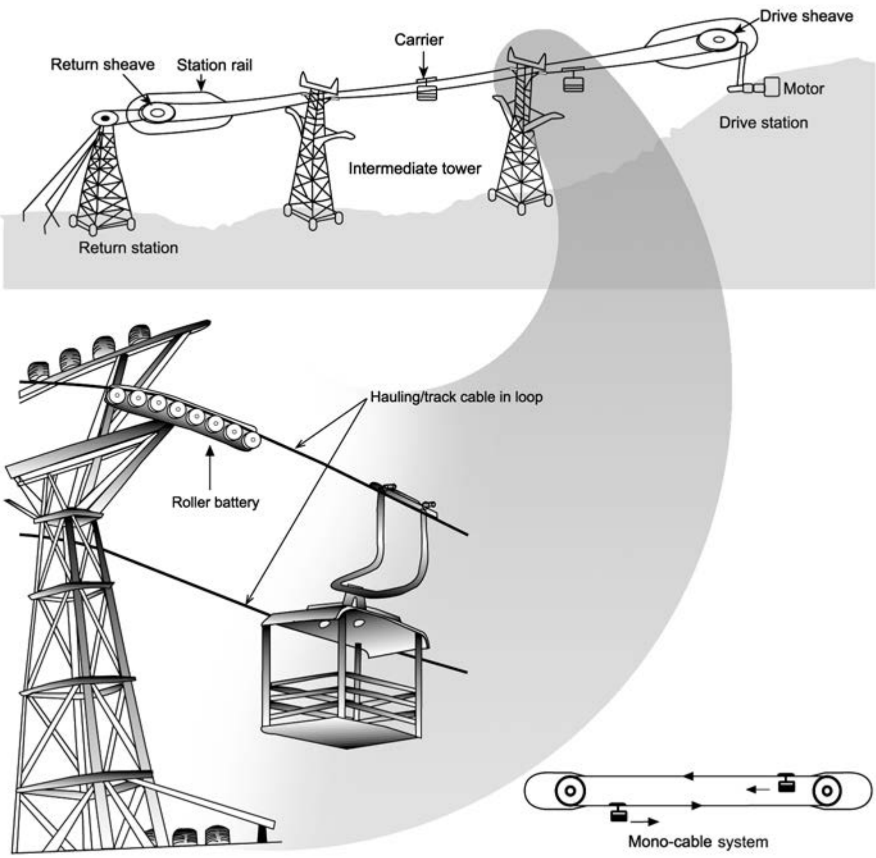


A mono-cable system uses a single rope, which serves the dual purpose of carrying and hauling carriers (see Figure 4.6). Carriages used in a mono-cable system do not have wheels; instead, they are attached to the rope by grips and move when the rope moves.

Ropeway systems may be further sub-divided into circulating and non-circulating systems and systems using fixed or detachable clips.

In a non-circulating system, the hauling rope (or hauling-carrying rope in the case of a mono-cable system) moves forwards and backwards between the loading and unloading stations. One important point about a non-circulating system is that, in a system with one track cable, it can move only one carrier. In a non-circulating system, if the hauling rope winds into a drum then the ropeway is called a drum-type non-circulating bi-cable system (Figure 4.7). In this case, when the carrier goes down, it moves with the force of gravity. The hauling rope has two functions: the first is to control the speed of the carrier when it goes down and the second is to pull it up.

FIGURE 4.6:
Mono-cable ropeway system



Instead of using a drum, the hauling rope can also form a loop but in this case the direction of motion of the rope must be changed in order to move the carrier back and forth. Such a system is called a looped non-circulating bi-able system (Figure 4.8). A looped system may also use two track cables, in which case it can move two carriers, one carrier on each side. The carriers are always on the same side of the line, because they do not pass the rotating sheaves.

If the carriers run on two sides, then the ropeway may be a mono-cable or a bi-cable to-and-fro system with one carrier on each side of the line. This type of system is arranged so that when one carrier is at the start station, the other is at the return station.

In a circulating system, the hauling rope runs continuously in one direction and passes around the sheaves at the ends. The cars move from one side of the rope to the

FIGURE 4.7:
Drum-type non-circulating bi-cable ropeway system

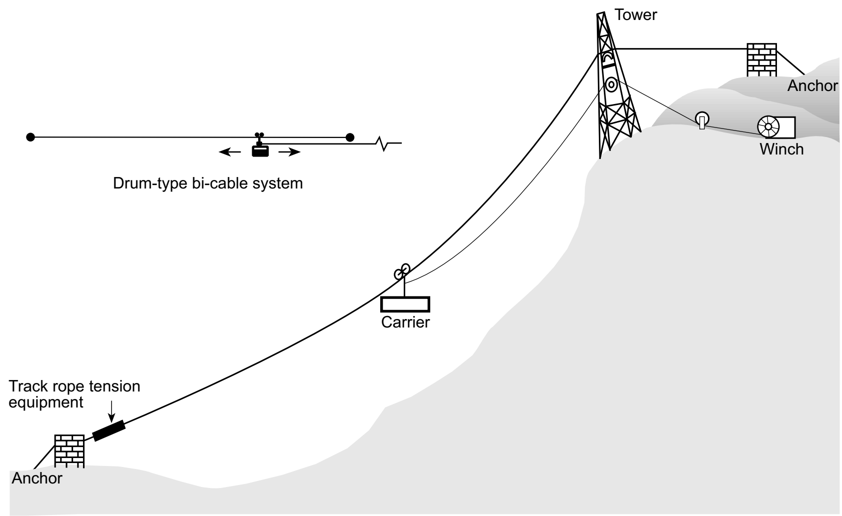
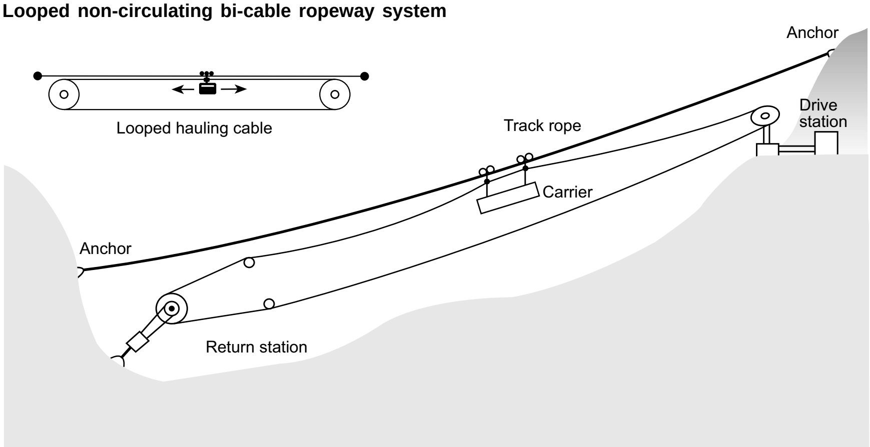


FIGURE 4.8:
Looped non-circulating bi-cable ropeway system



other as the rope moves from one station to the other and back. The carriers are detached from the hauling cable temporarily at a station and transferred to a fixed rail for loading and unloading; meanwhile the hauling rope keeps moving with other carriers.

Ropeways are also classified according to whether they have fixed or detachable clips. In a fixed-clip system, the cars are permanently attached to the hauling rope and remain so even when travelling around the sheaves. In a detachable-clip system, each car is manually or automatically detached from the continuously running rope when it enters the station. The car then moves along the station rail on a set of wheels provided in its box head to the other side of the line, where it is clipped back onto the moving rope (shown in Figures 4.5 and 4.6). This feature allows for flexibility in the loading and unloading of cars as well as ease of maintenance and easy removal or addition of cars without affecting the operation of the ropeway.

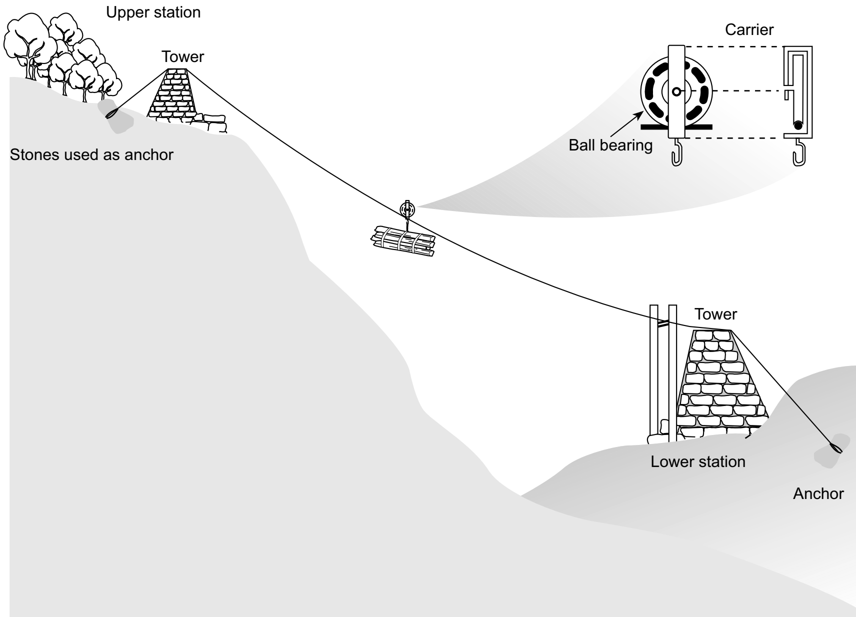
The ropeways mentioned above are powered either by electric motors or engines, but there is also another class of ropeway, the gravity-operated or self-driven ropeway, which has no external power service. This type of ropeway, whose points of loading and unloading are at different elevations is simple to construct, and thereby often used as a temporary setup (Figure 4.9). The type of ropeways currently used in Nepal are compared in Table 4.1.

There are also mobile ropeways called winch ropeways or cable cranes, which consist of the engine-powered drum of a winch and a specially-designed gripping device that travels on a temporarily-installed skyline cable (Figure 4.10). The cable from the winch passes through the gripping device and is used to lift or deliver loads. Unlike other ropeways, which have fixed stations for loading and unloading, a winch can be stopped at any point to drop or pick up a load. This flexibility makes a winch useful for transporting timber out of forests without damaging the environment. It is also used to transport construction materials across valleys and mountains. Laying

TABLE 4.1: Types of ropeways used in Nepal

Type	Operating procedure	Example
Bi-cable to-and-fro non-circulating system	Single carrier on one or two track ropes moves up and down.	Bhattedanda Milkway Barpak Ropeway
Mono-cable circulating system	Carriers travel round both sides of the rope and remain attached to it.	Hetauda Cement Ropeway Orind Magnesite Ropeway
Bi-cable circulating detachable-clip system	Carriers are temporarily detached from the hauling rope at the stations and re-attached when leaving.	Hetauda-Kathmandu Ropeway
Mono-cable circulating detachable clip system	Similar to the bi-cable detachable-clip ropeway as each car can be detached from the rope; the wheels on its box head carry it on rails.	Manakamana Cable Car
Gravity ropeway	A simple system that makes use of difference in elevation to transport goods from a higher to a lower level. The most important criterion during its construction is controlling the speed at which the car descends. The loading point is at the top.	Sikha Village, Myagdi District

FIGURE 4.9:
Gravity ropeways



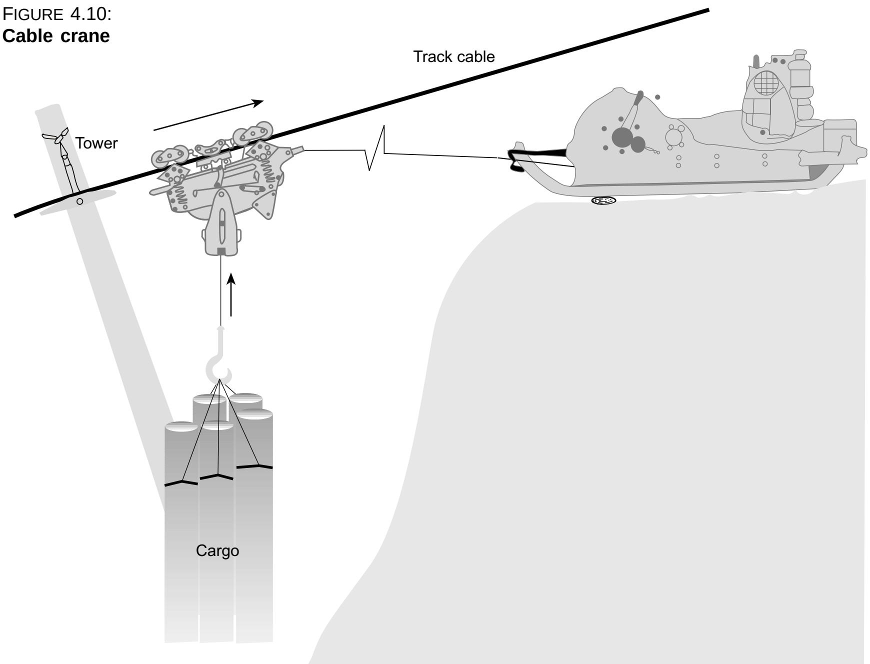
the pipes for the penstock of a hydropower plant or for a drinking water system, for example, can be done using a cable crane.

In Nepal, a cable crane was used to haul the concrete used to manufacture the tetra poles which stabilised the Charnawati River in Dolakha District, which had deepened by five metres during a flood in 1987 and, as a result, threatened the Lamosangu-Jiri Road. Tetra poles cast at the site were used to prevent the river from deepening further. Though transporting concrete by truck from the road to the site in the river channel about a kilometre downstream would have been less expensive, the idea of building an access road was rejected as it would have made the riverbanks more unstable and further jeopardised the road. In any case, the cable crane delivered the material right where the tetra poles were placed and thus provided flexibility in their construction.

MAINTENANCE

How well a ropeway functions—and ultimately its viability—depends on how diligently it is maintained. Even when no particular problem has manifested itself, the system must be religiously inspected at regular intervals. In the Barpak case described in this book (see chapters 9 and 10), the snapping of the hauling cable of the ropeway was attributed to the lack of timely lubricating and tensioning of its ropes.[1]

FIGURE 4.10:
Cable crane



Usually the manufacturer provides maintenance guidelines that must be followed very carefully, especially if the system is used for more hours a day than it is designed for. The wear and tear of the various moving parts of any ropeway reduces the life of that system. Just because a ropeway is operating does not mean that its overall performance will be free of problems. Tower bolts and parts loosen with time; pulleys are displaced from their original alignment; and the tension provided to the rope will decrease over time. Decreased tension could reduce the system's efficiency, causing the rope to sag excessively and the carriers to hit the ground. In extreme cases, the rope itself might touch the ground, damaging to it and the carriers. Too much sag also causes carriers to swing when it is windy and can result in collisions with towers. These problems need constant correcting.

Most accidents and ropeway failures occur due to slackness in maintenance as the following example of the 2.5-kilometre-long Darjeeling-Rangeet passenger ropeway demonstrates. Established in 1960, this ropeway was supposedly checked daily and overhauling was done annually. In October 2003, however, it snapped killing four persons and injuring eight others. The failure was attributed to the fact that routine maintenance procedures that were not alert enough to diagnose the brewing problem.[2]

High quality work is crucial to the successful operation of a ropeway, but is, in itself not sufficient. In order to ensure safe and efficient service, the regular inspection and maintenance of a system is equally essential. Timely and proper maintenance not only enhances the life of a ropeway but also ensures its efficient, smooth and safe operation. Lack of maintenance results in poor operation and can be fatal for operators, users and people living along the ropeway alignment.

Maintaining a ropeway system comprises two main activities: maintaining the tension of the rope and lubricating its moving parts. The rope must be kept at the recommended tension in order to limit its sag and to retain its load-bearing capacity and life. Tension equipment and anchors are used for this purpose. Tensioning must be carried out as soon as any shift in the alignment is noticed or the wire starts to sag more than is recommended.

Ropes must always be well lubricated. The exact frequency of lubrication needed depends upon factors such as weather, the duration and type of operation and the type of rope used. Since a fibre-core rope stores lubricant and supplies it gradually to the outer wires, less lubricant needs to be applied to it manually. However, one must still ensure that the core has adequate lubricant. Lubrications should be done more often during the monsoon when falling rain washes away the oil. Long duration of use, and/or continuous operation also requires that increasing frequency of lubrication to keep the rope clean and to protect it from the weathering effects of air, wind, storm abrasive dust particles. Lubrication also saves the ropes from chemical reactions associated with rains and the chemicals (especially acids) dissolved in it. By minimising friction between moving parts and supports, lubrication ensures that operation is smooth and quiet and as a result, the mechanical elements perform better and last longer.

The misalignment and wearing of pulleys can result in the displacement of the rope, which is heavy and under high tension. A slight shift in its alignment can transfer large stresses to pulleys and rope strands and thereby cause severe damage within a short period. This shift could occur for various reasons, the most likely of which is loose nuts and bolts. To keep the rope properly aligned requires that nuts and bolts be kept tight at all times. If pulleys are provided with rubber linings to minimise the wearing of the rope, they must be replaced as soon as they wear out. Worn-out and non-functional pulleys must also be quickly replaced.

In a bi-cable ropeway, the track rope remains stationary and the pulleys of the carrier roll over it. This action wears the upper side of the rope where the pulleys come in contact with it. Although the spiral construction of a rope causes it to rotate a little when a load passes along it, the other three sides of the rope wear less rapidly. To avoid the excessive wearing of only the top, the rope must be periodically rotated 90 degrees to ensure uniform wear around the rope and to prolong its life.

Maintenance also involves moving the track rope a few metres from its existing position. Though the rope is fixed and remains stationary, it moves slightly from its position at the saddle when a loaded carrier passes along it. After the loaded carrier has passed, the rope returns to its original position. In addition, changes in temperature cause the contraction and/or expansion of the rope relative to the saddle. This movement results in the lower surface to wear faster than the upper side of the rope caused by the movement of carriers because the additional load of the rope adds to the cargo load. Wear is also higher because the friction in sliding in higher than that in rolling. Since the rope comes back to its original place when the ropeway is at rest, such wear is difficult to observe. To prevent excessive wear, the track rope must be moved along its length by a few metres so that a new section rests on the saddle. This operation can be performed when rotating the rope.

The fraying of ropes causes most ropeway accidents. A rope does not snap at once; instead, fraying commences gradually. As each individual wire of a strand breaks, the strength of the rope is considerably reduced. Each successive wire breaks more easily and until the rope snaps. To prevent this from happening, the condition of the rope must be carefully checked. If any individual wire is broken, it indicates that the rope’s overall strength has declined. Broken wires can be spliced together by a skilled technician, but repeated splicing can reduce the rope's integrity and it must be replaced to improve safety. These maintenance activities help prevent accidents.

Ensuring effective maintenance essentially means inculcating a technological culture and a scientific outlook, which attributes are not prevalent to the required degree in any rural setting in developing countries. Since the ropeway industry is in its infancy in Nepal there are very few local experts that can provide maintenance support. Unlike operation training, which is provided by ropeway manufacturers at the time of installation, and for which the operators develop skill over time, such support, even if provided rigorously in the beginning, is likely to be weak when the actual maintenance activities are undertaken. A sound maintenance culture will come about only if those engaged in various aspects of ropeway industry—those in civil society concerned with safety as well as those in the government crafting and enforcing laws—engage constructively with each other. It is a long, hard and continuous, but ultimately beneficial process into which industries, owners and communities need to build a fair number of self-help, self-regulating and policing mechanisms.

NOTES

1 Earth Consult, 2000: *A Case Study of Rangrung-Barpak Ropeway*, A report submitted to ITDG Nepal, Earth Consult (Pvt.) Ltd., Kathmandu.

2 *Times News Network*, October 20, 2003

CHAPTER 5

A Pioneer Falters:
The Status of the Nepal Ropeway

SHYAM SUNDAR SHRESTHA

HISTORY OF A PIONEERING EFFORT

Ropeways have existed in Nepal for eight decades. The first was the Swayambhunath Ropeway, a British-model mono-cable system built in Kathmandu. Rana Prime Minister Chandra Shamsher commissioned it in 1924 to carry stones four kilometres from a quarry in Halchok to Lainchaur in order to construct Rana palaces as well as the roads that linked them. Though it operated till 1964, specific details about its performance are not known. After roads were extended to the corners of the valley, access to other quarries and the door-to-door delivery of stones by trucks forced its closure. All sixteen of its operators were transferred to the newly established NR, which was operated by HMG/N's Ropeway Office.

Nepal's second ropeway, the 22-kilometre-long Tri Chandra Nepal Tara Ropeway, came into operation in 1927. This mono-cable system crossed the Mahabharat Range southwest of Kathmandu and linked the village of Matatirtha with Dhorshing, a village near the roadhead town of Bhimphedi about 70 kilometres from Raxaul. This mono-cable system, which was first tested by the British during the third Afghan War, was brought to Nepal by Keymer Sons and Company, London. A residential engineer and a few advisory staff members of the Ropeway Office operated both the Swayambhunath and the Dhorshing-Matatirtha ropeways under the supervision of Kilburn, the chief engineer of the Bijuli Adda (Electricity Office).

In addition to the ropeway, other modes of transport were also used available between Kathmandu and Raxaul. The Nepal Government Railway (NGR) carried goods from Raxaul to Amlekhgunj, from where lorries carried the freight to Dhorshing. Then the ropeway was used for haulage to Matatirtha from which point trollies carried the goods to the customs office in Teku.

The original capacity of the ropeway was eight tonnes per hour, a rate capable of meeting the bulk transport needs of Kathmandu at that time. After 20 years of operation, constant wear and tear and the repeated derailment of its carriers had reduced its capacity to 5.6 tonnes per hour. In 1947, towers were erected to extend the ropeway from Matatirtha to Teku, a distance of 6.5 kilometres, but this section was not brought into operation because its carriers and spare parts were cannibalised to keep the Dhorshing-Matatirtha system operational.

In the early 1960's, worn-out ropes, the lack of spare parts, and grip failure increased the frequency with which carriers derailed from the supporting sheaves. The mounting loss of goods reduced the ropeway's reliability. Ultimately it could no longer sustain itself, and the government finally shut down the Dhorshing-Matatirtha in 1964. Its property and staff were transferred to the NR when the Hetauda-Kathmandu Ropeway was completed.

The US government helped extend the Dhorshing-Matatirtha ropeway to transport goods from Hetauda to Kathmandu because the Tribhuban Highway, which connects Kathmandu and Hetauda frequently closed. Opened to traffic in 1956, the Highway passes over steep terrain and has numerous hairpin bends. Winter snow on the mountaintops and heavy rains during the monsoon result in frequent landslides which block the road and every year bring frequent halts to the movement of vehicles. An agreement was signed between USAID/Nepal and HMG/N to construct a 42-kilometre-long ropeway with a hauling capacity of 22 tonnes per hour. Thirty years later, a USAID publication reflects on this venture as follows*:

> *An innovative project suited to Nepal's mountainous terrain was the Hetauda-Kathmandu ropeway, started in 1959. The 45 kilometres aerial cableway was built to carry freight from the developing industrial town of Hetauda, at the edge of the Tarai, to Kathmandu. By directly traversing two high ridges, it cut off two-thirds of the distance required to haul freight by road.*
>
> *The ropeway was intended to provide a dependable, economic, all-weather means of supplying essential items (primarily food) to the Kathmandu Valley. It would prove particularly advantageous in the monsoon, when landslides frequently blocked road access to Kathmandu. By utilising local electricity rather than imported diesel fuel, the ropeway was designed to save precious foreign*

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* Skerry, C. A., Moran, K., and Calavan, K. M., 1991: *Four Decades of Development: The History of U.S. Assistance to Nepal (1951-1991)*, United States Agency for International Development (USAID), Kathmandu. (The actual length of this ropeway is 42 kilometre—Editors)

exchange and reduce the cost of hauling goods by truck over the steep, winding Tribhuvan Highway.

This project replaced and extended the 22 kilometres mono-cable ropeway, which had been operating from the Tarai town of Dhursing into the Kathmandu Valley since 1927. The new system's capacity was 25 tonnes per hour, three times that of the earlier one. USOM contributed US$ 4 million and hired Riblet Tramways of Spokane, Washington, to install the ropeway. At the time, the project was the most technically advanced enterprise ever attempted in Nepal and it demanded incredible effort. It was supported by 280 steel towers, which were fabricated in the U.S, shipped to India, carried in pieces to sites and assembled on the spot. Tremendous lengths of steel cable were hauled into position by long lines of porters manoeuvring down narrow, steep, mountain trails.

Construction proceeded without major difficulties until a test run was made in 1962. When the cableway was operating, all the lights in Kathmandu dimmed. The capital's power supply was insufficient for the scheme. The power shortage and a number of technical and administrative difficulties slowed the completion of the project.

The ropeway was completed in April 1964 and was turned over to HMG/N for operation by the Nepal Transport Corporation. Actual use (17,000-37,000 tonnes annually between 1966 and 1970) was disappointing in comparison with the ropeway's capacity of 50,000 tonnes per year. Ropeway traffic constituted about 15 per cent of northbound freight along the Kathmandu-Raxaul corridor; the remainder was hauled in by truck. While the northbound lines were used to import foodstuffs and construction materials into Kathmandu Valley, the southbound route remained virtually unused because of the small volume of surplus produced in Kathmandu Valley. The ropeway received its greatest use as an alternative to the Tribhuvan Highway before the Bharatpur-Kathmandu road was completed in 1981. Today it remains operational but is underutilised, despite its potential energy-saving benefits.*

The ropeway began operating under the direction of a ropeway committee, but because HMG/N did not have a concrete policy its operation was unstable for about a year. In 1964, NTC was formed and the ropeway committee was dissolved. The Hetauda-Kathmandu Ropeway, along with the assets of the first two systems, was handed over to NTC and re-named the NR. HMG/N handed over its responsibilities to NTC, entrusting it to serve as the main operator. NTC's responsibility was limited

* This is the Bharatpur-Mugling section.—Editors

to operations; it did not aim to promote or develop the NR as a corporate firm. The limitations of NTC's role, unfortunately, stymied the institutional scope for the growth of ropeways in Nepal as a complementary mode of transportation.

From its high point in the early 1970s, the NR began a downward spiral which lasted for twenty years. The list of ailments is long but worth recording. Poor planning and marketing resulted in the severe under-utilisation of its capacity during much of the late 1970's and over the next two decades. Poor personnel management, the lack of job descriptions and excessive political interference resulted in overstaffing but at the same time a dearth of the technical experts needed to carry out urgent maintenance needs. Since there was no personnel management policy or personnel development programme, the level of morale among employees plummeted. In a vicious cycle with a negative feedback loop, dissatisfaction among staff contributed to poor standards of planning, budgeting, monitoring and maintenance. With the deterioration of its information and control systems, the ropeway became even more inefficient. The situation could not continue without the NR's becoming a financial burden to NTC, so the ropeway was closed in 2001.

TECHNICAL DESCRIPTION

The Hetauda-Kathmandu is a continuous bi-cable ropeway system that uses two ropes, a stationary track cable and a hauling rope. Carriers are suspended from the stationary track cable and attached to the moving traction rope using wedge-rope grips, which use springs to grip the traction rope and secure the carriers. The carriers used are single hanger, self-levelling platform carriers.

The line structures and anchors include towers, breakovers, tension stations, anchor towers, traction rope towers, track cable anchor equipment, and track cable tension equipment. They are made of steel and designed and located to support and control the track cable and traction rope between terminals.

In each tower, the track cable is supported on a grooved saddle which is free to rotate so that it can automatically compensate for the changing angle of the track cable caused as ropeway carriers approach and depart. A 10-inch-diameter roller on each side of the tower supports the traction rope. Carrier guides are provided to prevent the carriers from striking the structures should they swing. Breakovers are also towers, but they have the larger foundations and heavier structures needed to support the cable over long distances without using any intermediate support. Tension stations are provided at appropriate points along the line to break up its length and to maintain the tension of the track cable.

An anchor tower is a small tower provided next to a tension station. It is equipped with a saddle to deflect the track cable towards the ground, where it is connected to either a track cable anchor or tension equipment. One end of the track cable is anchored using anchor equipment and the other end is provided with track cable tension equipment to maintain the track cable tension. Tension stations and anchor towers do not support the traction (hauling) rope, so traction towers are strategically placed to prevent the traction rope from touching the ground.

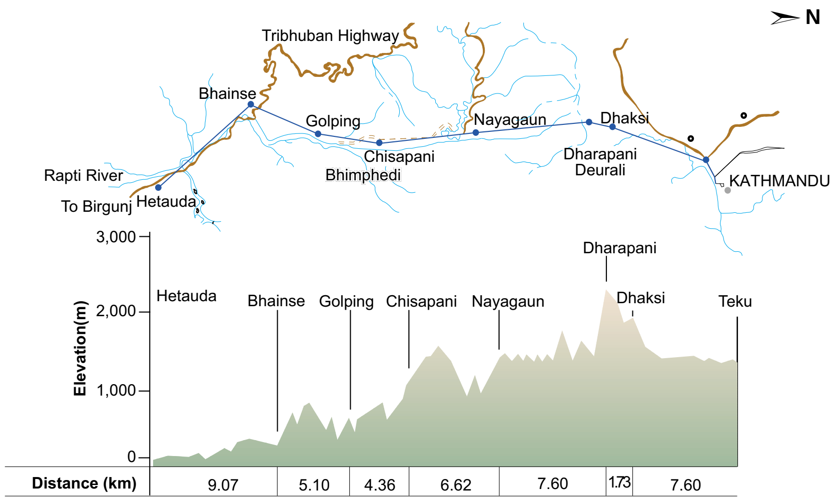
There are eight terminals (Figure 5.1), which are the main control points that regulate carrier movement over any or all sections of the repose. The terminals, which are constructed of steel parts, are located at each end of all seven sections of the repose. The track cables are anchored at each terminal, as well as at intermediate points between the terminals; the traction rope, on the other hand, is a continuous loop which runs between the terminals. Incoming carriers are pushed manually to the traction rope loop of the next section. In addition, a sidetrack (fixed rail) is provided in each terminal for removing the carriers from the line when necessary. The ropeway was designed and constructed with local considerations in mind. For example, in order to provide much-needed jobs, the manual pushing off of carriers was chosen over the sophisticated mechanised system usually found in ropeways.

OPERATION AND MANAGEMENT

Over the years, the NR experienced several problems. The lack of training and skill enhancement programmes for employees was one. In the initial years of operation, a team of qualified staff managed the NR. Subsequently, very little emphasis was placed on providing training to operators and maintenance staff. Deprived of formal opportunities, they were forced to resort to self-training by trial and error and learning by simple observation without theoretical backing. The gap was especially unfortunate for specialists such as rope splicers. The NR's senior staff could have conducted *ad hoc* training sessions of one or two days using an operation manual, but lack of interest at the higher levels of management prevented even this minor opportunity from materialising. The supplementary training of staff would have improved operation hours, employee efficiency and work standards as well as reduced the need for supervision. Had the NR established its own training wing, with a month-long programme of classroom and field teaching, both the senior and newly-recruited junior staff would probably have been able to contribute to the smoother operation of the ropeway.

The adverse effect of the lack of training was reflected in the unsatisfactory maintenance of the ropeway. The NR's maintenance management system, an essential element for keeping any system in operable condition at an acceptable cost, was very poor. To ensure efficiency and reliability, an acceptable standard is required of major facilities such as tower structures, anchor equipment, track cables, traction ropes, carriers, sheaves and other equipment and machines. Maintenance is particularly

FIGURE 5.1:
Alignment and profile of the Hetauda-Kathmandu Ropeway



■ Towers of the Hetauda-Kathmandu Ropeway important for a ropeway that passes through rugged and remote locations where infrastructure is limited. In an urban area, a staff member could, for example, make a single telephone call to get a disrupted electricity supply reconnected. In contrast, ensuring the smooth operation of a ropeway situated in a remote location may, because there are no communication facilities, require staff to walk for hours to inform authorities about a power cut.

A preliminary cost-benefit analysis indicates that the cost of maintaining a supply line from the nearest transformer to the ropeway terminal in order to secure an uninterrupted supply of power is minimal compared to the losses incurred if a ropeway is out of operation for a long period. The objective of regular maintenance is to minimise the total cost of keeping the facilities at an acceptable standard of efficiency and reliability; in the case of the NR, however, maintenance was not carried out satisfactorily for a long time. The results were low capacity utilisation and unreliability.

Though the actual amount of revenue lost due to the lack of spare parts for the NR is not available, a hypothetical case illustrates the serious impact on income generated which a breakdown has. The rate fixed by the government for goods transported by the NR was Rs 346.80 per tonne, whereas trucks charged Rs 480.00 per tonne. Provided there were sufficient goods to transport, the shut-down of the ropeway for a single day resulted in the revenue loss of Rs 53,407.* If it took 10 days to import a required spare part from India, a revenue loss would amount to Rs 534,070. If the required parts had to be imported from a third country, a minimum of 30 days would pass and the revenue lost would reach Rs 1,602,210. Besides this tangible loss, the NR would suffer from customer dissatisfaction due to delays in the transport of consignments. This in turn would diminish users' confidence in the ropeway and cause a loss of business for the NR.

The cost of the track cable accounted for more than 40 per cent of the total investment in the ropeway system. The cables were in bad shape as they had outlived their normal lives. According to records, the cable was replaced every 8 to 10 years due to abnormally rapid wearing; nevertheless, they still broke occasionally. The reasons for their rapid aging are discussed below.

The first reason had to do with lubrication. The operation manual recommended that the track cables be lubricated once a month, but this was insufficient, especially during the rainy season, when rain washed lubricant away. The lack of lubrication accelerated corrosion and wear by friction and rusting.

A second explanation for the unusually high wear was that the track cables were periodically rotated through an angle of 90^0 along their horizontal axes so that

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* This amount is obtained assuming that the ropeway operates for seven hours a days hauling 22 tonnes per hour at a rate of Rs 346.80

wear in the ropes would be uniform. Reversal stress caused by this periodic rotation resulted in fatigue failure and shortened the anticipated life of the cables. In fact, the regular cleaning and greasing of the thrust bearings which supported the cable ends and the cable supports on the towers would have been sufficient to ensure that the cable was wearing uniformly. Furthermore, since a spiral cable such as the one used by the NR rotates automatically when carrier sheaves travel on it, wear is minimised only on one side.

Third, due to the expense of purchasing new wheels, mechanics of the NR welded, re-grooved and machined worn-out carrier wheels and re-used them. A welded surface, however, is not homogeneous and does not posses the ideal hardness. These poor-quality wheels were one of the major causes of the abnormally high wearing of the track cables. Instead of fabricating carrier wheels in one piece, they were assembled with a hub and lined with two flanges or liners which could be replaced if they got worn out. A carrier with rubber-lined wheels would have had a much longer life than one running metal on metal, but rubber-lined wheels could not be used because the track cable wires were broken and spliced in many places.

A fourth cause was that the structure of the cable used in the NR was round with an 18/12/6/1 construction. This means that the innermost part of the cable had one wire surrounded by six wires, which in turn was surrounded by 12 wires and then 18. This type of cable has a small outer surface area whereas cables available nowadays have a large outer surface area which minimises wear and consequently breakage.

Because the traction rope was in bad shape, it had to be repaired repeatedly and operating time was lost. Splicing and excessive wear reduced the average life of a traction rope from ten to about four years. The main reason for the excessive wear was the metal-to-metal contact between the ropes and the supporting sheaves. A rubber-lined sheave could have been used, but the original design did not allow for adjusting the sheave. Alternatively, a slight modification of the sheave-supporting shaft would have been enough to bring the traction rope into alignment and reduce wear on it. Due to a lack of technical knowledge and expertise, however, not even such minor modifications were carried out.

ECONOMIC DECLINE

The stated objective of the NR was to transport goods from the southern plains to Kathmandu Valley, thus providing transport facilities and economic benefits to the people at large. Besides supplying goods to Kathmandu, the ropeway supplied food grains, fertilisers and construction materials to villages close to the ropeway terminals. The terminals at Dharapani and Nayagaun provided services to people in Phakhel, Markhu and Kulekhani VDCs of Makawanpur District. Likewise, the terminals at Golping and Jurikhet provided services to remote parts of Bhimphedi and Nibuwatar VDCs. Since these villages had no road access and were thus an assured and captive market, the NR was expected to become commercially viable.

Its objectives and economic potential notwithstanding, the NR's actual financial performance was poor. In the year 1972/73, the agency operated with a profit of over 0.3 million rupees (Table 5.1), whereas twenty years later, from 1991/92 to 1995/96, the agency incurred losses that varied from 1.3 to 6.9 million rupees a year (Table 5.2). This decline reduced the capital needed to buy spare parts for regular (routine and recurrent) and periodic maintenance. The new cables and ropes needed for rehabilitation were not purchased. Maintenance was not timely, and corrective measures to remedy the original design were not undertaken. As a result, the NR became both physically and institutionally dilapidated.

The NR took four hours and 12 minutes to cover the 42 kilometres from Hetauda to Kathmandu. In contrast, a truck took more than 12 hours to cover the 120 kilometres of the Tribhuban Highway. Since the road's steep gradients and hairpin bends made the cost of vehicle operation expensive, customers opted to use the NR to transport their goods to Kathmandu. When Narayanghat was connected to Mugling in the Prithvi Highway in early 1982, the travel time to Kathmandu from Hetauda via Mugling dropped from 12 to less than eight hours. Suppliers sending consignments

TABLE 5.1: Income and expenditure account for 1972/73 (Rs)

Category	Costs	Category	Costs (Rs)
Expenses			
Carriage maintenance	1,110,956	Building maintenance	4,581
Rope-track maintenance	137,688	Taxes, insurance	12,161
Divisional management	136,482	Stores	22,832
Total expenses			1,593,470
Revenue			1,937,021
Surplus			343,551

TABLE 5.2: Income and expenditure accounts for 1991/92 to 1995/96 (Rs)

Item/year	1991/92	1992/93	1993/94	1994/95	1995/96
Salaries and overtime	5,592,050	4,720,707	4,983,586	4,746,103	5,902,128
Operation expenses	2,104,492	251,363	838,698	353,655	179,879
Administrative expenses	932,571	5,033,798	4,733,987	788,855	1,813,559
Financial expenses	6,695	3,617	17,618	101,332	6,076
Total expenses	8,635,808	10,009,485	10,573,8890	5,989,945	7,901,642
Revenue	4,371,607	3,054,517	4,124,402	4,607,557	3,157,655
Losses	(4,264,201)	(6,954,968)	(6,449,487)	(1,382,388)	(4,743,987)

to Kathmandu from Raxaul did not use the Ropeway because they had to incur the extra costs of loading and unloading goods at the terminals. Also, by using the Highway, food grains produced in Chitawan District, for example, could be transported directly to Kathmandu without stopping in Hetauda. The volume and types of goods transported by the Ropeway dropped drastically in the 1990s (Tables 5.3 and 5.4). Moreover, the construction of the Kulekhani Dam and its powerhouse in the vicinity of the terminals at Nayagaun and Jurikhet made these areas accessible by road with as little as a half an hour's walk. As the pattern of transporting goods changed, the NR began to depend almost entirely on transporting cement from the factory in Hetauda to Kathmandu.

The importance of the NR was highlighted whenever landslides triggered by heavy rains blocked roads to Kathmandu. In 1979, monsoon rains washed away bridges and sections of the Prithvi Highway. Heavy rains in 1987 seriously affected the Thankot-Naubise section of the Tribhuban Highway. Likewise, the cloudburst and associated

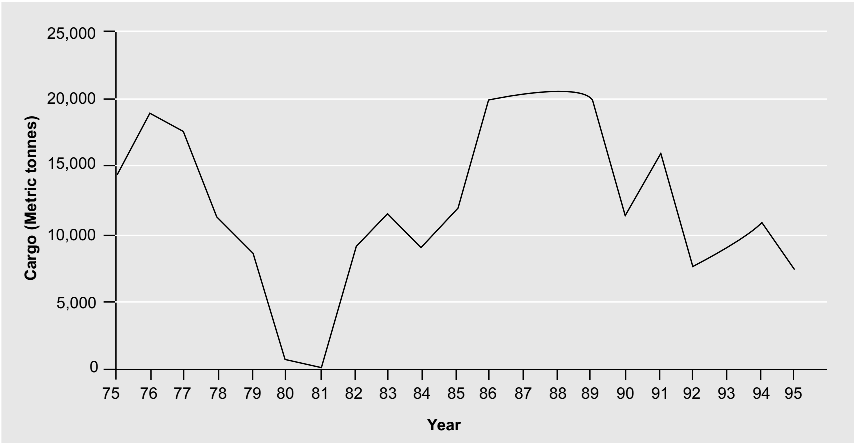
TABLE 5.3: Details of goods transported by the NR (mt)

Items/year	1968/69	1969/70	1970/71	1971/72	1993/94	1994/95	1995/96
Paddy	857	927	1,720	817	921	280	232
Rice	3,284	1,597	1,570	89	440	350	410
Corn	1,396	573	1,190	454	-	-	-
Flour	351	820	335	331	-	-	-
Salt	8,260	7,221	6,690	13,043	-	-	-
Sugar	1,512	1,985	3,292	3,304	-	-	-
Other food products	2,467	-	872	416	-	-	-
Cement	8,556	6,906	5,962	3,888	8,072	9,762	6,063
Fertiliser	6,532	12,990	71,857	8,957	-	-	-
Timber	3,116	1,915	3,029	387	-	-	-
All other goods	835	-	606	1,504	152	501	500
Total	**37,166**	**34,934**	**33,123**	**33,190**	**8,985**	**10,893**	**7,205**

TABLE 5.4: Transportation of goods from fiscal year 1975/76 to 1995/96 (mt)

Fiscal year	Metric tonnes	Fiscal year	Metric tonnes
1975/76	14,422	1976/77	18,862
1977/78	17,517	1978/79	11,007
1979/80	8,766	1980/81	566
1981/82	105	1982/83	8,816
1983/84	11,577	1984/85	9,009
1985/86	11,800	1986/87	20,000
1987/88	20,500	1988/89	20,645
1989/90	20,120	1990/91	11,502
1991/92	16,060	1992/93	7,501
1993/94	8,985	1994/95	10,893
1995/96	7,205		

FIGURE 5.2:
Load carried



floods of 1993 caused major damage to bridges, culverts and sections of both the Tribhuban and Prithvi Highways. On all these occasions, the ropeway proved its usefulness.

Roads are built, maintained and rehabilitated by the government; vehicles plying roads pay a nominal tax to the government as road users. The NR, on the other hand, had to repair and maintain its cables and towers, operate carriers and pay for electricity on its own. Coupled with operation, maintenance and management difficulties, the NR gradually began incurring financial losses. Furthermore, the agency had to pay for spare parts in dollars while the revenue it collected was in rupees, whose value decreased considerably over the years.

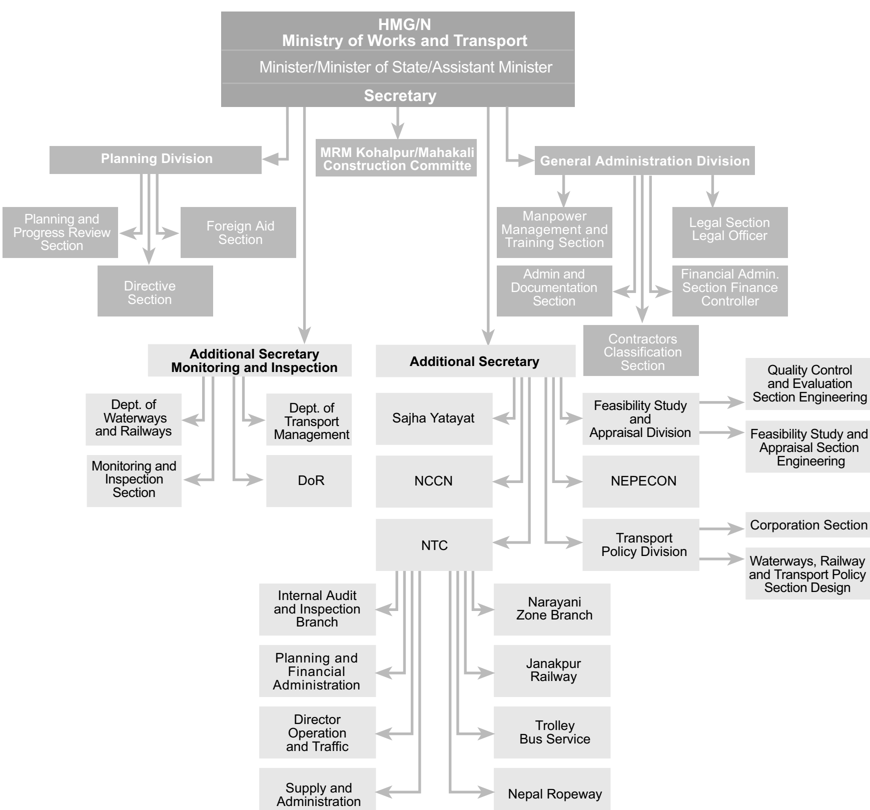
LEARNING FROM POLICY FAILURES

The NR was a public sector corporation which, in the long-run, suffered from political interference aimed at short-term gains. From hiring people unqualified for the job to a serious lack of political commitment, the failure of the government to provide adequate support meant that NR's decline was inevitable.

Recognising the contribution that the NR made and its importance, especially in hilly terrain, the NPC incorporated policies and programmes to improve the NR's services and to extend facilities to rural areas starting from the Fifth Five-Year Plan. Except for allocating money in the budget for the maintenance of the NR, HMG/N provided the organisation with no substantial assistance. When no funding or foreign support for maintenance and rehabilitation was forthcoming, an economical appraisal of the system was carried out. Following this study, HMG/N obtained a grant of ten million French francs, which it allocated for the rehabilitation of the ropeway. When rehabilitation was complete, neither the MoWT nor the NTC conducted an evaluation. Although had one been conducted, it would have identified the degree to which the goal of rehabilitation had been achieved and might have identified any unanticipated consequences. It would have helped assess the conditions under which the system could have become more productive.

One major reason for this official apathy is the flawed institutional structure under which the NR functioned. As Figure 5.3 shows, neither the structure of the MoWT, under which the NR was located, nor the board and internal management structure of the NR were conducive to either policy support from above or innovations from below. NR managers had to cross too many levels to reach the attention of the final decision-makers.

FIGURE 5.3:
Organogram position of the NR within MoWT (1989)



CONCLUSION

The story of the NR is the story of failed institution building in Nepal. Its closure signals the dysfunction of a valuable technology appropriate for the country's terrain. It is the story of a reluctance to learn and to innovate so that the potential of an investment with multi-faceted benefits could be realised. There are several serious security and strategic reasons why the NR should have been properly maintained. Its importance was evident during the 1993 floods, when the Kathmandu was cut off. The NR could also have reduced Nepal's dependence on imported fossil fuels and used domestic hydropower. Political actors, however, paid only lip service to this idea. The failure of the NR is, for that reason, a national failure.

A ropeway system generates revenue by transporting goods and people. To meet the needs of ropeways, the government needs to formulate a break-even policy. It is surprising that, in an era marked by the ideology of the liberal market, the government decided to shut down NR rather than make it a candidate for privatisation, which could have created incentives for improving the performance of the NR.* Considerations for new ropeway ventures in the future must include the following:

- A culture of maintaining mechanical devices which, due to their moving parts, are sensitive to mismanagement, needs to be inculcated through a concerted support campaign if possible.
- A risk-reduction and insurance arrangement for rehabilitating ropeways has to be designed and put in place so that they can provide services during times of disaster.
- The economics of roads must be compared with those of ropeways. This approach must be holistic and include both the full investment costs of all components as well as the macro-economic analysis of carbon-based fuel and hydropower. Such comparisons must be part of the feasibility studies of all future roads in Nepal
- The impact of interruptions in power supply needs to be considered, especially for long-distance ropeways, and contractual responsibilities for losses must be borne by the electricity supplier.

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* Even when the 'privatisation' fad was at its height in the 1990s, no effort was made by the government to try this model of management even though a study to do so had been conducted in the mid 1980s. See Chapter 3 for a description of the proposed privatisation study. It is not that the private sector was not interested. See endnote 24 of Chapter 14—Editors.

CHAPTER 6

Construction Ropeways in Nepal

RESHAM RAJ DHAKAL

PECULIARITIES AND ANTECEDENTS

While building a hydropower plant, hotel or resort which is far away from a roadhead, ropeways are used specifically to transport construction materials, and sometimes construction crews. To take advantage of scenic spots, hotels and resorts are frequently built on the tops of ridges although the lack of roads renders them inaccessible. To obviate the need to build expensive roads to a site, a construction ropeway (unlike a road) can be erected for the duration of a project and then dismantled after the work is completed.

The benefits that a project in a remote site are likely to reap from the use of a construction ropeway need careful analysis before the decision to install a ropeway is made. How much a ropeway will cost and how it is constructed depends on the profile of the terrain and the length of the ropeway. The distinct problems each ropeway built would face are site dependent and each would require its own unique specifications. Unlike a regular passenger ropeway, a construction ropeway is temporary: it can be dismantled after a project is completed and later reinstalled at another site, thus adding significantly to the equipment's economic value.

The minimum safety factor for a ropeway that ferries people is seven, while that for a material ropeway is between three and four. Although the factor of safety of a construction ropeway is lower, its installation must nevertheless be based on serious scrutiny by competent technical persons. Because it is operated non-stop during the construction period, the risk of accidents is high. Construction ropeways have evolved gradually and the technology they use has improved. At present, efforts towards improving them are being directed towards perfecting their constituent materials: for example, light but very strong alloys are being used. The efficiency of such systems is being improved through automation.

In terms of tower support, a construction ropeway has more options than a passenger ropeway. Although concrete or timber can never be used to construct the towers of passenger ropeways because they are not safe enough, construction ropeways generally use one or the other of these cost-effective materials. If a ropeway is used for construction activities that involve major cement or concrete works, reinforced concrete towers are economical; otherwise, where hardwood like *sal* is locally available, timber towers save money.

The ground along the ropeway route must be made ready for erecting towers and pulling ropes. Trees along the ropeway's alignment over a width of four to eight metres should be cut down before a ropeway is installed. If access to the site is difficult due to the condition of the terrain, it is advisable to build a light auxiliary ropeway parallel to the proposed route to carry the components of the ropeway. In some cases, it may be economical to use a helicopter to transport the components of the auxiliary ropeway.

One major task involved during installation is the delivery of the skyline or track rope to the site. If the road to the site is suitable for carrying the load and if the track rope is not too long, it is advisable to transport the entire track rope in a single piece to avoid having to splice or couple lines. For longer lengths, the skyline is delivered in sections and connected on site. Because it may weigh as much as 40 tonnes, transporting a rope for a passenger ropeway is a difficult task: the track rope of a construction ropeway, in contrast, weighs less. Furthermore, safety needs in passenger ropeways preclude the possibility of splicing or coupling lines.

For those of us engaged in building construction ropeways, reflecting on the experience of others is useful. In 1936, the first aerial ropeway for transporting goods was constructed by POHLIG on the Chile-Bolivia border. The 14,000-metre-long ropeway serves as a gravity transport system that connects the crater of Mount Auchanquilcho at an elevation of 6,150 metres to the stations built 2,150 metres below.

The bi-cable ropeway of Sweden that connects Kristenberg and Boliden is 96,000 metres long. It is the longest ropeway in the world and is aligned over marshy land unsuitable for other forms of transport. The ropeway is supported on 503 concrete towers, of which only three are built on rock; the rest have reinforced concrete-pile foundations. The ropeway is split into eight sections, each of which is operated by a 135-HP motor with special speed-control gearing. It has a total of 916 carriers, each with a net load capacity of 1.25 tonnes and can carry 57 tonnes per hour.

The longest and probably the highest mono-cable ropeway is in Dorada, Columbia. Built in 1919 by Ropeway Ltd. (London), the 73,350-metre-long ropeway transports 20 tonnes of materials per hour. It has 15 sections varying in length from 2,538 to 5,800 metres. In 1962, British Engineering Co. Ltd. (BRECO) built and commissioned a 76-kilometre-long mono-cable ropeway in Gabon and Congo. Split into ten sections and designed to haul manganese ore, this system has a transporting capacity of 150 tonnes per hour.

NEPAL'S CONSTRUCTION ROPEWAYS

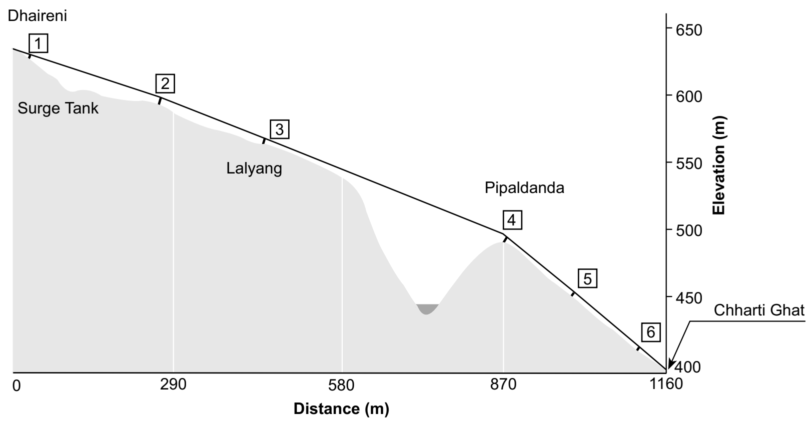
In Nepal, Himal Hydro has been involved in ropeway construction since 1984. Its first venture was the Andhi Khola Ropeway, which was implemented both as an experiment and to meet construction needs at the site. According to Tore Skei, the former General Manager of Himal Hydro, there was no easy access between the headrace and the tailrace tunnels of the Andhi Khola Hydro Project. Construction workers had to walk for more than one-and-a-half hours and porters were either not readily available or were too expensive. The company also faced problems hauling construction materials to the tailrace site of the hydropower plant. An attempt was made to build a road, but this necessitated launching the long bureaucratic process of securing approval from the DoR and the Department of Forest (DoF). Some Norwegian experts visiting the project area suggested that Himal Hydro build a ropeway to haul construction materials. Since ropeway technology was new for the agency, Odd Hoftun, the founding engineer of Butawal Power Company and Himal Hydro, contacted HMV Norway, a ropeway building and manufacturing company, to get information on how to design and build a construction ropeway.

Himal Hydro began the survey and construction of the ropeway under the supervision of Mark Gill. The 1.2-kilometre-long ropeway was installed in 1985. Although there were problems, the ropeway performed satisfactorily throughout the project's construction period, transporting cement and reinforcement bars to the site. Later a slightly more advanced ropeway system was built at Jhimruk. It was 1.8 kilometres long. Himal Hydro went on to build another ropeway at the site of the Khimti Hydropower Project in Dolakha District; this one was two kilometres long and had passenger transportation facilities.

Andhi Khola Ropeway

The Andhi Khola Ropeway was a single carrier, bi-cable, non-circulating material ropeway. The loading station was at the headrace tunnel of the plant and was accessible by road, while the unloading station was located near the tailrace tunnel. A very simple winch (a second-hand one imported from Norway) was used at the loading station to

FIGURE 6.1:
Profile of Andhi Khola Ropeway (not to scale)



The number in box represents tower

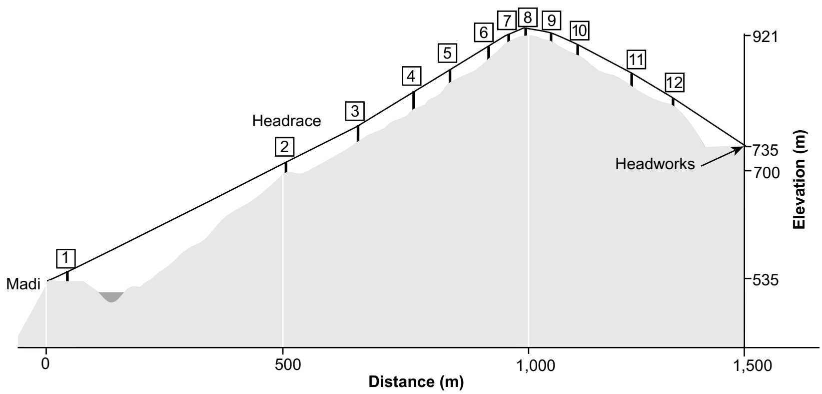
operate the system. The one-track rope had a single 300-kilogramme-capacity carrier. Cement and steel bars were transported from the headrace to the tailrace and the sand required for constructing the surge shaft was transported in the opposite direction. A total of six towers were built. *Sal* wood poles manufactured by Butawal Plywood Factory were used until tubular poles became available.

Since it was Himal Hydro's first ropeway, the company encountered many problems during its construction and operation. For example, in Lalyang, near pole no. 3, the cable was about two metres out of line; it was later aligned by trial and error. Because pole no. 4 was not high enough, there was insufficient clearance and the bucket kept hitting the ground. To solve this problem the ground was dug up and its elevation lowered by half a metre. Occasionally buckets would fall off because the alignment was not perfectly straight. In a bi-cable system it is very important to have the alignment straight to avoid derailment. The cable used was spliced together, which created a small bump in the rope. It was not certain whether the old cable had to be replaced or whether adjusting the buckets after every run would suffice. The Himal Hydro team could not decide whether it was more economical to replace the cable or to keep muddling along with re-loading and adjusting the bucket because the system was expected to work only for the duration of the construction. They also had to ensure that neither workers nor people in the vicinity were hurt.

Jhimruk Ropeway

In 1990 Himal Hydro built the Jhimruk Ropeway, its second venture in construction ropeways. The headworks of the Jhimruk Hydropower Plant, where major construction

FIGURE 6.2:
Profile of Jhimruk Ropeway (not to scale)



The number in box represents tower

work took place and where most of the materials were needed, was located at the point farthest from the project's main store. The ropeway served both the main store and the headworks. The horizontal length between the two stations was 1,520 metres, while the actual length of the rope was 1,640 metres. The buckets travelled 2.5 metres per second and took 11 minutes to move from one station to the other.

The ropeway had three stations: the store at Madi (used as the drive station), the headworks site (used as the return station) and the shaft (the intermediate station). The transfer system at each point included a gib/electric hoist[1] to transfer loads onto and off of the ropeway as fast as possible. Flatbed bogeys were used to transport materials to and from the stations to user or storage points. The intermediate station was provided with a separate ropeway going directly to the store 170 metres away.

Constructing the Jhimruk Ropeway was more difficult than constructing the Andhi Khola Ropeway. We had problems stringing the cable and controlling the bucket's speed while it moved from the ridge to the bottom. Clearing the site was another problem as obtaining permission from the Department of Forest was a slow process that caused delays. Access to the main ridge from Madi was also a major problem as this section was heavily forested. Intermediate stations were used to support the cables, thereby taking advantage of the hilly terrain and keeping the number of towers required to a minimum.

In addition, the wind created problems, which were revealed by the scratch marks made on tower no. 3 by swinging buckets. A bucket which hit the tower would stop and twist off the cable. To counter the problem, guiding pipes were attached to the ends of the buckets to prevent collision. Another reason that buckets fell off was that the tower close to the headrace was out of alignment. Misalignment pulled the track cable away from the bucket's trajectory and also resulted in excessive wear on the pulleys. Shifting the tower and correcting the alignment of the rope solved the problem.

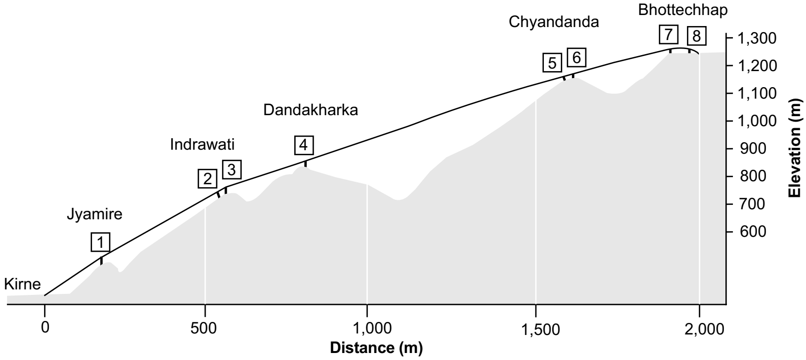
We were also uncertain about the level of initial tension to be provided to the track cable and tentatively set it at five tonnes. Later we established that this was the maximum allowable tension. It was measured using a two-tonne-capacity dynamometer connected by a four-rope block-and-pulley system with an anchor and chain blocks. This setup was accurate but after the cable had been secured and the chain block released, it was difficult to assess the loss in tension due to the slack that occurred at the clamps and fittings. It became clear that five tonnes was far too much because the cable almost lifted out of the cable shoe at towers no. 2 and 4.

In fact, at any tension greater than 2.5 tonnes, the track cable came out of the track shoe at tower no. 3, which was too low. In order to prevent the cable from lifting out from the shoes, clamps were used and the pretension was set at four tonnes (it measured about three tonnes after the release of the dynamometer). The problem stemmed from a lack of communication between the designers, who were out of Nepal when the ropeway was being installed, and the erectors, who did not know what design assumptions had been used. We learned how important it was for someone who understands the workings of cable systems to be available for consultation when a ropeway is installed and adjusted. Ultimately, through trial and error, we found out that the most suitable pre-tension value for the track cable was three tonnes measured at the drive station and that the best pre-tension load for the hauling cable was 800 kilogrammes.

Khimti Ropeway

The Khimti Ropeway was used to transport both materials and passengers from Kirne to Adits 5 and 4, both of which were inaccessible. This system had three stations: Kirne (drive), Adit 4 (return) and Adit 5 (intermediate). Tractors were used to transport materials from the unloading area to the portals of the tunnel. The ropeway had a six-passenger chair which could be easily assembled and dismantled as and when needed. The Khimti Ropeway was designed with a maximum design payload of three tonnes, which was the weight of one nine-metre-long section of penstock piping. In addition to the penstock, the ropeway also transported pipes, cement bags, sand, aggregate and reinforcement bars. The horizontal length of the ropeway was 1,952 metres, its line length was about 2,100 metres, and the difference in elevation between the end stations was 622 metres. The speed of the bucket was about two metres per second, or 17 minutes between end stations. A round trip, including the loading and unloading of loads, took about 40 minutes.

FIGURE 6.3:
Profile of Khimti Ropeway (not to scale)



The number in box represents tower number

USABILITY AND DIFFICULTIES

A construction ropeway can, in principle, be dismantled and used elsewhere once it is no longer needed in one area. For example, the ropeway cables and winch from the Andhi Khola Ropeway were first used to string first the Jhimruk and then the Khimti ropeways. Roads do not have the benefit of reusability that ropeways do. In fact, making a road in a dense forest area is undesirable and in the hills it cannot guarantee regular service during the monsoon. Another advantage of a ropeway is that it can be operated any time except when wind speed is very high.

While the Khimti Ropeway was being installed, problems such as acquiring land and cutting trees emerged. Securing permission to cut trees, in particular, resulted in delays. Because the forest along the track was dense, sighting was difficult and the design tolerance limit[2] was extremely difficult to maintain. The visibility maintained in the horizontal plane was less than 2.5 feet. The alignment had to be surveyed more than 10 times so that it would remain within allowable limits. Towers nos. 4, 5 and 6 were located on private land and the owner was initially not willing to sell the land or to allow any work on it. Only after difficult negotiations was the land bought. The forest along the alignment also caused difficulties during the survey.

Another problem encountered was transporting materials to intermediate locations. Most of the ropeway parts were prefabricated and many were heavy; some weighed up to 700 kilogrammes each. Since mules and porters could not transport such heavy components, helicopters were used. Transporting the 30-tonne track cable from Calcutta to the site, particularly along the leg from Mugling to Naubise, was another major problem. This was because floods had washed out three bridges in 1993 and they had not been rebuilt. At these three crossings, new diversions were made. At the Charnawati Bridge (near Charikot in Dolakha District) extra support was provided from below the bridge because of uncertainty about its load capacity. It took a month to transport the ropes to the site.

Communicating between intermediate stations while stringing the cable was a challenge. The towers were more than 300 metres apart, so neither shouting nor signalling worked. Effective communication required walkie-talkies.

The designed height of tower no. 3 was 12 metres but during the stringing of the cable, it became evident that the cable did not touch tower no. 2. So that the cable would rest on all the pulleys and pressure on both towers would be equal, tower no. 3 had to be lowered one metre by cutting its legs. According to the specifications, the pre-tension of the main cable was to be 35 tonnes; to overcome the sag, however, pre-tension had to be increased to 40 and then to 46 tonnes. The salient features of the Andhi Khola, Jhimruk and Khimti ropeways are listed in Table 6.1.

COST COMPARISON

Since the three ropeways were built in different years, in different context and using different design assumption a single approach cannot be used to compare and evaluate their economic performances. Even so, a comparison of costs is insightful. The components of a ropeway that have to be imported from overseas countries make up almost 70 per cent of its total cost. Local materials, including towers, account for the rest. If the capacity of local manufacturers to build ropeway components was enhanced, overall project costs would come down by about 20 to 30 per cent.

TABLE 6.1: Salient features of Himal Hydro's ropeways

S N	Description	Andhi Khola	Jhimruk	Khimti
1	Length (km)	1.2	1.8	2.07
2	Longest span (m)	300	535	822
3	Number of poles	12	19	8
4	Elevation difference (m)	250	200	523
5	Pay load (kg)	300	350	3,000
6	Line speed (m/s)	2.5	2.5	2
7	Loading and unloading time (min)	10	10	15
8	Skyline Dia (mm)	12	15	42
9	Hauling cable (mm)	9	10	24
10	Total construction cost Rs $\times 10^6$	2.3	3.5	35
11	Commissioned (yr)	1985	1990	1996
12	Dismantled (yr)	1990	1994	2000
13	Total hauled tonnes per year	1,300	3,375	22,000
14	Load travelling time (min)	16 (round trip)	11 (round trip)	17 (one way)
15	Winch type	10 kW motor (14 HP) diesel winch	15 kW 1,470 rpm 380/220V	77 kW, T-2,300- V, 380 x 3 V

The cost of transporting materials by the Andhi Khola Ropeway can be compared to the costs of road, porter and mule transportation. To gain 250 metres in elevation for every 1,200 metres traveled in the existing terrain would have required constructing three kilometres of road, which, at the prevailing prices for hilly terrain, would have cost about Rs 30 million. (The rate for a 'green road', is lower, but this estimate takes into consideration that this road would have to support heavy construction equipment). A second choice was to hire porters. But at Andhi Khola porters were expensive: they were hired by *lahures* coming home from the Indian or British armies and commanded prohibitively high wages of about two to three rupees per kilogramme. Mules were available at rates up to Rs 1.5 per kilogramme.

Considering the depreciation of the plant and its equipment as well as the interest on the borrowed capital (20 per cent depreciation and 15 per cent interest), the annual capital cost of the ropeway was estimated to be about Rs 805,000 (0.35 × 2.3 million). The plant's annual operation and maintenance costs came to Rs 110,000 a year. In one year the Andhi Khola Ropeway transported 1,300 tonnes of construction materials at the cost of Rs 704 per tonne. This was three times less expensive than what would porters would have charged.

The total cost of building the Jhimruk Ropeway was Rs 3.5 million and its annual operation and maintenance costs were about Rs 140,000. It transported 3,375 tonnes a year. The estimated cost of transportation worked out to Rs 405 per tonne, which is less than the cost of the Andhi Khola Ropeway. In Jhimruk, too, porters or a road could have been used. Porters charged Rs 1.5 per kilogramme. The ropeway, which reduced the cost to less than one rupee per kilogramme, was clearly more economical. To reach the headworks four to five kilometres of road, at a cost of about Rs 40 to 50 million, would have had to be built. It would have required nearly 1,125 trips by truck (at three tonnes per trip) to carry the materials, which would have added Rs 450,000 (at Rs 500 per trip) to the cost.

For the Khimti Hydropower Project, there were three alternatives for reaching Adit 4 from Adit 5: building a road, hiring porters or using mules. Since mules could not transport reinforcement bars, pipes or wooden beams, they were ruled out. Although they could have been used to transport sand, cement and aggregates at Rs 1.5 per kilogramme, instead porters were used to transport loads at the rates of Rs 1.61, Rs 2.0 and Rs 2.68 per kilogramme for easy, medium and difficult loads, respectively.

The total cost of building the Khimti Ropeway was Rs 35 million and its operation and maintenance costs for one year totalled about Rs 3.3 million. The total annual cost, including interest, depreciation, operation and maintenance, was Rs 10.1 million ,and the ropeway transported about 22,000 tonnes of construction material a year.

Thus, the estimated cost of transportation of material was about Rs 459 per tonne or Rs 0.46 per kilogramme. This rate is less than those charged by porters and by mules. In addition, the ropeway had the benefit of transporting people. The cost of an eight-kilometres road (six kilometres to Adit 4) would have required an investment of a minimum of about Rs 80 million rupees. Building a road would have had another limitation: once the construction of the power plant was complete, there would have been no economic justification for it as there would be no regular traffic on it. The 'scrap value' of a road is zero, whereas that of a ropeway is high if it is sold as metal scrap. Its value is still higher if it is used at another site. A comparison of ropeways with roads is given in Table 6.2, and supporting details are provided in Annex A.

OTHER ROPEWAY INITIATIVES

In addition to constructing ropeways at Andhi Khola, Jhimruk and Khimti, Himal Hydro conducted feasibility studies for other ropeways. In 1990, Himal Hydro and Butawal Power Company (BPC) jointly completed a feasibility study of a nine-kilometre-long material ropeway in Manma in the Far-Western Development Region. The ropeway was to have a capacity of one tonne per hour with a single bucket. In 1995 Himal Hydro completed a pre-feasibility study of a ropeway intended to transport construction materials from the road head at Timbu-Ghangul to the intake site of the proposed Melamchi Water Supply Project. The seven-kilometre-long ropeway was to have double buckets and a capacity of 1.5 tonnes per hour. The estimated cost was about Rs 17 million.

In 1996 Himal Hydro prepared a feasibility study for the Bagmati Watershed Project for extending the Bhattedanda Ropeway. The proposed four-kilometre-long ropeway was to have a single bucket and a target capacity of 600 kilogrammes per hour. The company also prepared a feasibility study of and preliminary design for a

TABLE 6.2: Comparing ropeways with roads

Type	Ropeways		
	Andhi Khola	Jhimruk	Khimti*
A. Ropeways			
1. Capital cost (Rs $\times 10^6$)	2.30	3.50	35.00
2. O and M (Rs $\times 10^6$)	0.11	0.14	3.30
3. Energy cost (kwh/kg)	0.02	0.012	0.01
B. Roads**			
1. Capital cost (Rs $\times 10^6$)	35.00	45.00	84.00
2. O & M (Rs $\times 10^6$)	0.70	1.00	1.50

* The cost of the Khimti Ropeway was Rs 16.7 million per kilometre, much higher than the costs of the Andhi Khola and Jhimruk ropeways. This was because the Khimti Ropeway was heavy and was designed to transport people as well as materials.

** The energy costs of an equivalent road to Khimti are discussed in Annex A.

seven-kilometre-long ropeway designed to transport 500 tonnes of solid wastes daily from Kathmandu and Lalitpur to a proposed landfill site at Simpani. A feasibility study for a five-kilometre-long passenger ropeway from Matatirtha to Chakhel that would be able to carry 150 passengers per hour, was also completed. Himal Hydro was the main civil contractor responsible for building the Manakamana Cable Car from Kurintar to Manakamana temple (Chapter 11).

CONCLUSION

Construction ropeways are an appropriate technology for transporting goods to areas where road construction is not feasible or is environmentally undesirable or where the road would not be used once a project was complete. Ropeways can be built at a reasonable cost. The use of construction ropeways in Andhi Khola, Jhimruk and Khimti has shown that they are a cost-effective method of transporting materials. Although the initial investment in and the operation costs of the Khimti Ropeway were high, other methods of transport would have been even more expensive. In addition, while the Khimti Ropeway was built in six months, a six-kilometre-long road would have taken at least a year to complete. Besides, roads in the hills can be blocked by landslides or washed away during the monsoon halting the supply of materials to the site and causing delays in project completion.

Before a decision to build a ropeway is reached, maintenance and operation aspects must be given serious thought. Regular maintenance is necessary for continued services; without it, the costs of operation increase, sometimes dramatically. As far as safety and control are concerned, ropeways longer than three kilometres are difficult to operate and must be designed with adequate provisions. In addition, a single operator cannot monitor a long ropeway and employing more than one operator complicates management. Splitting a reach into small sections and allowing each unit to be operated by different individuals may overcome such constraints, but then coordination becomes problematic.

Though ropeways have been in use in Nepal for a long time, the technology is not widespread and not much is commonly known about them. Ropeways should be promoted as an appropriate and useful technology and the local institutional capacity for designing, building and using them strengthened. Care should be taken, however, as incorrect selection and use of a technology can earn it a bad reputation in the early stages before it is popular. An important question is how the cost of a ropeway can be reduced without compromising its safety. As mentioned above, imported mechanical parts constitute 70 per cent of the total cost of a ropeway, where as local materials constitute just 30 per cent. Designing and manufacturing mechanical parts locally would bring down the total cost significantly.

NOTES

[1] A gib or electric hoist is a device made from steel parts which is fixed at loading and unloading stations and operated by electric power to transfer loads into a bucket.

[2] The design tolerance limit is the allowable variation in the alignment. In this case it was ±3 millimetres in the horizontal plane over a two-kilometre span.

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CHAPTER 7

Industrial Ropeway at Hetauda Cement Factory

GANESH KUMAR SINGH

HAULING STONES

Many industries use ropeways to transport raw materials to their production lines. In a cement factory a ropeway can be used to bring limestone from the quarry to the processing plant, which is one of the central activities in cement production. The cost of transporting limestone determines the cost of the cement produced, and, as a result, the commercial viability of a plant. Heavy-duty vehicles are also often used to transport stone. Though this practice has the advantage of flexibility, a large number of mechanics are needed because vehicles require regular maintenance to avoid breakdown. Furthermore, transport by trucks is expensive because they run on imported fuel. Shortages of fuels, which occur from time to time due to local, national and international causes, jeopardise their smooth operation.

A ropeway is a reliable system for moving stones. Though a ropeway runs on expensive equipment requiring high initial capital investment, its maintenance and operational costs are less compared to those of trucks. Another advantage of a ropeway is that, except for high winds—which last for a short time anyway—unfavourable weather conditions, in particular the monsoon rains, do not affect its operation. Its effective operation is, however, critically dependent upon regular maintenance and immediate repair. Continuity is essential as even a brief stoppage in the provision of limestone can completely disrupt cement production.

For a cement factory, using an electric ropeway is a viable alternative to relying on trucks. A ropeway ensures a regular supply of stones and, in view of Nepal's hydro-electricity potential, fits well into the local economy. The following sections describe some technical aspects of the ropeway used at the Hetauda Cement Factory; the technical details are provided in Annex B.

THE ROPEWAY SYSTEM

The Hetauda Cement Factory uses a bi-cable circulating ropeway system to bring stones from a quarry located 11 kilometres away (Figure 7.1). Usha Breco Ltd., an Indian company, constructed the ropeway, which can transport 150 tonnes of stones an hour from the silo at the quarry through the needle gate and the apron feeder and along the conveyor to the unloading station at the factory. Not only is a ropeway reliable, the cost of transporting a tonne of limestone by ropeway is Rs 61, thirty rupees less than transporting the same amount by truck. By using a ropeway the factory saves about two million rupees annually in stone transportation alone. The ropeway presents no major operational problems as long as the supply of electricity is uninterrupted.

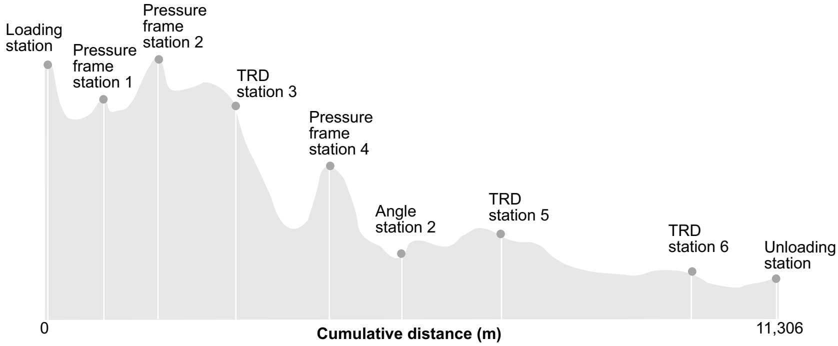
The Hetauda Cement Factory Ropeway System has three major components: line equipment, a loading station and an unloading station.

Line equipment

The essential characteristic of this system is the use of two static overhead ropes on which carriers run. Each carrier has a hanger, from which a bucket is suspended. The hanger is attached to the hauling rope, which moves continuously in a loop. The wheels of the carrier enable it to ride over the track rope. The ropes are supported at a convenient height above the ground by means of trestles or towers spread out along the line. Each trestle is provided with oscillating saddles with grooves that support the track ropes and rollers that support the hauling rope. One track rope carries loaded buckets, while a second rope, whose diameter is smaller, carries empty buckets. Because the buckets carry loads from the quarry to the plant but return to the quarry empty, two different sizes of track ropes are used. The two track cables run parallel; the distance between them (the ropeway gauge) is four metres. The carriers grip the moving hauling rope along the entire line, they are detached only at the loading, divide and unloading stations, where they are removed from the track rope and moved onto fixed rails.

If the distance between the supporting structures is great, the tension in the track ropes is high. This situation often occurs when a tower cannot be located at a proper site or the ropeway crosses a wide valley. When spans are long, large and strong supports are provided and pressure-frame-cum-track-rope divide stations are installed. In these stations, a battery of rollers support the hauling rope. The track rope is supported either by the front or rear saddle of the pressure-frame-cum-track-rope divide station. It has to be anchored near the station entrance or exit either by

FIGURE 7.1:
Profile of ropeway from loading to unloading stations



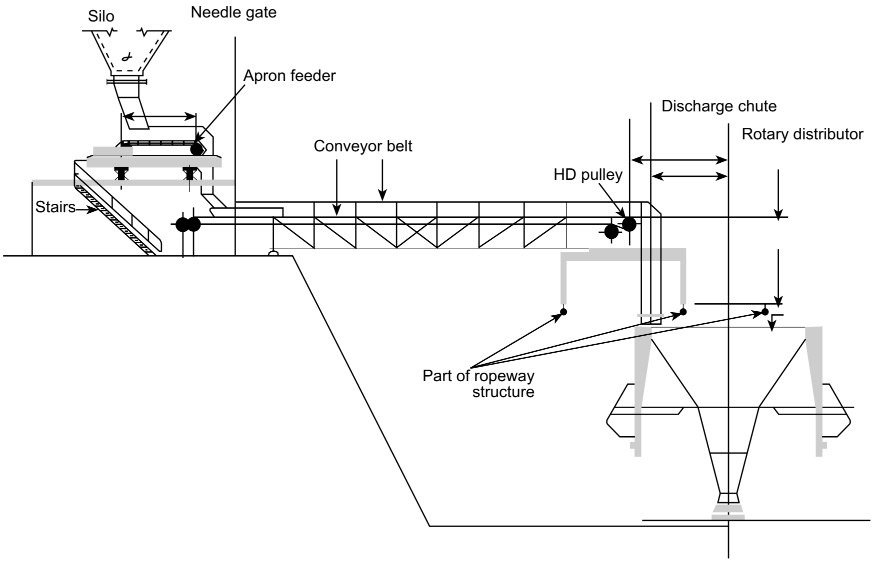
dead-weight or tension anchors. A tension of about 76 metric tonnes is provided on a loaded rope, whereas on the unloaded side the tension is maintained at a maximum of 33 metric tonnes. The track rope is divided into small lengths along the ropeway line to avoid high tension and the need for thick ropes. A frame called a pressure frame (PF) is used to take up the load. In addition to the PFs, the ropeway has track-rope divide (TRD) stations where track ropes on one side of the station can be tensioned using weights. There are three PFs (PF-1, PF-2 and PF-4) and three TRDs (TRD-3, TRD-5 and TRD-6) in the Hetauda Cement Factory Ropeway. There are fifty-seven trestles and one divide station. In all, there are nine stations. At each TRD and PF station, buckets move onto rails upon entering the station.

Each steel-latticed trestle has a cast saddle with grooves for supporting the track rope and providing for oscillation. When the line is empty of buckets, the hauling rope sags excessively; thus, two rollers are provided on each trestle to support it. V-shaped rods guide the hauling rope onto the rollers. A cathead is provided at the top of each trestle to allow for the lifting of the track ropes with suitable tackle while removing a saddle or hoisting a rope. Each tower supports seven wires at the top; they are used for telephoning, issuing commands, emergency control, standby operations, and to indicate faults at the unloading station. These wires help control and monitor ropeway operations. There are 164 bottom-discharge buckets with catch levers and chains for automatic tripping and self-latching. Each carriage has a bucket made of a steel frame, four wheels with nylon liners, and an automatic jaw-gripping device equipped with an operating lever to clamp it to the hauling rope.

Loading station

Once limestone is mined, it is crushed using heavy machines at the quarry. Then it is fed to a silo, from which it flows through a needle gate onto an apron feeder. The

FIGURE 7.2:
Loading station at Hetauda Cement Factory (schematic)



feeder, in turn, discharges the material onto a belt conveyor, which carries it to the loading station, where it is fed to the rotary distributor for loading into buckets (Figure 7.2).

The apron feeder and the belt conveyor are designed to transfer 360 tonnes of limestone per hour at peak capacity. The apron feeder has a variable speed drive arrangement to regulate the flow of limestone. The centre distance of the apron feeder is 3,658 millimetres. A 15-kW motor with a controlled eddy current, variable speed drive and a speed rating between 120 and 1200 rpm is used to drive the feeder. The belt conveyor has an independent drive provided by a 10-HP squirrel cage motor. The conveyor is equipped with a weighing arrangement to indicate the flow rate of the material.

A speed-sensing device controls the start and stop of the apron feeder motor. Unless the ropeway attains full speed, the apron feeder will not start. The ropeway takes nearly 90 seconds to accelerate to full speed, whereas the feeder motor accelerates instantly. This speed-sensing device is used to prevent the spillage of material on the floor of the station due to any inaccuracy in timing its transfer to the ropeway from the feeder.

The rotary distributor is divided into four compartments, each with an attached chute. The complete unit rotates in such a way that material is delivered to each compartment as it passes under the four discharge chutes. Each chute, in turn, feeds the material into a ropeway bucket, which is pushed around the station rail loop by an arm attached to the rotating distributor chute. The speed of the distributor is adjusted so that it will continuously deliver full buckets of material at the correct time interval. The distributor is driven by the driving sheave, so its speed is controlled by the speed of the ropeway.

A steel structure forms the rail support, which carries the buckets after they arrive at the station and are detached from the hauling rope. The speed of the buckets is reduced and finally stopped by an automatic spacer, which allows each bucket to enter the rotary distributor at the correct time interval. The spacer is guided by a trip mechanism operated by the distributor. The bucket is then loaded by the distributor and pushed automatically around the return loop onto the outgoing side. At this point the rail slopes in order to accelerate the buckets to the speed of the hauling rope under the control of the overhead chain retarder driven from the ropeway sheave. Each bucket is then attached to the hauling rope using a jaw-gripping mechanism before it passes out onto the line. Four rail switches are provided either for transferring buckets from the station rail to the parking rail, where the buckets can be repaired, inspected, or changed, or for loading new buckets from the parking rail to the station rail.

The main drive gear comprises a 240-kW, 1500-rpm DC motor, a drum-type coupling with a manual brake, a gear box, a geared coupling, a driving pinion, a fleeting sheave in a spherical roller bearing plumber blocks, and a thrust bearing. The sheave is driven by spurring fitted to the sheave rim. Also attached to the sheave rim is a brake ring. The hand brake is operated by weights. The drive sheave is mounted on a sheave frame and the complete drive gear unit is mounted on a fabricated bedplate fixed on a foundation.

Also present at the loading station is the hauling rope lubricator, which consists of a tank filled with oil and is equipped with a shut-off cork and rope lubricating brushes. The hauling rope is lubricated using a drip-feed system.

Unloading station components

A loaded bucket arriving at a station is transferred from the rope to the rail after passing over the entrance saddle bar. It continues through the unlocking frame, where its grip is automatically detached from the hauling rope. The bucket then decelerates under the control of the overhead chain haulage. It passes over the hopper, where it is emptied when the bucket-catch strikes the trip gear. Under the control of a chain retarder, the bucket then passes onto an accelerating grade into the locking frame, where it is re-attached to the hauling rope. It then passes over the exit saddle and saddle bar onto the return sidetrack rope. The unloading station has provisions for removing damaged buckets from the line and replacing them with good buckets.

Damaged buckets are kept in the parking rail for maintenance. Rail switches are operated manually and are used to put on or take off buckets. The unloading station also houses the hauling rope tension gear.

INSPECTION, REPAIR AND MAINTENANCE

To ensure its good performance, long life and smooth operation, it is necessary that the various parts of the ropeway system be inspected regularly and repaired if necessary. The track rope, hauling rope, carriers, tension equipment, and towers, as well as other equipment in the loading and unloading stations, should be inspected every three months or after 1,000 hours of operation. They should be cleaned, greased, and adjusted as required.

To lubricate the ropes there is a track-rope oiling car equipped with a special carriage which has an oil tank. As the car traverses the line, oil is fed onto the rope from the tank through pipes. A special car called an inspection car is used to inspect the ropes. The inspector sits inside the car, which is enclosed in wire mesh for his protection. The car is fitted with a collapsible ladder on which the inspector can stand when inspecting the rope.

Routine maintenance is necessary to ensure that bolts are tight and that steel parts missing from the towers, stations and pressure frame are replaced. To prevent corrosion, the structures are periodically painted. The alignment and level of the foundations of the structures are also regularly checked. The foundation material is likely to erode or sink in the monsoon, and the structures may tilt. The level of a trestle is important as its sinking may lead to serious damage or may cause the track rope to lift off the trestle. Insulators and overhead wires on the tower top are checked to ensure that they are in proper working condition. Damage to the wires, such as the fault and emergency wires in the unloading station, will prevent the ropeway from starting. An oiling and cleaning record is maintained for each station. A record of the cars, arranged in numerical order, is also kept to note the date on which each carrier was last oiled and serviced. The major areas requiring repair and maintenance are discussed below.

Track rope

To prevent the track rope from becoming dried out and rusty and to ensure that the rope is lubricated at all times, the oiling carrier must be sent out along the line at regular intervals. The exact interval depends on humidity, temperature, and other weather-related factors. The rope must be lubricated more often during the rainy season and must also be checked to ensure that there is no breakage. Both activities can be done from the inspection carrier. If a wire is broken, immediate remedial action must be taken, either by brazing the wires or by using a sleeve cover over the broken part. While carrying out repairs, care must be taken that there are no protrusions of wire which could cut into the nylon carriage wheels. Also, when the rope is lifted from a saddle onto a trestle, care must be taken so that the rope doesn't kink.

Track rope tensioning

To replace the entire track rope or a section of it, the following procedure is adopted. The tackle is rigged at the dead end in order to lower the tension weight and the old rope is lowered to the ground. The new rope is pulled out over the ground, protecting it from obstacles using logs and rollers. The actual method of pulling depends on the availability of equipment. At the Hetauda Cement Factory a heavy bulldozer with tracks and a winch drive is usually used. It is necessary to position the reels along the line and to avoid pulling the entire length at once, a process which requires a very powerful winch.

Splicing

When it is necessary to splice the hauling rope, the first step is choosing a location for carrying out the work. Splicing can be done only on the ground. Any point along the line where the trestles are not very high and access is convenient can be chosen.

Carrier

The carriages are inspected every three months. They are cleaned, greased, and adjusted. All worn-out parts are replaced. A spare carrier replaces any damaged carrier on the line so that the ropeway can still operate while the damaged carrier is being repaired. The damaged carrier is repaired immediately and kept in a parking rail at a station as a spare. All castings are carefully examined for cracks, particularly if a carrier has fallen or derailed. Another potential problem is with the carriage unlocking rollers; if they are worn out they may prevent the carrier from detaching from the rope. They must be kept well lubricated so that they can rotate easily and do not wear out. A roller must be replaced as soon as its diameter is worn down by more than 10 millimetres. Likewise, gripping jaws always have to be kept clean so that they work properly; this step is necessary because safety depends heavily on the reliable action of moving parts. The nylon liners in the carriage wheels break or wear out often. When that happens, they have to be replaced with new carriage wheels or the nylon liners have to be changed.

OPERATIONAL PROBLEMS

Ropeway operation sometimes poses problems. Despite routine maintenance and repairs, some mechanical failure is inevitable. Some of the problems that have occurred in the past were due to parts becoming old and worn with use, while others were due to weather or the lack of parts and equipment. Over the years quite a number of problems have occurred, ranging from the simple to the bizarre.

The coupling of a load sidetrack rope failed once. This major snag took one-and-a-half months to rectify. In order to avoid such problems in the future, about 1,000 metres of track rope was replaced while the coupling was being fixed. The track rope has fallen off the towers twice; each time it took two to three months to repair and cost 1.7 million rupees. Of the seven wires on the tower tops, only three are currently working: the emergency wire (for stopping the ropeway) and two telephone wires. There was also a problem with the DC motor winding at one point and four of the coils had to be changed. They were ordered from Kirloskar, an Indian company, at a total cost of one million rupees, but since Kirloskar said it could supply the coils only after six months and it was not desirable to keep the ropeway inactive for such a long time, locally-made coils were used temporarily. The motor started running at a slower speed—1,000 rpm as opposed to 1,400 rpm—but the factory had to make do until the new coils arrived.

A new problem that has occurred after 17 years of operation is that one pressure frame has sunk because of a landslide and is no longer supporting the track rope. Heavy rainfall and the difficulty in accessing the pressure frame have made it necessary to shut down the ropeway temporarily. Because some of the towers and pressure frames have been built in places that are difficult to access by road, it is difficult to rectify problems which occur at these locations, especially during the monsoon season. Even problems that could have been solved easily became problematic and rendering them time-consuming simply because it was hard to reach the towers. To overcome such problems, the Udayapur Cement Factory, which has a similar ropeway system, has built all its supporting structures in easily accessible locations in order to reduce the time and effort required for repair and maintenance.

One bizarre problem occurred when the local municipality started dumping garbage under the ropeway line. A dumpster truck got entangled in the hauling rope and was lifted by it and carried over a mountain before it fell off. Luckily no one was hurt, but it could have been a serious problem endangering lives and damaging the ropeway. This unexpected problem was the result of ignorance. A few other operational problems that have been encountered are itemised below.

1. High voltage can cause surges and even burn ropeway components, both of which are problematical.
2. Breaker trips due to interruptions in the supply of electricity are a common problem faced by the ropeway.

3. Gearbox lubrication pressure needs to be maintained at all times.
4. High wind speeds cause buckets to swing. It is important to stop the system until the wind speed decreases.
5. Scattered pieces of limestone accumulate along the line, causing low clearance and obstructing the passage of the buckets. These accumulations need to be swept away periodically .
6. Nylon tyres should be replaced as soon as they are damaged.
7. Nuts and bolts become loose during operation; their tightness must be checked daily before and after operation.
8. The gearbox is a vital part of the system and when changed should be replaced. A spare must be kept available in the inventory.
9. If the grip of a bucket is loose, it fails to hold onto the rope. It then runs faster due to gravity, striking other buckets on the line and damaging them. To prevent this, all grips have to be checked regularly.
10. It is necessary to employ a trained splicing expert. The factory has trained technicians to splice the hauling rope.
11. The emergency system still uses a naked wire, which causes problems because it breaks down often. If possible, naked wires should not be used.
12. The factory uses a naked wire and an old-style telephone system for communication. It is unreliable and breaks down frequently. As a result, communication among the various stations along the ropeway fails every now and then. A modern communication system would prevent such failures.
13. The side roller should run smoothly. While the clamp is being unlocked, the carriage should not jerk sideways or grind on guard angles. Locking and unlocking must be smooth and free from any jerking or snagging.
14. A minimum of three buckets should always be in the retarder and at the spacer. Fewer than three buckets results in a missed spacing and the material for the missing bucket will be discharged onto the ground. To prevent the material from spilling, whenever damaged buckets are put on the parking rail for servicing, good buckets should replace them.

CONCLUSION

This semi-automatic ropeway system brings limestone from the quarry to the Hetauda Cement Factory as part of the continuous feeding of raw material to the production process. For this reason, it could be thought of as an industrial ropeway. For the plant to remain operational, the ropeway must keep delivering limestone; any delay in supply diminishes the plant's cement output. Unlike other ropeways used for transporting cargo or passengers, this ropeway is an integral part of the production process and must run to ensure that cement production continues. Time is very important in any production line. Proper coordination between the operation of the ropeway and that of the main cement plant is critical.

Because it carries stones, the parts of this ropeway wear out quickly. Also, since it works automatically at several stations, including the loading and unloading stations, a snag at one point creates problems for the entire cement production system. Continuous monitoring of the system and a very effective repair and maintenance team is an absolute necessity. Though a few problems have hampered the delivery of stones in the past, the maintenance team at the factory has ensured the proper functioning of the ropeway.

The ropeway runs for long hours. The people involved in the operation and maintenance of the ropeway at the Hetauda Cement Factory are able to operate it as required and to deal with challenges successfully. The ropeway helps bring down the cost of cement production to a competitive level, which is important if the industry is to contribute to the national economy.

The use of a ropeway to transport limestone has proved to be effective. The main reason for its success is that once the ropeway begins running it can transport limestone almost continuously with very few stoppages. Fewer employees can operate and maintain it than would be needed to operate a fleet of trucks. Time and again there have been shortages of petrol and diesel in Nepal; if trucks had been used this would have resulted in disruptions in the supply of limestone to the factory.

One problem regarding the ropeway is that when breakdowns occur the time required to repair the system can sometimes be long (measured in months) simply because replacement parts are not available within the country. The stoppage can result in financial losses because production is hampered. Another problem is that some towers and stations are located in isolated places and accessing them to conduct repairs is difficult, especially during the monsoon. A final disadvantage is that a specialised maintenance crew is needed to check the system thoroughly because of the large distances over which inspections and repairs must be carried out.

CHAPTER 8

Bhattedanda Milkway:
Making Markets Accessible to Marginalised Farmers

MADHUKAR UPADHYA

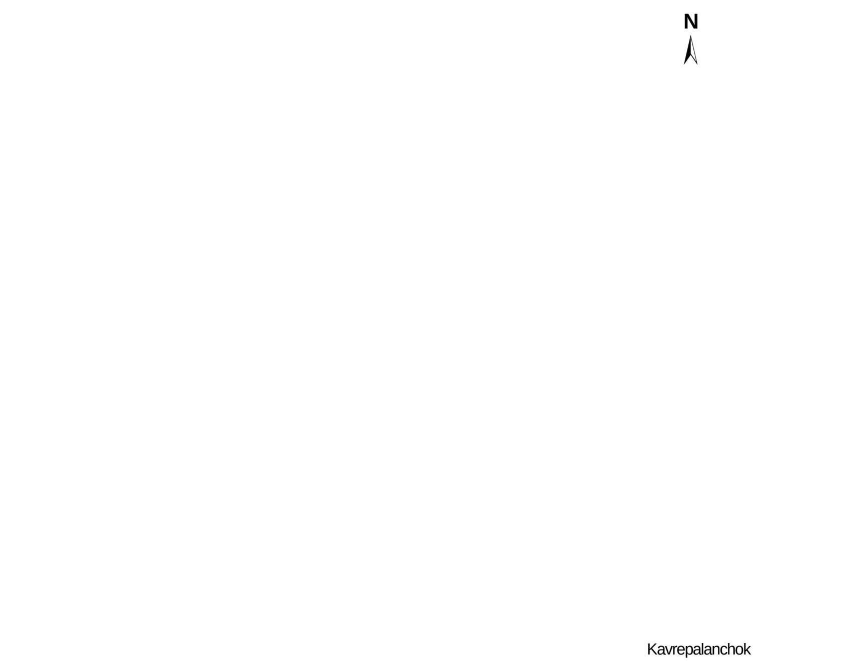
BIRTH OF AN IDEA

In March 1990, the villagers of Ikudol VDC of Lalitpur District south of Kathmandu invited a team from the Bagmati Watershed Project (BWP), a joint venture of HMG/N and the European Union (EU), to study a landslide in a locality called Chila, which lies beyond the valley of Tungan Khola. Chila is about a five- to seven-hour walk from the road at Tinpane (Figure 8.1). The landslide threatened three houses located close to its head, and the villagers wanted the team to suggest protection measures. We spent the afternoon inspecting the landslide and, because it was late in the evening when we finished, we had no choice but to spend the night in the village.

The woman of the house we opted to stay in arrived at about 7:30 in the evening, when it was almost dark, with a load of firewood. She welcomed us inside and served us a bowl of buffalo milk. Then she borrowed some rice and mustard leaves (*saag*) from her neighbour and started cooking a meal for her three children and us. While the rice was cooking, she milked, fed and bedded down her two buffaloes. At about 9:30 PM, when she put her children to bed, washed the dishes and cleaned the kitchen, we assumed she would go to sleep, which is what we ourselves had hoped to do. To our surprise, she lit a kerosene lamp, and, after making a larger fire, she began boiling about five litres of milk to make *khuwa* (the thick paste left after reducing milk). Since the room was full of smoke, we could not sleep and instead began talking with her as she continuously stirred the milk and regulated the fire.

She was worried. The landslide had already washed away some of her land and the remaining parcels, even though they produced only enough for six months,

FIGURE 8.1:
Map of Lalitpur District



■ View of South Lalitpur Valley from Jhankridanda had to be protected as a primary source of food for her family. To sustain themselves for the rest of the year, her family had no choice but to raise buffaloes, convert milk into *khuwa*, and sell it in Chapagaun in South Lalitpur, the trading town nearest Ikudol. The income generated was enough for her to meet the needs of the family for the remaining six months.

■ Boiling milk to produce *khuwa*

She told us that every day she used about three times more firewood to produce *khuwa* than to cook meals and that every family of Chila produced about four kilogrammes of *khuwa* every day (Figure 8.2). When we asked her why she didn't sell fresh milk to a dairy company, she replied that she was unable to carry the milk to the closest collection centre at Tinpane fast enough. It was a five-hour walk and the milk would curdle before reaching the collection centre. *Khuwa*, in contrast, does not curdle and would survive the ten-hour walk to Chapagaun. She was well aware that selling milk was more profitable than selling *khuwa*, and said that, if conditions were favourable, she would rather sell milk.

All night I thought about *khuwa* and especially about the astounding quantity of firewood burnt and drudgery involved. The BWP focused on reforestation as one measure for stabilising landslides, but compared to the amount of firewood burnt to produce *khuwa*, our efforts appeared insignificant. Conventional watershed management tools focussed only on building retaining walls and check dams and on afforesting catchments; linkages with the development practices of the people themselves were very limited. We had no idea about the marketing of milk or how villagers could be provided with alternative opportunities so that they would not have to make *khuwa*.

The challenge for watershed management as it unfolded before us was both to preserve the forest and to enable farmers to market milk instead of *khuwa*. Focusing only on reforestation without providing any means to transport milk to the collection centre and thereby stop *khuwa* production would be insufficient. If milk could be transported, *khuwa* need not be made. In consequence, less firewood would be burned and the forest would be preserved. But how could milk be transported from the village to the collecting point so that it would not curdle? First, we thought of laying a high-density polythene pipeline to convey milk, like drinking water, under pressure. We

FIGURE 8.2:
***Khuwa* producing areas of Lalitpur District**

rejected this possibility because the pipeline would have to be cleaned daily before pouring in a new batch of milk. There was not enough water to do this and even if there were, we could not be sure that the pipe would get cleaned enough to prevent the milk from curdling. We considered stretching a steel cable across the valley and using it to transport fresh milk to the roadhead in a much shorter time. Thus the concept of a milkway began to emerge.

In 1995, a ropeway, which was officially called a conservation ropeway, was built at Bhattedanda to transport milk and discourage the forest-consuming trade of *khuwa*. For five years it enabled the villagers of Ikudol to transport milk and brought them a new sense of hope. It ceased to operate in early 2001. Then, when all hope of its being re-opened seemed to have vanished, it resumed milk transportation again in August 2002. This chapter describes the roller-coaster history of the successes and failures of this initiative and draws lessons for future developments in ropeway technology.

POLITICAL ECONOMY OF *KHUWA* PRODUCTION

By 1993, many of us working for the BWP were convinced that burning wood to produce *khuwa* led to the high rate of deforestation in the project area (the southern parts of the districts of Lalitpur and Kavrepalanchok). Depending upon the type of firewood, it takes three to five kilogrammes of firewood to produce one kilogramme of *khuwa* from four litres of milk. This is the direct cost of production. *Khuwa* making also involves many other indirect costs. It entails drudgery, particularly for the women who collect firewood. During firewood collection young plants are trampled while important tree species and fodder are cut; these activities degrade the landscape's biomass. Time is another hidden and intangible cost. To make one kilogramme of *khuwa* about four litres of milk has to be constantly stirred at boiling temperature for about two hours**.** Family members, including babies, involuntarily inhale smoke from fires in open hearths to the detriment of their health (Upadhya, 1993). These costs are not reflected in the selling price of *khuwa,* which is far less than that of fresh milk. We will discuss this difference later, but first let us look at *khuwa*-making as a source of livelihood in the mountainous areas of South Lalitpur.

The history of *khuwa* production in South Lalitpur is not very old. Local villagers suggest that people moved into these mountains about 150 to 200 years ago and began raising livestock as their source of livelihood. Farming came later. They raised cows and buffaloes and with the milk, produced *ghiu* (clarified butter). *Ghiu* is used as cooking oil, to light holy lamps and to prepare traditional sweets (*mithai*). It is also sold in Kathmandu to earn cash.

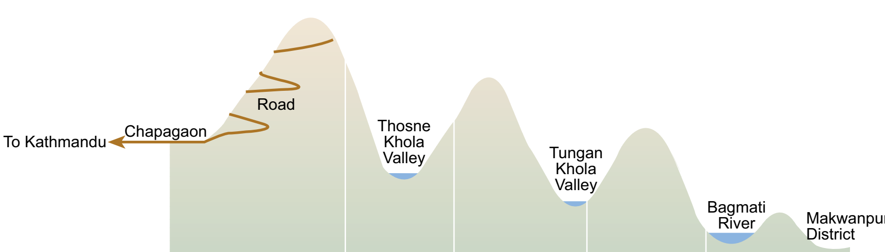
Small though it was, the capital did have a *mithai* market and needed *khuwa*. The price that *khuwa* fetched was roughly 75 per cent higher than that of *ghiu*. When they discovered that selling *khuwa* was more profitable than selling *ghiu*, villagers of Nallu, Bhardeo, Dalchoki, Bukhel, Bhattedanda, Malta switched to making *khuwa*. These villages are less than one day's walk from Chapagaun where *khuwa* is sold. Villages further south across Tungan Khola Valley, including Ikudol, Asrang and Gimdi, are more than a day's walk from Chapagaun. In these villages, farmers make *ghiu* even today.

Chapagaun in Southern Kathmandu Valley is the nearest market in which farmers of South Lalitpur can sell their *khuwa*. The merchants of Chapagaun also buy brooms, agricultural produces, herbs and *ghiu* from farmers and, in turn, sell them kerosene, salt, animal feed, clothes and farm tools. This market is controlled by the merchants, who fix the prices of the goods bought. The relationship is asymmetric and imbalanced but farmers prefer conducting transactions in Chapagaun because they are based on tradition and long-standing relationships. Although downtown Patan is only about 10 kilometres away and a regular bus service operates between Chapagaun and Patan, farmers prefer to buy and sell in Chapagaun because traders there allow them to make purchases on credit during festivals like Dasain or Tihar, whereas merchants in Patan do not.

The merchants of Chapagaun also provide farmers with loans to buy buffaloes—with conditions attached that is. Typically, an indebted farmer must sell *khuwa* to a trader at a rate lower than the prevailing one until the loan is paid off. Despite the strings attached and the high interest rates, farmers turn to Chapagaun traders because they do not have to offer collateral; the loan provided is based on mutual trust rooted in tradition. Securing a formal loan from a bank involves lengthy bureaucratic procedures, proof of citizenship and putting up collateral. Such high transaction costs force farmers, especially *khuwa* producers, to turn to moneylenders, who honour a farmer's social assets like family networks and long-standing connections.

Generally, milk producers are better off than *khuwa* producers while *ghiu* producers are the poorest (Figure 8.3). Farmers who live less than three hours away from the roadhead sell fresh milk to the Diary Development Corporation (DC). Most of their houses have corrugated galvanised iron (CGI) sheet roofs and their children go to school and even to college. Farmers who live further away across the first valley can only sell *khuwa*. Although they work harder than milk sellers, their houses have thatched roofs and their children do not attend school beyond the secondary level. Still further south across the second valley, about 9 to 12 hours from the roadhead, where farmers can export only *ghiu*, their living conditions are worse. Most people live in single-storey thatched-roof houses and their children do not go to school beyond

FIGURE 8.3:
Milk producers isolated from the market by valleys:
A conceptual scheme of economic gradient in South Lalitpur



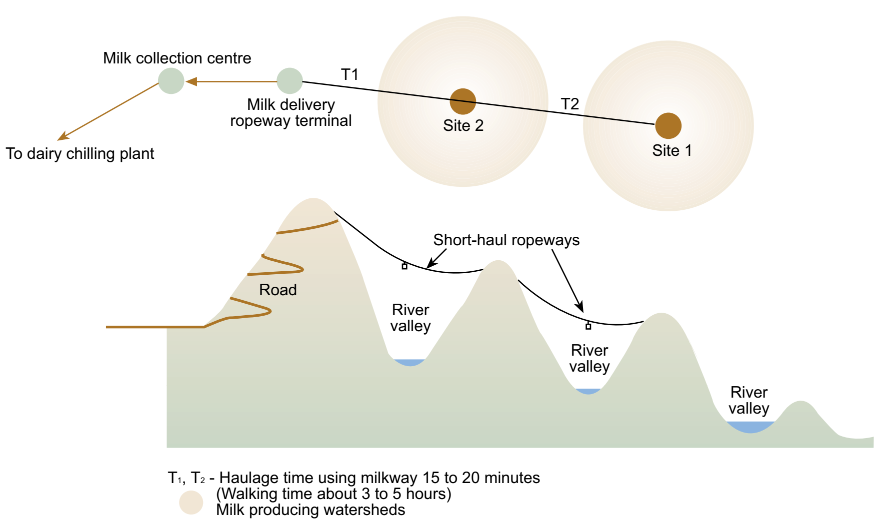
Average walking distance from nearest roadhead (hours)	3	4-8	9-12
Dairy produce	Milk	*Khuwa*	*Ghiu*
Cash earnings from the sale of dairy produce (per cent)	100	70	40
Housing	Houses with CGI roofs	Houses with thatch roofs	Mostly single-storey houses with thatch roofs
Education	College	Secondary school	Primary school
Attitude to state services	Indifferent	Discontent	Resentful

the primary level. Economic conditions thus seem to decline as proximity to markets decreases. The Bhattedanda Milkway was one attempt to alter the negative economic gradient by finding access to market for locally produced milk (Figure 8.4).

Khuwa production is a lose-lose venture for farmers and the environment. Because of high consumption of firewood, forests in *khuwa* producing areas have declined rapidly. And despite their hard work, farmers do not benefit from selling *khuwa* as middlemen and traders corner most of the profit. When farmers bring *khuwa* to Chapagaun, the merchants first test its purity using iodine and adulterated batches are rejected. The merchants may then reprocess the *khuwa* (sometimes by mixing in maize flour) before taking it to Kathmandu for sale. In Kathmandu, *khuwa* may fetch higher price than in Chapagaun. Thus the traders of Chapagaun profit from the chain of *khuwa* economics, while farmers are often forced to sell at low prices due to seasonal gluts. In spite of the disadvantages, economic necessity forced thousands of families to make *khuwa* till the early 1980s.

Things began to change towards the end of 1981. In September of that year, an unprecedented cloudburst hit South Lalitpur.[1] Landslides damaged cultivated terraces and rivers washed away land parcels. The event destroyed the local economy, impoverished farmers and affected the food balance. The amount of local biomass was reduced as trees and other vegetation was washed away by the torrent. One way to compensate for the loss of agricultural income was to produce more *khuwa*, but because firewood was insufficient, farmers could not continue making *khuwa* and thereby lost a mere source of

FIGURE 8.4:
Correcting economic gradient: short-haul ropeways provide access to markets and favour farmers deep in the hinterlands



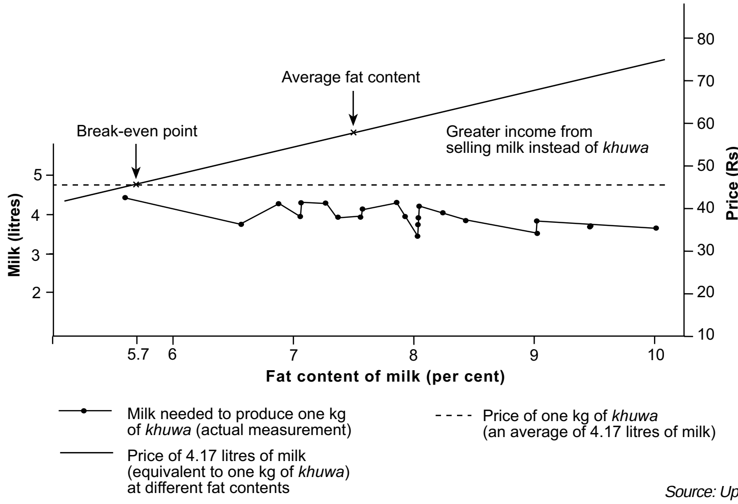
income. *Ghiu* could be manufactured but did not fetch enough money to support families. Many families in the area faced three years of hardship. The crisis forced farmers of South Lalitpur, who had been hit by the cloudburst to seek alternative sources of livelihood.

Two energetic farmers, one from Bukhel and the other from Ghusel, contacted a private dairy and asked it to collect their milk at Tikabhairab and Lele, villages that were connected to Kathmandu by a fair weather road on which a milk-collecting van could ply. The private dairy company began collecting milk brought to Tikabhairab and Lele by farmers of these two villages; the van left for Kathmandu at 11 AM. Because selling milk was more profitable and because *khuwa* making had become increasingly difficult due to the lack of firewood, many other farmers who could reach Tikabhairab or Lele before 11 AM also began selling milk. The volume of milk brought to these two places gradually increased until the private company could no longer buy all of it. At this point the farmers requested the DC to collect their milk; it began to do so circa 1985/86. Once the DC milk tanker began servicing Lele and Tikabhairab, still more farmers started selling milk.

A profitable milk business emerged. Following the disaster of 1981, HMG/N implemented development activities in South Lalitpur. After fair-weather road between Lele and Chandanpur was completed, the milk business spread to other villages further off. In 2001/02, South Lalitpur supplied between 15,000 and 18,000 litres of milk to the DC and another 6,500 litres to three private dairy companies every day. An additional 2,000-3,000 litres of milk was sold to local consumers and teashops.[2] By selling milk farmers received better prices than they had by selling *khuwa*. The benefit was obvious because one kilogramme of *khuwa* fetched Rs 45 (at 1993 prices), whereas the equivalent milk (4.17 litres on average) sold for Rs 53 to Rs 65, provided that the fat content was greater than 5.7 per cent (Figure 8.5), which, incidentally, is the break-even point between the price of *khuwa* and that of milk. Higher fat content makes the sale of milk even more profitable. The average fat content of milk in Ikudol, for example, was around 7.5 per cent, which meant that milk would fetch 30 per cent more money than *khuwa* (Upadhya, 1993).

Despite these changes more than 1,000 families which live far away from the roadhead beyond the Tungan Valley still convert 5,000-7,000 litres of milk into *khuwa* daily. In one month they sell about 30 tonnes of *khuwa*; this implies that there is a great stress on the existing forests. One of the reasons for the continued production of *khuwa* is that these villagers cannot get their milk to the collecting centre fast enough; for them, it is more than a five hours walk, within which time, the milk curdles. In South Lalitpur, proximity to a market determines which of three dairy products—milk, *khuwa*, or *ghiu*—a farmer produces. The varied impacts their production has on the land and forests helps determine the living conditions of the producer.

FIGURE 8.5:
Comparison between returns from milk and *khuwa* at different fat contents



Source: Upadhya, 1993

BUILDING THE MILKWAY

Having identified what may be called the root cause of *khuwa* production, the main challenge before the BWP team was to find ways of helping villagers transport milk to the collecting centres so they could take advantage of the market. We thought of stretching a steel cable across the valley to slide milk cans to the roadhead. The proposal seemed technically possible if the speed, which, we found, could reach as high as 300 kilometres per hour, could be controlled. Since this could not be done with a single rope without powered machines, this idea, like the pipe, was rejected. We finally focused on installing a ropeway with a winch mechanism to regulate speed. In 1993, the BWP management team made a study tour of the Austrian Alps to observe different types of winches and ropeways, including the heavy-load carriers used to transport construction materials and timber. The team also observed ropeways used by individual farmers to transport grass from high pastures to their farms as well as those run by owners of tourist resorts who transported food and beverages for trekkers and skiers.

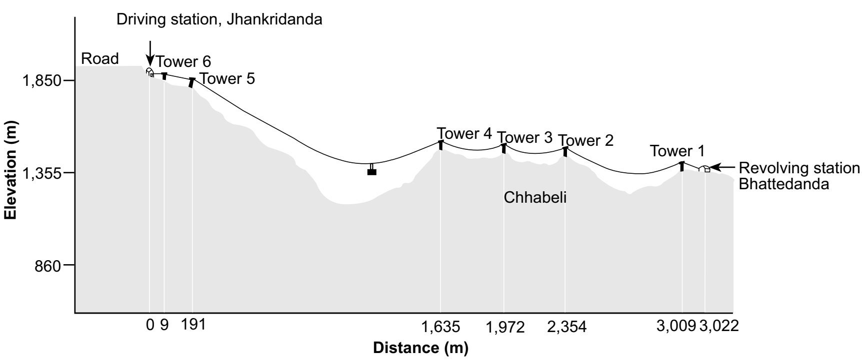
As a pilot project, we decided to establish a single carrier, bi-cable ropeway system to carry up to 450 kilogrammes per trip. The ropeway was to be three kilometres long and connect Jhankridanda and Bhattedanda. Farmers of Ikudol would transport their fresh milk to Bhattedanda, from where it would be transported to Jhankridanda using the ropeway and then by truck to the collection centre. Once the overall system was agreed upon, a short-term Austrian consultant was hired to help design the foundations and towers and to supervise their fabrication. Five towers were proposed;

a drive station at Jhankridanda and a turn-around (revolving) station at Bhattedanda would complete the system (Figure 8.6).

The consultant assisted the BWP in ascertaining which components could be manufactured locally in Nepal and which needed to be imported from India or from Europe. Anchor bolts for towers, the main stand of the revolving station and the driving stations required steel of high quality and tensile strength, which was not available locally. The main motor and accessories such as pulleys and shoes, which had to be of better quality and precision than could be found locally, were imported from Austria. The steel cable was imported from India while the towers were fabricated at Balaju Yantra Shala (BYS) in Kathmandu. An Indian-made 20-kVA diesel generator was purchased in Kathmandu as the prime mover. Because only a few specialised companies manufactured these tailor-made parts, the costs were relatively high (Annex C).

Construction of the foundations, towers, and stations began in the winter of 1994. The BWP provided cement, steel bars, and aggregate. The villagers of Bhattedanda formed the Ropeway Construction Committee (RCC) in order to maximise local labour contributions. Most of the members of the RCC were people from Bhattedanda, as was its chairperson, who was also the VDC chief. Some farmers from Ikudol were also members, but they couldn't oversee the daily work as they lived at least three hours away from the construction sites. The BWP did not seek contributions of free labour; instead, local workers were paid the going rates. Since the task of installing a ropeway was unfamiliar to the villagers, skilled workers from Kathmandu were also hired. BWP staff helped RCC members and local labourers to maintain the quality and precision required for the foundations, some of which, like the ones for the tilted towers, were specialised and particularly difficult to build. Once the towers were transported to their respective sites, local labourers erected them with help from the skilled workers from Kathmandu.

FIGURE 8.6:
The Milkway's longitudinal profile



The installation of the drive equipment and cables started about one year later, after the towers had been erected and other infrastructure was in place. The BWP hired an erector from Gantner Company in Austria, who stayed at the project site for six weeks. Stretching the cable was the most difficult task of the entire installation process. It required more than 100 people each day to pull the steel wire across the terrain. Some villagers and students from the local high school worked voluntarily for two days to pull one cable. The villagers who pulled the remaining four cables were paid for their efforts by the BWP. Two Land Rover jeeps were used at Jhankridanda (the driving station at the road) to pre-tension the cable while a hand-operated max-puller was used for final tensioning. A test run was carried out at the end of May 1995, after installations were complete. Unfortunately, the ropeway was too low and the loaded carrier, which was supposed to be at least two metres above the ground at the lowest points, hit the ground. We had to increase the height of towers nos. 6, 5 and 3 by one or two metres each and add an extra 18-metre-high tower, tower no. 4 (see Figure 8.6).

The ropeway, appropriately named the Bhattedanda Milkway, began operating on 9 June, 1995. The RCC was dissolved and the Ropeway Operating Committee (ROC) set up to manage daily operation and regular maintenance. Since the ROC was formed as a long-term business, its members included those involved in the construction work, some village elite, two milk producers from Ikudol, the *dudh thekedar* (milk contractor) who handled milk transportation, and the chairperson of Bhattedanda VDC. Even though the ROC included only a few of the actual Milkway users, it also acted as a Ropeway Users' Committee (RUC), a fact which made it easy to register the ROC at the District Administrative Office (DAO) and to hand over responsibility of its management.

BENEFITS OF THE MILKWAY

Despite the initial scepticism of many of our official colleagues, we were confident that once the Milkway began to operate a steady stream of benefits would accrue to the people, whose income could rise by as much as 30 per cent. We were not wrong. The Milkway provided access to the market to farmers who lived four to eight hours from the road. Every day 143 households in Ikudol used the Milkway to sell fresh milk. They lived within a three-hour walk from the low end of the Milkway and had made *khuwa* prior to its installation. Collectively they sold between 600 and 900 litres of fresh milk every day. This volume sold for Rs 15,000 to 20,000 (1995 prices). Had it been turned into *khuwa* it would only have fetched them just Rs 11,000 to 14,000. By selling fresh milk, farmers earned an additional 4,000 to 6,000 rupees (BWP, 1997).

Several categories of people benefited from the Milkway. The primary beneficiaries were the farmers of Ikudol who exported milk daily. The second group of beneficiaries were the farmers of Bhattedanda who exported seasonal vegetables and other farm produce once a week. Finally, local merchants, construction contractors, local cooperatives and development workers who used it occasionally to transport their goods also benefited. Some benefits were totally unintended. The Milkway was not designed for passengers and hence, except for the Milkway operator and some project staff that rode the Milkway for maintenance, ferrying people was strictly prohibited. But once, in an emergency, an expectant mother who experienced complications during delivery was taken in the Milkway carrier to the road, where a vehicle was found to take her to hospital. Even though it was a significant bending of safety rules, using the Milkway saved both the mother and her child.

The Milkway also helped farmers to export *ghum* (local umbrellas made of tree leaves), herbs, brooms, cucumbers, and pumpkins. The District Agriculture Office had earlier formed 19 groups of women farmers to promote vegetable farming. These women farmers were the first to take advantage of the Milkway to export vegetables from Bhattedanda. Half of the groups used the Milkway to send vegetables and curd to a weekly market in Lagankhel in Patan and earned about Rs 10,000 every week; the other groups were not yet ready to do so. The income from the sale of vegetables and curd belonged to the individual women who sold them. Many women from Ikudol exported marigolds during the festival of Tihar in 1995; the total value sold was Rs 10,000.[3] Farmers also transported zinc sheets, polythene pipes, and oddly shaped pipes difficult to carry along narrow winding trails.

The Milkway employed five operators and three helpers to operate the system. The principal operator ran the machine in Jhankridanda. Two assistants helped him handle goods. In Bhattedanda, a single operator handled goods and an accountant kept the books. They were all paid by the ROC using income from the Milkway. Twenty porters were employed by milk producers to carry milk from the villages to the station in Bhattedanda. The Milkway also created jobs for seven persons who collected milk from and kept records of the milk containers sent by farmers. The cooperative at Chhabeli collected the milk to send to the DC. Seven loaders were employed to transfer milk containers from the Milkway terminal in Jhankridanda to the milk van. The cooperative paid the porters and loaders and the expense was added to the cost of transporting milk. The loaders also were paid to carry other goods by the owners of those goods.

Within 18 months, several proxy indicators showed that the Milkway had had a positive impact on the wellbeing of the milk producers in Ikudol. First, the proportion of houses with CGI roofs increased from 16 to 26 per cent. CGI roofs have several advantages over thatched roofs: they last longer, pose no fire hazard, and are a symbol of social prestige. Many had CGI roofs even over their cowsheds, indicating they had about Rs 10,000 to spare. The proportion of improved cowsheds increased from about four to over 12 per cent of the total. Another improvement noted was the construction of separate cowsheds. Similarly, there was an increase of six per cent in the proportion of two-storey houses. Food balances also improved: the proportion of farmers reporting a food deficit of six months or more declined from 55 to 45 per cent while the proportion of households with a food sufficiency of 12 months or more increased from 11 to 19 per cent. The proportion of households owning *lahure* buffaloes, an improved breed, increased from 26 to 45 per cent. The average number of low-yielding local cows per household was halved.[4]

In Ikudol, by rendering *khuwa* production unnecessary, the Milkway reduced the consumption of an estimated 1,000 kilogrammes of firewood per day, or at least 300 tonnes per year (BWP, 1997). The savings may not mean much in terms of economic value, but by saving firewood the Milkway enhanced the local environment. First, it reduced pressure on forests and demonstrated that sustainable harvesting is a concept worth pursuing. Second, reduced consumption of firewood meant that fewer people entered forest and consequently that fewer young plants were trampled. Third, the drudgery of foraging in the forest every day was reduced.

The Milkway transported a maximum of 65,000 kilogrammes of goods in one month (Table 8.1 and Figure 8.7) and its highest monthly income was Rs 71,580.

TABLE 8.1: Goods transported by the Milkway

Year	Month	Goods up (kg)	Goods down (kg)	Total goods transported (kg)
1995	June	2,314.00	7,582.50	9,896.50
	July	3,890.50	28,119.30	32,009.80
	August	5,100.80	12,267.00	17,367.80
	September	15,736.00	28,738.00	44,474.00
	October	20,145.00	17,117.00	37,262.00
	November	28,535.00	18,655.00	47,190.00
	December	43,673.00	21,588.00	65,261.00
1996	January	38,547.00	21,671.00	60,218.00
	February	10,992.00	3,603.00	14,595.00
	March	10,630.00	3,988.00	14,618.00
	April	6,045.00	1,224.00	7,269.00
	May	9,021.50	5,000.50	14,022.00
	June	12,475.00	5,800.00	18,275.00
	July	12,822.00	8,846.00	21,668.00
	August	15,639.50	627.00	16,266.50
	September	14,177.00	695.00	14,872.00
	October	4,455.50	546.00	5,001.50
	November	12,035.00	2,725.00	14,760.00
	December	11,737.00	577.00	12,314.00
Total	**Jun-95 to Dec-96**	**277,970.80**	**189,369.30**	**467,340.10**

FIGURE 8.7:
Load carried by the Milkway

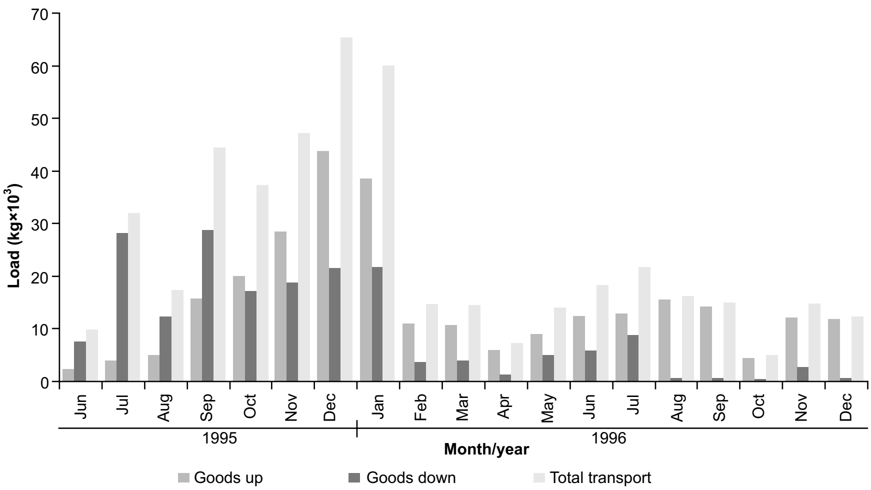
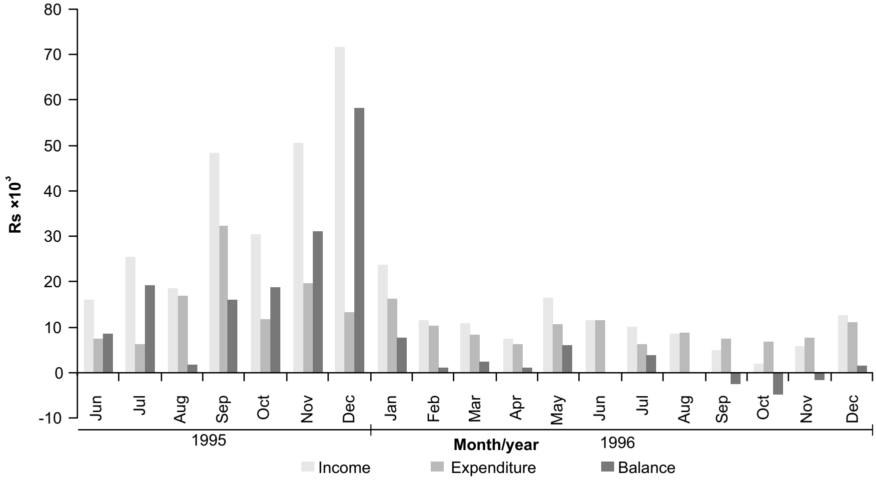


TABLE 8.2: Income and expenditure of the milkway (Rs)

Year	Month	Income	Expenditure	Balance
1995	June	15,972.00	7,489.00	8,483.00
	July	25,554.00	6,306.00	19,248.00
	August	18,446.25	16,799.75	1,646.50
	September	48,365.75	32,331.75	16,034.00
	October	30,532.25	11,748.25	18,784.00
	November	50,688.75	19,583.00	31,105.75
	December	71,580.25	13,224.50	58,355.75
1996	January	23,805.50	16,125.00	7,680.50
	February	11,424.50	10,289.50	1,135.00
	March	10,717.50	8,305.00	2,412.50
	April	7,448.75	6,352.00	1,096.75
	May	16,530.50	10,507.00	6,023.50
	June	11,511.50	11,482.00	29.50
	July	10,109.00	6,226.00	3,883.00
	August	8,540.00	8,770.00	-230.00
	September	4,959.50	7,450.00	-2,490.50
	October	2,007.25	6,837.00	-4,829.75
	November	5,839.25	7,534.00	-1,694.75
	December	12,578.50	10,982.00	1,596.50
Total	**Jun-95 to Dec-96**	**386,611.00**	**218,341.75**	**168,269.30**

This also included the fees charged to carry other types of goods. In one-and-a-half years of operation (1995-1996), the Milkway earned about Rs 386,000, approximately Rs 218,000 of which was spent on operation and maintenance (Table 8.2 and Figure 8.8). The amount spent also included the cost of correcting the alignment of some pulleys. The cost of operating the Milkway was about Rs 8,000 per month, which was

FIGURE 8.8:
Income and expenditure of the Milkway



spent on the salaries of its five operators and on diesel for the generator. The Milkway provided benefits to the local community, the local environment and showed that, if replicated, several such efforts could add positively to the country's development.

After the road to Chhabeli was opened in February 1996, the monthly load declined sharply, as will be discussed subsequently.

LESSONS FROM THE FIELD

Despite the obvious benefits of the Milkway, many problems arose at different stages of the project. They ranged from the lack of a skilled workforce, which was a major hindrance, to problems related to decision-making and lack of understanding among authorities in ministries, departments, and funding agencies. This section attempts to document the hurdles faced by this pilot initiative in watershed management in Nepal.

Planning phase

At the conceptual level, the tasks of watershed management in Nepal are viewed only as reforestation, protection of forests and stabilisation of landslides and gullies. Overt management strategies do not include improving the livelihoods of villagers through implementing income-generating activities or reducing drudgery. When the idea of constructing a ropeway emerged, the first question raised was why a watershed management project should implement a transportation-related activity. The officials of the Ministry of Forest and Soil Conservation (MoFSC) argued that constructing a ropeway was the responsibility of the MoWT. A ropeway, this view suggested, could only connect two towns (e.g. Hetauda and Kathmandu, the historical example in

Nepal). The Ministry initially did not accept that a ropeway had links with the wellbeing of milk producers and with forest protection. Analysis of the economics and impact of *khuwa* production has never been, nor is it now, a part of the official discourse on natural resource management. The BWP had to go through several cycles of meetings in Nepal and Brussels before it could convince the authorities that a ropeway was far more cost effective than conventional watershed management activities such as building check dams or afforestation.

In finding a power supply, too, the BWP faced resistance from authorities. The lack of a back-up for the 20-kVA diesel generator compromised the reliability of the system. The grid was far away, so a better solution seemed to be constructing a 25-kW MHP at Thosne Khola and placing the diesel generator on standby. This obvious solution, however, led to serious inter-ministerial disputes within the MoFSC and was not pursued further.

Procurement policy limits

According to HMG/N rules in force at that time, equipment worth more than Rs 150,000 could be purchased only through tender and the lowest bidder had to be accepted as the supplier unless there was a strong reason to reject its offer. In practice, rejection was almost impossible as several statutory bodies were ready to pounce on any project manager who entertained higher bids with charges of corruption. To avoid the rigidity of the government's rule, the EU was asked, and agreed, to provide the necessary equipment and accessories in the form of commodity aid. The equipment was manufactured and supplied by the Gantner Company of Austria. This procedure added time, but the quality of the ropeway's components was ensured.

The towers, steel cables and generators for the ropeway were purchased using regular tendering procedures. The construction of the foundations and other structures was carried out through the RCC. The motor, control panel, communication system, pulleys, and ropeway shoes were purchased from reputed suppliers. As this was a pilot project venturing into unknown territory, the selection of suppliers should have been guided by the need to avoid trouble during operation; instead, government policies dictated choice. To cite one negative consequence, the generator bought from the lowest bidder in an open tendering bid broke down after a month. Before it could be fixed, milk worth Rs 20,000 curdled in a single day and many farmers were left unhappy with the RUC.

Detailed survey

The detailed survey considered the alignment of ridges and valleys close to the stations but did not prepare a complete profile. As a result of this oversight, when operations started, the cable sagged and touched smaller ridges. To overcome this flaw, the heights of three towers had to be increased and an additional tower had to be erected.

Trees posed another problem. The erector from Gantner had advised that trees be cut and bushes cleared along a three-metre-wide land strip below the alignment in order to ease the hoisting of cables. However, since we wanted to save as many trees as possible, we decided to cut only those that actually came in the way. With this goal in mind, we felled only five mature trees, though hundreds of branches were cut. This decision ended up creating a major hurdle during the pre-tensioning of the cables: since many trees remained along the path of the ropeway, the cable sometimes got caught in them. The problem was that once this happened it was risky to cut the offending tree as felling it could cause the cable, which is under tension, to snap or create a dangerous whiplash.

Cable transporting and pulling

The towers were partly pre-welded and transported to Jhankridanda by mini trucks, and then to their respective sites by twenty human porters each. It was a difficult and risky operation. Transporting cables to the site was another dangerous feat. The general practice for transporting steel cables for suspension bridges in the mountains is to unwind the cable from the reel and employ as many porters as required so that each porter supports two to three meters of cable. In Bhattedanda, it was not possible to use this procedure because the skyline cable was more than three kilometres long and the hauling cable, more than six kilometres long. Both cables were wrapped around reels, each of which weighed about three tonnes, and small trucks were used to carry them to the roadhead. Because of the concentrated loads of the reels, the floors of the trucks were damaged as they negotiated jerks on the earthen road. Unloading the reels at Jhankridanda had to be done with great care and proved to be very difficult. At that time private helicopter companies were rare, but today perhaps reels could be ferried to sites by helicopters despite the additional expense (see chapters 9, 10 and 11).

Pulling the cables across the valley and over the ridges was another difficult task. More than 100 persons pulled the cable along the steep alignment and an additional 10 to 15 people were needed to unwind the reel at the roadhead. Coordinating work among those hoisting the cable spread over three kilometres and the unwinders of the reel at the roadhead was extremely difficult. Once the reel started to unwind, it was difficult to stop because of increasing momentum. We had no walkie-talkie sets with which to communicate so we used red and white flags for signalling. When reel operators did not receive messages in time, people pulled the rope when they should have stopped and stopped when they should have continued pulling. As a result, in many places the released cable piled up and twisted into knots. Hundreds of knots had to be undone before the cable could be pulled again. Knot formation also compromised the cable's integrity and strength.

The safety of those pulling the cables was a major concern. When the cable was first pulled, it was on the ground some meters away from its actual alignment. While pre-tensioning, the cable slowly lifted from the ground and gradually moved towards its alignment, at which position its final tension was about five tonnes. If the cable got stuck in trees while moving towards its alignment the tension instantly increased to eight to ten tonnes. The blocking tree had to be removed before further tension was applied, and any mistake while removing it put workers in danger. We told the persons who cut down the trees to stand on the opposite side of the cable, but we could not see or continue to advise them: we had no choice but to rely on their wisdom. Despite our inexperience, we were lucky that only two sustained injuries: one person fell from a tree and hurt his face, and a log used as a braking device to stop the moving reel flew from the rolling drum and hit me on the head. Fortunately, I survived to write this chapter.

Limits to participation

According legal status to the RUC, which was formed after the RCC was dissolved, posed another knotty problem. Under the prevailing government acts, only three types of users' committees are legal: a group of people forming a club to work voluntarily for the benefit of society becomes legal when it is registered at a DAO, a shareholding company can be registered under the Company Act, and a cooperative, which must distribute profit among members, gains legal status by registering under the Cooperative Act. The RUC, however, did not fall in any of these categories. It provided a service, but it was not a voluntarily operation. On the contrary, the Milkway charged for its services so that it could function and provide a level of reliability only achieved by ensuring good maintenance. Although money was earned, the villagers did not receive any; all profit remained with the RUC. Getting the legal status of the RUC recognised was, therefore, difficult. It was finally registered as a voluntary club at the request of the users themselves, but this classification invited subsequent problems.

Securing support from the users to install the ropeway through the RCC was difficult. Farmers who lived along the ropeway's alignment were not its intended users; the actual beneficiaries lived far from the revolving station in Bhattedanda. They could not come to the construction site even if they wanted to because a one-way trip took three hours. Although, non-users were the main employees during construction, the support of both groups was necessary to make the Milkway operational. The people of Bhattedanda were to operate the Milkway and then its earnings would be used to extend it to Ikudol. Bhattedanda folks, however, made no serious effort in pursuing an extension, a situation which understandably frustrated the villagers of Ikudol, for whom it was not practical to get involved in daily operations. Had the problems of lack of interest in Bhattedanda and helplessness in Ikudol been sorted out early on, perhaps the Milkway would not have ceased operating.

The management of a ropeway requires that operators possess basic operation and maintenance skills. In the first few months, the local users were given on-the-job training in operation and maintenance. They learned to successfully perform minor tasks such as tightening tower bolts, fixing pulley alignments, and greasing and oiling but they were not able to handle major breakdowns. In the first six months, the alignment of the cable was carefully checked but the pulleys were dislocated anyway. Its alignment shifted due to loose nuts and bolts and the system was damaged. The cable had to be re-tensioned two times in two years with the help of a mechanic from Kathmandu. The manufacturing company recommended that every two years the skyline rope be moved about six metres from its original position towards the lower station to avoid excessive wearing of the part of the cable resting on the shoes and to prolong the life of the rope. Such details of mechanical engineering cannot be easily transferred to new users in a short time.

Qualified technicians who can repair a ropeway's electro-mechanical parts must provide back-up support. Such technicians are not available locally and skilled persons from Kathmandu see no appeal living in a remote place like Bhattedanda just to provide services to a single ropeway. This is a major institutional challenge that needs to be tackled by both the industry and the government if efforts to promote ropeways are to be sustainable.

END OF THE BEGINNING

The residents of Ikudol and Bhattedanda VDCs agreed to work together to construct the Milkway. To jointly own the Milkway, the users and the operators had to develop a unique understanding and partnership, but it turned out that Milkway demanded more than what villagers knew about uniting to work together. After January 1996, goods traffic on the Milkway declined sharply because the road to Chhabeli was opened to milk-collecting vehicles. Local support in Bhattedanda for the Milkway waned as the people there felt they could do without it. The people of Ikudol had no control over these changes. BWP's technical support for repair and maintenance gradually declined.

The RUC, which had been made fully responsible for managing the Milkway, carried out the regular maintenance of pulleys, cables, and towers; and it established contacts with technicians in Kathmandu who could maintain the generator. When the EU's funding for the BWP stopped in May 1997, the project office could only provide minimal backstopping support. Because of limited funding, the skyline cable was not moved six metres from its position at the shoes as had been recommended. We did not expect the RUC to move the cable itself since this involved risky procedures; instead, we hoped to execute this task ourselves in the second phase of the BWP, due to begin in July 1997, when the Milkway would be extended. But the second phase had not started even in November, at which time the villagers reported that one of the pulleys was badly worn out. The RUC hired a technician to check the pulley, and he reported that the skyline cable at the shoes had also worn out more than expected.

The situation demanded that the skyline cable be adjusted even if the BWP had no funds available. Because we could not hire skilled labours and because experienced technicians were not available locally, we decided to move the cable with the villagers who had helped install the Milkway. As we could not afford to buy new max pullers or quality grips, we were forced to use the old tools left in the store room after installation.

November in Bhattedanda is cold: nighttime temperatures fall below freezing. To add to our difficulties, it started raining as we left for the site. When we reached Bhattedanda, the intensity of rainfall had increased and it had began snowing on the ridges. Since we had already spent a week organising the repairs by bringing staff and skilled technicians together and the users had decided that the repairs would be done that day, we started the work despite the bad weather.

Releasing six metres of cable from the driving station was done easily. Because of the shortness of November days and the drizzling rain, we didn't really have enough time to pull the cable from the revolving station to provide the necessary tension. However, since shutting down the Milkway for even a day would incur losses of about Rs 20,000 worth of milk, we decided to work until late evening and complete the task so that Milkway would be ready for operation the next morning. Taking all necessary precautions, we managed to pull about five metres of the released cable. When the Milkway was installed all the tension was provided from the driving station. This time, we pulled the cable from the revolving station, a much harder task because of the extra sag between the intermediate towers at higher elevations.

It was almost dark and still another metre of cable had to be pulled. We decided to take a break for *khaja* (snack) at a nearby teashop after making sure that all the grips and the max pullers were properly tightened. No sooner had we started eating, than we were shaken by a sudden loud noise: it was as if a mountain had collapsed due to an earthquake. The noise echoed for some time. It wasn't an earthquake, but none of us could figure out exactly what had happened.

Rushing to the station, we found that the cable had slipped off the grips because the low temperature had caused it to shrink. The max puller was nowhere in sight. So strong had been the force that the cable had sliced a tree with a 30-centimetre diameter like a knife slices a radish and had wound itself into ten loops around the tree stump. Fortunately, no one was hurt. The lessons were clear: the alignment of a Milkway should always avoid buildings and settlements and one has to be sensitive to temperature changes.

We thought that the Milkway had been irreparably damaged. What would farmers say when they came in the morning with their milk cans and found that the cable had snapped? We thought it would remain out of commission indefinitely and that farmers would have to carry their milk to the road for a few days. This accident would attach a stigma to the villager-run Milkway and critics would reject similar proposals in the future. Fortunately, it was winter and very cold, so the milk would not curdle fast. To get the system back into operation, the cable would have to be pulled from the ground as if a new cable were being strung. We made an extra effort to get the Milkway back on track in the next few days. With a new max-puller and sturdy grips bought on credit in Kathmandu, it took two days to pull the cable to the lower station and an extra day to tighten it. Then much to our relief, the Milkway came back into operation.

I asked the chairperson of the RUC if he still recommended extending the Milkway after all the high drama. He said, 'I'm not sure if we want to do new milkways but this one must be extended to the next ridge south (Majhkhanda), no matter how difficult it is. People on the other side of the valley must not be deprived of the benefits of selling milk and improving their living conditions'.

BEGINNING OF THE END

Despite its obvious benefits, the Bhattedanda Milkway stopped operating in January 2001 after providing more than five years of service. The main reason was that with the opening of the road from Jhankridanda to Chhabeli, the trucks which had once collected milk only in Jhankridanda, now began collection in Chhabeli.

The performance of the Milkway also started to decline for several other reasons. The real users in Ikudol were happy to have access to a market via the Milkway but they did not want to be dictated to by the operators and the *dudh thekedar* in Bhattedanda. The users even argued that unless the government guaranteed the extension of the Milkway to Majhkhanda they would not use the existing one. The partnership between the users in Ikudol and the operators in Bhattedanda did not improve and local politics took over. Neither the users nor the operators could influence the *dudh thekedar*, who had final authority over whether to send milk by the Milkway or by truck.

Because the idea of a ropeway was born in the village of Chila in Ikudol VDC, the people there had expected that a ropeway would be built nearby. In fact, the feasibility study had recommended that the ropeway be constructed between Majhkhanda and Bhattedanda but this proposal had entailed some practical difficulties. Farmers would have had to send milk by ropeway to Bhattedanda, from where it would have had to be carried by porters in Bhattedanda to the roadhead at Jhankridanda. To avoid this complication we decided instead that the pilot ropeway would be built between Bhattedanda and Jhankridanda so that farmers from Ikudol could themselves carry milk to Bhattedanda and send it to Jhankridanda. The BWP told the farmers in Ikudol that if the ropeway proved to be as effective as expected, it would subsequently be extended to Majhkhanda and Chila; and the farmers accepted this proposal in good faith. In a sense, the layout of the Milkway was influenced more by the BWP's view of itself as a promoter and its concerns with ease of construction and demonstration effect, than the interest of the villagers in the deep hinterlands.

When the Milkway was completed in 1995, it served 143 households and transported a maximum of 900 litres of milk before 9 AM each day. It could have collected milk from other farmers but it would have had to operate beyond 9 AM, when the milk van left Jhankridanda. The existing volume of milk, however, was too low to warrant hiring a second van. Extending the Milkway to Majhkhanda would have brought in an additional 1,000 to 1,500 litres of milk and the efficiency of the entire Milkway system would have increased. For this reason an extension was proposed in 1996.[5] The plan was to extend the Milkway in two directions and to build two separate systems. One system would stretch about four kilometres from the existing turn-around station at Bhattedanda, connecting the southern village of Pyutar and crossing Majhkhanda on the ridge top. The other system, was to be about 2.5-kilometres-long, would run to the village of Chila south-east of Bhattedanda. We also proposed building an MHP that would generate about 20 kW (enough to run the Milkway) in a stretch of Thosne Khola in Bhattedanda.[6]

Phase II of the BWP, which was re-named the Bagmati Integrated Watershed Management Project (BIWMP), started in 1998. A new consulting company provided technical assistance and a new team of support staff was introduced. This phase was supposed to employ staff from Phase I, but, due to the long delay in its implementation, many personnel had already left and the Ministry had transferred others. Only a few old staff members remained.

The people in Ikudol were not happy that the first ropeway had been built in Bhattedanda and that its extension was discussed, surveyed, and estimated again and again, but never built. This happened despite the glowing encouragement of all high-level dignitaries who visited the Milkway (see Box). The assumption that the ropeway would be extended to Ikudol once the pilot project showed its effectiveness proved false and the people south of Bhattedanda became disillusioned with politicians and with the Milkway.

BOX: Glowing encouragement

'… am happy to see the ropeway built in Bhattedanda with cooperation of EU and the local people. …found it exemplary for other areas of the kingdom of Nepal. …..am confident that it will be extended by implementing the next phase (of the project). ….there will be a full co-operation from HMG'.

Narayan Raj Tiwari,
Secretary, Ministry of Forest and Soil Conservation.
20 November, 1996

'. ..am very happy to see that the ropeway, built with the cooperation of EU, has helped people in difficult transportation. .. am encouraged that people of this remote area have operated the system. Wish its successful operation'.

Rajib Parajuli
Minister of State, Ministry of Local Development.
10 October, 1996

' … I am impressed by the way the ropeway fits with the Nepali environment. In that sense it is really innovative. It is cooperation in its deepest sense'.

Alain Vandersmissen
Directorate, South and South East Asia, European Commission, Brussels.
22 June, 1996

'…an excellent alternative to building roads. I hope it can be a model for other locations in Nepal'.

Peter Moulton
Global Resources Institute, Kathmandu.
8 March, 1996

'…What an excellent way to transport the produce. It should be replicated in many other parts of Nepal where roads don't exist'.

Annmaree O'Keefee
Australian Ambassador to Nepal.
18 January, 1996

Source: Visitor's Book at the Bhattedanda Milkway

The political instability which followed the second general election in 1995 began to have an effect at the local level. The UML government left office within nine months and was followed by a series of coalition governments culminating in the third general election in 1999. Horse-trading between members of parliament to make up a simple majority became the norm. Party representatives fought for perks and benefits, thereby severely obstructing the administration and functioning of government departments. Donor-supported projects became the first victims because they had financial resources subject to misuse by self-serving officials in cahoots with politicians.[7] The BIWMP and the Milkway became victims of this situation. The knowledge and the lessons gained through experience during Phase I gained through experience faded away and were not passed on to Phase II.

The political scene at the centre was replicated at the village level, too. Development works initiated by one candidate were anathema to others, who used all means to discredit projects as hotbeds of corruption, malpractice and inefficiency. Villagers were divided in their support of different political parties. Sometimes the division ran so deep that the supporters of each political party patronised separate shops and teashops and influential villagers would not support a development activity unless their own party came in to power. Over the years the fine line dividing political parties and their supporters grew deeper and more pronounced in Bhattedanda as well.

The first VDC chairperson of Bhattedanda was a *pradhan pancha* (leader) for 17 years during the Panchayat era until multi-party democracy was restored in 1990. He joined the Nepali Congress party and was elected chairperson of the VDC in the first local elections held in 1992. In the second local election, however, the CPN (UML) candidate was victorious. The Milkway fell between the agendas of the local-level minions of the two parties. Consequently, the former chairperson lost interest and the new chairperson, who had not been consulted about initiating the Milkway, never developed any interest. Although he had not been elected, the former chairperson commanded substantial support in the village, and was nominated to be the chairperson of the RUC. He was not enthusiastic about this role. On the contrary, he used his influence to ensure that decisions regarding the control of the Milkway remained with him. He seemed to wish to drive home the point that without him things wouldn't be the same and that by voting him out of position the villagers had made a mistake.

COOPERATIVE POLITICS AND INSTITUTIONAL COLLAPSE

Putting up a technical artefact such as a ropeway, difficult though it was, seems, with hindsight, relatively easy compared to the problem of organising milk production, collection and transport. The institutional aspects involve hundreds of farmers, many intermediaries, and very different institutional styles of working. In its own way, the politics of the milk cooperative also contributed to the demise of the Milkway. Before we discuss its actual modalities, it will be edifying to discuss the nature of the dairy business, which, in the mountains, involves more than just a buyer and a seller. Milk is collected from individual farmers by village-based cooperatives contracted to supply it to the DC. Each cooperative represents milk producers or a multipurpose cooperative registered with the DC. The secretary of the cooperative is entrusted with the task of collecting milk from the farmers and supplying it to the DC.* He plays a dominant role in the business.

Farmers bring fresh milk to the cooperative early each morning, usually before 9 AM, so that the milk contractor can take it to the nearest chilling centre before it curdles. The contractor records the fat content and the quantity of milk each farmer provides and collects it in 20 or 40-litre milk cans. The fat content varies from farmer

* The villagers call the secretary *dudh thekedar.*

to farmer and, even for a single farmer, from day to day. The contractor pays farmers according to the fat content rate fixed by the DC. The full milk cans are then transported to the chilling centre using porters and small trucks. At the chilling centre the milk is collected on behalf of the cooperative and the fat content and quantity (now in bulk) is again measured before it is dispatched to the main processing centre in Balaju. After the milk arrives at Balaju, it is processed and its quantity is adjusted, sometimes by mixing in water and powered milk, before it is distributed.

In the summer months, the milk contractor adds water and soda to the milk to keep it from curdling during transport. Adding water increases the volume of the milk but decreases its fat content. When the contractor adds water it is done to prevent milk which has not yet been chilled from curdling. If a milkcan is transported without adding water, milk rich in solid-not-fat (SNF)curdles very fast. Thapa (2002) observed that water is also added at the chilling centre, a practice which is difficult to understand as it unnecessarily increases the volume to be transported.

Farmers are paid on the basis of fat content only, whereas the DC pays the respective cooperatives separately for the fat, SNF, and lactose contents of their milk as well as for an additional 18 per cent of these components, termed ‘total solid (TS) commission’. Payment for SNF, lactose and TS commission covers the cost of transportation and the other expenses of the cooperatives.

The DC sends money to the bank account of each cooperative at Nepal Bank Limited in Chapagaun every two weeks. The secretary and the chairperson of each cooperative jointly withdraw this money to distribute to the farmer members. For each fat per cent per litre the farmers get Rs 2.70 (2001 price). The price was Rs 2.10 in 1995 when the Milkway was installed. When the milk reaches the chilling centre, its average fat content is usually less than at the collection point because water has been added. Since farmers are paid according to the original fat content, the contractor makes a profit because he increases the volume using water and transports more milk.

The relation between the secretary of the cooperative and the responsible official at the chilling centre is equally interesting. The two are the final authorities in deciding on fat content, which in the end dictates how much money the DC pays. The added water and fat content are then adjusted in the books. In this process the richness of the milk is degraded and the milk in fact becomes contaminated by water of uncertain quality taken from whatever springs and taps are available. The water added is usually not safe for drinking and goes untreated to the milk-processing centre. There is no mechanism for checking such adulteration.[8] A farmer who complains about this practice, even in the name of *dharma* (citizen’s duty), is likely to be dropped from the cooperative. If a farmer is dropped, s/he is deprived of the only milk market available at her/his doorstep. Thus a farmer has no desire to annoy either the milk contractor or the chilling centre official.

As mentioned earlier, only registered cooperatives can collect and supply milk to the DC. It is the cooperative (or, more precisely, its secretary) that decides on the mode of transportation, not the milk producers themselves. The responsibility of milk producers ends as soon as they deliver their milk to the cooperative. The milk producers in Ikudol may have wanted to use the Milkway but if the secretary decided to use a truck or a minibus, so it was.

New milk producers in Ikudol (who produced *khuwa* until the Milkway was established), had no idea how to form their own cooperative even if they had possessed the confidence to do so. The milk business does involve some risks, particularly for the secretary who transfers milk from the village to the chilling centre. Since he has to pay for all losses if the milk curdles, he pays careful attention to the cleanliness of the milkcans. The negligence of just one farmer may spoil the whole batch of milk. A great deal of trust is also needed. Since the people in Ikudol felt they were too inexperienced to take this risk, they depended on the nearest cooperative, that of Bhattedanda. This cooperative began collecting milk from the area of Malta (west of Bhattedanda) at Chhabeli and sent it by truck to Jhankridanda. The same cooperative also collected milk from the farmers of Ikudol at Bhattedanda and sent it to Jhankridanda by the Milkway.

This arrangement of sending milk from Malta by truck and milk from Ikudol by the Milkway worked fine until the road that had once ended in Chhabeli was extended further west, nearer to the village of Malta, thereby bringing more farmers in contact with the milk market. The volume of milk from Malta gradually increased and surpassed the volume from Ikudol. While the number of farmers supplying milk using the Milkway remained almost the same, the *dudh thekedar* found it increasingly inconvenient to manage collection in two places and consequently asked the farmers from Ikudol to climb 15 minutes to deliver their milk to Chhabeli instead of leaving it in Bhattedanda. Porters were given incentives to transport milk cans to Chhabeli rather than to the Bhattedanda Milkway terminal: they were paid an extra 25 *paisa* per litre.

Another reason that the *dudh thekedar* chose to use the truck was that the Milkway charged for every litre of milk whereas the truck charged a fixed price for a trip, irrespective of the actual load. This made a big difference for the *dudh thekedar* as he could transport hundreds of litres for no extra cost in a truck. There were also complaints that Milkway operators mishandled the milk and that the *dudh thekedar* lost some milk in transportation. Similar complaints were made regarding other goods, some of which, farmers said, were stolen during transportation. The lack of a mechanism for monitoring was another major problem. While the political economy of milk introduced problems, the situation of the BIWMP led to new difficulties relating to follow up and monitoring.

Apart from once hiring a technician to reset the skyline cable in 2000, the BIWMP provided no monitoring or follow-up. Monthly reporting on financial transactions had already ceased, leaving the RUC institutionally weak. Soon other undesirable things started to happen. Rules and regulations made by the RUC were completely ignored. Not a single meeting was held in three years. The RUC chairperson arbitrarily reduced the transportation charge for milk from Rs 1 per litre to just Rs 0.50 and even as low as 0.25 without consulting the users or the other members of the RUC. The savings in the bank of about Rs 150,000 gradually shrank to about a hundred thousand, which was later given as an interest-free loan to the operators and the *dudh thekedar.* They did not pay it back and neither the BIWMP nor the new VDC chairperson took the trouble to follow up on these wrongdoings.

Because they were isolated by distance, the farmers of Ikudol were not part of any decision-making regarding the Milkway. Despite the repeated insistence of the cooperative at Bhattedanda that farmers of Ikudol send their milk to Chhabeli, they, assuming that it would be extended, kept using the Milkway. They organised several delegations to the BIWMP and put forward a request for an extension. However, since the extension did not come about, they began sending their milk to Chhabeli. If the Milkway had been extended to Majhkhanda, perhaps the institutional incentive to maintain it would have been sustained. This did not happen, though, and the Milkway became defunct in January 2001.[9]

MILKWAY RESURRECTED

On July 21, 2002, incessant rain and landslides damaged the road to Bhattedanda in several places. A large section of the road between Jhankridanda and Chhabeli collapsed. About 2,000 litres of milk a day could not be sold. Security forces opened the road to Tinpane on 25 July, but this did not help dairy farmers export milk.[10] It was estimated that the road between Jhankridanda and Chhabeli would take five to six months and nearly three million rupees to repair and re-open. This road was not a priority for the government because floods and landslides had also affected other parts of the country, killing many and damaging vital road and bridges.[11] There were no political representatives to put pressure on the government to allocate funds to repair the road to Bhattedanda.[12]

The livelihood of the farmers in Ikudol had improved substantially in five years. When the road collapsed, however, they lost access to the milk market and found themselves in a quandary. Their regular income from milk stopped but their expenses did not. They tried their best to cope. Some farmers from villages as far as Pokhari Chaur near Majhkhanda carried milk to Tinpane on foot. It took them more than five hours, by which time the milk had curdled. Some resorted to making *khuwa.* Although they were able to convert only about a fifth of the milk produced, they still sold about 60 kilogrammes of *khuwa* every day. Many others made *ghiu*. They were losing about 30-60 per cent of their daily income. As a result, they stopped importing animal feed, which they no longer needed to increase milk yields.

The farmers in Ikudol had already invested millions of rupees in purchasing high-yielding *lahure* buffaloes, each of which cost between Rs 30,000 and 40,000. Between 2000 and 2001 they had taken a total of about 2.5 million rupees in loans to buy buffaloes. The interest was accumulating. They would not be able to repay their loans or interest on them by selling *ghiu* or *khuwa*, so they would have to sell their buffaloes to the *momo* (steamed dumplings filled with ground buffalo meat) market in Kathmandu for about Rs 10,000 each. Having to sell buffaloes for one-third to one-fourth of their purchase price would have been a disaster pushing dairy farmers into poverty.

Many years ago, in the village of Kharidanda in Bukhel, Lalitpur, a farmer explained a similar situation in his own way. A polythene pipe had been laid across a landslide to supply domestic water to about 50 households. Having water at their doorstep helped farmers to raise buffaloes and sell milk. Within three years, however, the polythene pipes had weathered and leaked in many places. Unless they were replaced before they snapped, farmers suspected that one day they would lose the milk business. One farmer said, '*Sir harule aaj ta rasbari khanu bhaa chha, dudh bechna payena bhane momo khanu parlaa'* or 'You have been eating *rasbari* (a popular *mithai* made of milk), but if we fail to sell milk you will have to eat *momo*'. His argument had not struck me at that time but observing how the cloudburst in 2002 had devastated access to the market, the implication of what he meant hit me like a lightening bolt. If farmers in Ikudol failed to sell milk they would have to sell their buffaloes because they could not feed them to no purpose. Selling milk for *rasbari* meant a sustainable livelihood for farmers, but selling buffaloes for *momo* meant the liquidation of assets and the loss of livelihood.[13]

Behind every cloud, however, there is a silver lining. Sometimes a disaster can goad people into pursuing a collective endeavour which will protect their interests. The cloudburst of 21 July, 2002, seems to have done just that. All hope of the Milkway being repaired with government help had waned, but the farmers did not wait for an outside agency to help them. On 26 July, 2002, the *dudh thekedar*, the new chairperson of the dissolved VDC and a few Milkway users from Ikudol requested a BIWMP engineer who had been involved in the construction of the Milkway in 1995 and was still doing other work in the village, to help them re-operate the Milkway. Local politicians also made a similar request to the BIWMP through their respective channels.

It is worth mentioning that before the Milkway stopped operating, the users had, in early 2001, requested the BIWMP to fix the carrier and some pulleys. The BIWMP, presuming that this would be done while extending the Milkway to Ikudol—a development which never materialised—never made the repairs. After the cloudburst, the Milkway users did not expect the BIWMP's help. They decided to use the Milkway's own funds to fix the problems themselves and to restart the operation of the ropeway as quickly as possible.

The BIWMP engineer hired a skilled technician who had previously helped maintain the Milkway. Together with the users, they fixed the carrier, overhauled the generators, and re-tensioned the rope. The Milkway still had about Rs 70,000 which it had given to the *dudh thekedar* as an interest-free loan; about Rs 25,000 of it was spent on fixing the pulleys and the generator. The Milkway rolled again on August 10, when it began transporting rice and other goods. It began transporting milk when the road between Jhankridanda and Tinpane section opened on 16 August, 2002. The RUC was replaced with a temporary committee. A new charge of Rs 0.50 per kilogramme for goods was fixed. The Milkway carried between 700 and 900 litres of milk and 700 kilogrammes of other merchandise daily. As of July 15, 2004, a total of 1,046,294 kilogrammes had been hauled and a total of Rs 523,147 earned (Table 8.3). Of this amount, Rs 316,204 was spent on diesel and the salaries of the operators.

By securing access to the milk market, the Milkway had provided the villagers a sense of security and prevented them from growing poorer after the cloudburst of 2002. Because of this, they vowed that they would not abandon it in the future.

REFLECTING ON DEVELOPMENT POLITICS

The development path to Bhattedanda Milkway was not easy. First, bureaucrats, politicians and donors did not view the idea of a ropeway for transporting milk positively. Those in the corridors of power in Kathmandu were cynical, and, in the initial stages at least, most officials in the Department of Soil Conservation and Watershed Management (DSCWM) within which the BWP operated felt that the idea of a milkway was an

TABLE 8.3: Goods carried and cash earned by Milkway (from 20 August, 2003 to 15 July, 2004)

Types of goods	Bhattedanda to Jhankridanda (kg)	Jhankridanda to Bhattedanda (kg)	Total load carried (kg)	Gross cash income (Rs)
Milk	556,000	-	556,000	278,000.00
Khuwa and vegetables	155,717	-	155,717	77,858.50
Rice	-	97,079	97,079	48,539.50
Other goods: (Animal feed, noodles, kerosene, sugar, wheat flour, fertilizer, soap, salt and biscuit)	-	237,498	237,498	118,749.00
Total	**711, 717**	**344,577**	**1,046,294**	**523,147.00**

Source: Personal communication with Jagat Thing , who works as ropeway operator at Jhankridanda.

example of misplaced exuberance and, as a project, not viable.[14] Though scepticism was dominant, the milkway proposal had some supporters in the government, too. Having seen small ropeways in the Alps transport farm produce, the EU's counterpart in the BWP agreed to support the milkway, as did the EU representative in Kathmandu.

A new problem emerged after the project was approved and field implementation had begun: purchasing tailor-made equipment. EU rules only allowed the purchase of equipment from Europe or from countries receiving EU support. This required surmounting the hurdle of transferring funds from capital support to commodity aid. Furthermore, before approving the purchase, the EU asked that a report be submitted containing a detailed justification of the milkway, an economic analysis and a discussion of the choice of location, type of system, and so on. If this stipulation was not complied with, the EU indicated, any expenditure in relation to the construction of the ropeway would be frozen.

The BWP did not have such details to present, but it also could not stop the construction of the towers, which was already in progress. The construction work had to be completed by the end of the fiscal year, which was hardly two weeks away. Consequently, the BWP suggested that it would be a tragedy if the construction of the ropeway came to a halt because a few details were missing from its report.[15] The EU conceded, and the Milkway came into existence. When it began operating in 1995, everyone who visited it opined that similar short-haul ropeways should be built in other parts of the country in order to increase access to remote mountain villages (see Box), but none of the views expressed were pursued to use stages of rethinking, planning or implementation.

Extending the Bhattedanda Milkway was to be a major activity of the BIWMP, which began in 1998. According to the Project newsletter *Jaladhar* (2001), fieldwork did not start until 2000, by which time the Milkway was running at a loss. The BIWMP had used the first two years for preparatory works[16] as well as to prepare a proposal for a biodiversity project.[17] Between 1999 and 2001, six consultants, including some expatriates, were separately hired to study and survey the ropeway alignment to Majhkhanda. Each recommended extending the Milkway.[18] A detailed survey for the extension and a report on the MHP in Bhattedanda were completed.[19] An expatriate consultant who visited Bhattedanda estimated that the extension to Majhkhanda would cost Rs 60 million. The estimate of a local company was, due to the difference in the systems proposed, just half of that. However, even the lower estimate of about Rs 30 million was higher than what had been allocated by the BIWMP and much higher than the amount spent on the Milkway.

Implementing the extension seemed more complex than expected for several reasons: there was no expertise available, it demanded more financial resources than allocated and there was no way to verify the costs estimated by the consultants. As a result, the proposal for an extension was gradually pushed aside as an alien activity outside the purview of watershed management proper. The BIWMP dropped the idea of extending the Milkway, but continued supporting the local people in their desire to build a road from Chhabeli to Bhattedanda and beyond. In most stretches the road had to be supported by retaining structures, for which the BIWMP provided gabion boxes. Because the cloudburst of 2002 caused widespread damage to the road, no vehicle ever plied it.

The pressure to extend the ropeway continued on the part of both the EU as well as the villagers of Majhkhanda. At this stage, the BIWMP sought the help of a suspension bridge expert. If Indian materials were used, the expert suggested, the cost could be lowered to about Rs 20 million. To sort out operational problems, the BIWMP studied the institutional arrangement of the Milkway. Within three months, two studies, both of which recommended a new organisational structure to manage the Milkway, including the proposed extension, had been completed.[20] The Milkway stopped functioning in January 2001, six months after these two studies were completed. Six months after its closure, yet another study was undertaken to examine the reasons the existing users' committee had failed to function.[21]

The operational problems highlighted in this report legitimised the postponement of the ropeway's extension. In November 2001, in the third year of its implementation, the EU reviewed the progress of the BIWMP (MTR/BIWMP, 2001). The review mission was not impressed with the Milkway because it was not functioning. It recommended that an extension not be constructed if local people failed to re-operate the existing system within six months. Apparently, the mission blamed the villagers for the ropeway's failure. The villagers, in turn, blamed the chair of the users' committee. The BIWMP blamed the design of the system and the institutional arrangement set up for its operation.

The Milkway's institutional ills were broadcast publicly. In November 2002, a daily newspaper reported that the Bhattedanda Milkway had not operated for many months. The villagers were fed up with the repeated assurances of BIWMP officers that the Milkway would be extended. The Nepali co-director of the BIWMP acknowledged that the extension had been delayed because the feasibility studies had not been completed. The newspaper reported the allegations of some villagers that the officers had come to the area only after the Milkway was built and that instead of extending it, they had squandered funds on unproductive activities.[22]

The EU, it was argued, had always wanted the extension to take place. When the EU saw no evidence that the Milkway was being extended, it decided to close the BIWMP in April 2003, the end of its five-year period. A new Nepali co-director, the third, was appointed just four months before the termination of the Project. Despite the limited time he had, he was eager to extend the BIWMP beyond April 2003 and continued to pursue the proposal to extend BIWMP at various levels.

In the meantime, Badri Narayan Basnyat, after being appointed the Minister of Forest and Soil Conservation, wrote to the EU headquarters in Brussels in February 2003 requesting that the BIWMP be extended. In his reply to the Minister, Christopher Patten, a member of the European Commission, wrote in March 2003 that the BIWMP could not be extended beyond April 2003. Patten hinted that the EU was disappointed that the Milkway had not been extended to promote agricultural activities in the five years from 1998 to 2003 but suggested that the EU would agree to consider the construction of new ropeways for poverty alleviation activities within the context of future cooperation.

EU funding ceased in April 2003, but HMG/N extended the BIWMP until July 15, 2004, on the grounds that the Milkway had to be extended and that the financial agreement was still valid until December 2003. The BIWMP (now supported only by HMG/N) requested the EU to support the extension of the Milkway. On 26 September, 2003, three months before the financial agreement of the BIWMP between HMG/N and the EU expired, Nepali news media, for the second time in eight years, published stories about how the Bhattedanda Milkway had helped to reduce poverty and preserve the environment.[23] One newspaper said that the extension had been hampered because the BIWMP had closed in April.[24]

BACK TO THE BEGINNING

The above is a story about the drudgery in the lives of hills farmers and the politics of development. A variety of agricultural produce is grown at different altitudes in the mountains in Nepal but because there is no access to markets, such produce cannot be sold. Hence, many families who might otherwise have been innovative and entrepreneurial are not. Short-haul ropeways can help provide markets for goods and foster income generation. They can connect thousands of hill villages to roads and thereby improve access to markets.

Bringing about such a change is easier said than done because ropeway development is a multi-faceted task. Lessons at Bhattedanda throw light on some of these dimensions. The Bhattedanda Milkway was an innovation introduced to open a marginalised region of South Lalitpur with twin objectives. The first was to improve the economy by providing farmers with access to the milk market. The second objective was, by creating the incentive to sell milk, to get families to stop making *khuwa* and consequently to burn less firewood and minimise deforestation. It took four years for the idea to materialise although the Milkway itself was built in less than a year.

In addition to using the Milkway to transport milk, the villagers also used it to export vegetables, brooms, and even flowers on occasion. Cement, pipes, and corrugated zinc sheeting were imported to the villages. The Milkway introduced local changes; it earned money for its upkeep and rendered local operators capable of undertaking regular maintenance. These developments demonstrate that farmers are capable of making the best of a situation. A development-oriented welfare state should capitalise on such local initiatives.

In the end, however, the Milkway fell prey to conflicting interests. One interest group promoted the Kanti Rajpath, a highway which passed through Bhattedanda. It had been started about 40 years ago but never completed. No bridges or culverts were built and landslides had damaged the road in many sections. After the restoration of multi-party polity in 1990, the rehabilitation of this highway became a political ball game to woo voters. From 1994 onward the government allocated budget to rehabilitate the section of the road from Tinpane up to Chhabeli. The amount was used to dispense patronage to local contractors, villagers, politicians, truck owners and transport lobbies, but no serious action was taken to rehabilitate the road.

The continued operation of trucks created another disincentive for operating the ropeway. Milk contractors exercised their influence in order to promote transportation by trucks. For government officials, the Milkway was one of hundreds of development initiatives and meant very little after it was inaugurated. Bureaucrats had no incentive to analyse the contribution of the Milkway, which ushered in only micro-level benefits to the farmers of one region. Unlike the road, the Milkway met neither local nor national political-economic interests.

We, as outsiders and perhaps catalysts, had conceptualised the idea that a ropeway could be the solution to the villagers' difficulty in selling milk. As a pilot activity, more attention was paid to the technical aspects of the ropeway than to its social and institutional dimensions. The Milkway project used development jargon like 'community participation,' 'appropriate technology,' and 'government as facilitator,' yet the process of building and operating it did not foster desirable changes in the beginning. Consequently, the Bhattedanda Milkway, like its predecessors, ended up being an agency-guided, donor-funded, target-bound, top-down activity. One major reason for the hiatus in the operation of the Milkway was the absence of a social carrier attuned to its ethos. Another problem was that the lag time between initial use in a pilot project and the widespread diffusion of a new technology is long, longer than most project log frames.

To assume that the users' group would operate and manage a ropeway like a water supply system was unreasonable. The operation of a ropeway demands particular institutional practices to sustain its uninterrupted operation. That the operators and users lived in two different villages did not help to build a viable institution. *Khuwa* producers living in remote villages faced different problems and had different aspirations than the ropeway users' committee and the operators did. A committee of users alone could not be formed, so a joint group with users and operators was made. Because their interests were different, however, only a few users ended up joining the RUC as members. Most members were operators and individuals from Bhattedanda.

Integrating the interests of the users and operators demanded continuous engagement with both groups, but this ceased after the Milkway began operating. Simply put, the operators in Bhattedanda had nothing to lose if the Milkway did not run. They had no incentive other than the wages they earned operating the Milkway and by engaging in other, related activities. The RUC was not able to play the role of a mediator in order to establish communications between the operators and the users. The DAO at least should have monitored the revenue collected—which was misused—but it did not. Perhaps the expectation that the DAO would assume this responsibility was unreasonable because it had so many other activities to oversee. As a result, problems among the committee members, the operators, and the *dudh thekedar* gradually escalated. Disputes could have been resolved had there been a set of rules for community-based transport systems but there was not. This is because transportation is regarded as the responsibility either of the government or of private businesses but not of a community. The political economy of the milk business did not allow users to make decisions about the mode of transportation used. In the end, the *dudh thekedar* made the decisions. Consequently, the Milkway did not operate and remained idle until landslides damaged the road from Chhabeli to Jhankridanda.

The Milkway began working anew because of this natural disaster: milk could not be exported and everyone lost. Attempts to transport milk manually did not work. Thousands of litres of milk curdled. The crisis stimulated those involved to work together despite their differences in order to get the Milkway operational. Without the support of outsiders, they repaired the Milkway and got it functioning. This process provides a key lesson: in response to collective constraints arising during times of crisis, individuals of a community put aside differences and engage in bringing forth both technical and social innovations.

In the end, all involved in the Bhattedanda Milkway found it inspiring. Some section of HMG/N did realise that the Milkway helped reduce poverty and protect the environment. Even villagers who refused to use the Milkway for over a year saw it as a *bardan* (boon). The EU as donor also saw the rich potential that lay in this approach for its future cooperation with Nepal. Though the lessons of Bhattedanda have yet to ignite a fresh development paradigm, those of us who were there in Chila in 1990 exploring measures to stabilise a landslide cannot but marvel at the serendipity that started it all.

NOTES

1 See DPTC (Undated).

2 The estimate of quantity of milk produced and marketed in South Lalitpur is based on personal communication with *dudh thekedars*. Also see Upadhya (2002).

3 These flowers fetch a high price in Kathmandu during festivals but are imported from Siliguri, India, despite their abundance right near Kathmandu.

4 The Milkway began operating in June 1995. At that stage baseline information was collected. This was compared with a second survey about two years later which also monitored impact of the Milkway. See BWP (1997).

5 The report (BWP/Himal Hydro Consult, 1996) says that the extension is not only feasible but also necessary to provide market access to thousands of families who live in remote parts of Lalitpur which no road will reach in the foreseeable future.

6 In 1995 BPC Hydro Consult conducted a feasibility study of the proposed Bhattedanda MHP for the BWP. The idea was to construct a MHP in Bhattedanda along with a ropeway to Majhkhanda.

7 On 18 and 25 June, 2004 *Rastriya Bimarsha,* a Nepali weekly, printed full-page investigative reports by Kedar Subedi that highlighted how the BIWMP's fund had been misused. The weekly headline read '*Ek Arab Bis Karod Ko Yojana: Dubne Ra Dubaune Kam'* (Deeds that destroyed a Rs 1,200-million project).

8 On 23 September, 2003 *Rajdhani* a daily Nepali newspaper, reported that some milk samples from the market showed that coliform was present but the report did not state to which dairy the samples belonged. They could have been from private dairies. *Kantipur* and other Nepali daily newspapers on 14 June, 2004, reported that 23 per cent of the samples of DC milk and 100 per cent of the milk samples of many private dairies showed presence of coliform bacteria.

9 The exact date is not known because no records are available.

10 The Maoist insurgency that began in 1996 had spread across many rural areas of Nepal. On 2 January, 1999, the Maoists killed two and injured four policemen stationed in Bhattedanda. Following this incident, the government put security forces in strategic locations such as Kotdanda near Tinpane to control the movements of the insurgents.

11 Floods and landslides affected 47 districts (40 of which were in the hills) and caused the deaths of 441 persons. The loss of property was estimated to be about 418.91 million rupees. For details, see HMG/N (2003).

12 All VDCs and DDCs were dissolved. Elections were not held due to security concerns. The Lower House of Parliament was dissolved.

13 Nepali law prohibits slaughtering female animals but female buffaloes are slaughtered in Kathmandu to make *momo. Rasbari* is considered a luxury. Thus, a milk market would decide not only the fate of a farmer tending buffaloes up in the hills but also who gets to eat what, *momo* or *rasbari.* Milk and *momo* also have distinct social implications. Milk can be produced sustainably without compromising assets (buffaloes) whereas making *momo* liquidates that same asset.

14 This initiative was labelled '*nautanki',* or 'comic street show'.

15 See BWP/IDC (1994).

16 According to *Jaladhar* (2001) no field activities were implemented in the first two years.

17 The EU was interested in supporting a watershed-based biodiversity project which would protect the core of the Phulchoki area. The BIWMP spent approximately Rs 10 million over three years to develop a biodiversity project proposal for a 27 million-Euro project. It was not clear which department within the Ministry of Forests and Soil Conservation would implement the project. The project did not materialise in the end.

18 Bechter (1999) found that it would be able to transport an additional 1000 litres of milk daily after the extension. The study also recommended establishing a chilling centre in Bhattedanda to cope with the additional milk supply of 2000 litres per day. The milk could then be transported in the afternoon, too.

19 Himal Hydro and General Construction Limited (1999) and BPC Hydroconsult (1999) prepared detailed surveys of a potential ropeway and carried out a feasibility for a MHP.

[20] See BIWMP (2000a and 2000b).

[21] See BIWMP (2001).

[22] *The Himalayan Times*, 10 November, 2002.

[23] In a news bulletin, Nepal Television reported that the installation of the Milkway in Bhattedanda, Lalitpur, had brought smiles to the faces of the local people. *The Himalayan Times,* an English daily, reported on September 26, 2003 that the Milkway served 265 families by carrying agricultural products worth 22 million rupees from the area each year. According to the daily, the national co-director of the BWP said, 'We have even studied, designed and estimated the cost of an advanced Milkway. Hopefully, the EU will sanction the budget of 16 million rupees after November [2002]'.

[24] *Nepal Samacharpatra*, 26 September, 2003.

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CHAPTER 9

Barpak Experience:
An Entrepreneur's Testimony

BIR BAHADUR GHALE

LEARNING ABOUT MICRO-HYDRO

In 1989, when talks on the Trade and Transit Agreement between Nepal and India were being held, the Agriculture Development Bank of Nepal (ADBN) organised an exhibition in Kathmandu.[1] Its aim was to promote alternative sources of energy such as biogas, solar, and MHP. At the exhibition I saw a notice that said that the government would provide a subsidy of 50 per cent to those interested in installing an MHP. I did not know then what a subsidy was, but later I learned that it was money that the government would provide to anyone interested in setting up an MHP and that the ADBN managed these subsidies. I thought this was a very good policy.

I was then based at Naubise in Dhading District, working as a petty contractor to the Chinese, who were constructing a section of the Prithvi Highway. When the talks between Nepal and India failed, trade between the two countries came to a halt at the end of March. The import of petroleum via India also stopped and construction activities came to a standstill. The Chinese contractor prepared to leave, and I had no reason to stay in Naubise either. On the evening before I left, as I was having dinner in a roadside hotel, I noticed to my surprise that the fluorescent tube light in the hotel flickered constantly. The hotel owner told me that the electricity was generated at a nearby multipurpose water mill and that when the mill was used to grind maize or rice, the power supply became erratic. Once the grinding was complete, the light stopped flickering.

Naubise, it seemed, had electricity even before it was connected to the Integrated Nepal Power System (INPS). Out of curiosity, I visited the mill the next morning. It had a small dynamo coupled to a water turbine. The whole arrangement did not look complicated at all and I became excited at the thought of installing a similar system in my village, Barpak, in Gorkha, the district with the largest community of Gurungs and Ghales in Nepal.

A month later, with the thought of generating electricity there, I returned to my village. Barpak proper consists of about 786 houses clustered together and strikes one as a small town. It is situated south of Manasulu Himal at an elevation of about 1,900 metres. It takes nearly two days to reach it on foot from Pokharithok, the district centre of Gorkha. The major trail to other villages in North Gorkha passes through Barpak. Many people from the village are employed in the Indian and British armies and some work in other countries doing blue-collar jobs. In fact, foreign remittance is the primary source of income for many families. The main crops grown in the village are corn, wheat and rice, but the income generated from farming is not enough to sustain most families. With money sent home from abroad, however, families in Barpak live a comfortable life. One unique characteristic of Barpak is that unlike in many other Nepali villages, where economic disparity is stark, one cannot differentiate between the poor and the affluent.

Barpak is rich in natural beauty. The village has abundant water resources but is seldom affected by floods or landslides. The Daraundi River flows about 1,000 metres below Barpak, and many streams around the village eventually join this river. I had studied hydro-electricity in the ninth grade and remembered that the greater the head of water, the greater is the quantity of electricity that can be generated. I wondered if it would be possible to generate electricity in the streams in my village and whether the electricity thus generated would be enough to supply the whole

■ Barpak, Gorkha District

village. Though I had little money, I was interested in finding out the cost of setting up a hydro plant and generating electricity.

While visiting the exhibition in Kathmandu, I had asked how much it would cost to set up an MHP. I was told that the cost would be between 500 and 600 thousand rupees, of which 50 per cent would be subsidised by the ADBN. I thought that getting a loan of 300 thousand rupees would not be a major problem for such a novel cause and resolved that I would pursue the idea of establishing a hydropower plant in Barpak. I approached the ADBN for a loan, but since these were the early days for MHP development, there was confusion among the bank staff about how to sanction a loan. It was unclear, for instance, whether the bank would provide a loan for transmission lines or for generating equipment or for both. The bank advised me to contact one of several private and public companies which could undertake a feasibility study and estimate the cost. The report would help the Bank determine how much to provide as a loan and how much as a subsidy. The list of companies included Balaju Yantra Shala (BYS), Kathmandu Metal Industries (KMI), Vikash Consultancy Services (VCS), and Khawa Engineering (KE). Since BYS had already supplied turbines to Barpak on earlier occasions and was familiar with the area, I decided to contact it.

Though I did not know what this visit would bring in the end, I thought that it would be a worthwhile investment. I was interested in bringing new ideas to Barpak, not simply in repeating what others had already done. The situation in my village, however, was not conducive to change. Partisan politics had pervaded all aspects of social life and individuals with vested interests dominated village politics. As a consequence, I had to be very careful that my initiative was not politicised before it even took shape. Also, I was young, just 22. On many earlier occasions, I had had to pretend to agree with the elders just to show them respect. It was important that I have a strong case before I told them of my plans.

I asked BYS technicians to visit Barpak, paying them a daily allowance of Rs 450. I pretended that they represented the Water and Energy Commission of the Ministry of Water Resources and had come to undertake a feasibility study of MHPs. I had to do this because Barpak had had an unpleasant experience in the past. The Resource Conservation and Utilisation Project (RCUP), a USAID-funded natural resource conservation project, had undertaken a similar study in the early 1980s and had destroyed a large tract of forest but built no hydropower project. The people of Barpak, obviously, were unhappy about what had happened.

Their experience with the RCUP had made a very unpleasant impression and since then the villagers had been unwilling to allow any feasibility studies for MHPs to be conducted. In order to regain their trust, I had to create a legitimate façade. My approach seemed to work. The villagers were curious about the technicians and asked them a lot of questions. Before things could go wrong, I intervened and told them a story about how I had met them on the way and accompanied them. I said that since there were no hotels in the village, I had offered to let them stay at my house. I explained that I would take them to the different sites they were to investigate. At that time, no one in the village, not even my family members, had the slightest knowledge of my true intentions.

After they had completed the survey and feasibility study, we returned to Kathmandu, and the technicians prepared a report. It included the cost, which they had estimated at between 2 and 2.5 million rupees. I was stunned. The cost was four times higher than originally predicted. The shock did not, however, deter me from pursuing my dream of establishing an MHP. I would need to answer one major question, though: if I ever set up a plant with a bank loan, would I be able to repay it? The first thing I had to find out was how much the villagers were willing to pay. I also had to find out if the revenue the villagers would generate would be enough to pay back the loan and keep the plant running. I was convinced that even if the villagers did not have much money, if they had a strong desire to use electricity, they would pay for it and sufficient money would be raised. With this conviction, I decided to begin my MHP investigation in Barpak. The next challenge was to read the people's minds about their willingness to pay for electricity without telling them that I was going to establish an MHP.

During the 1989 monsoon, I went home and began to ask the villagers how they felt about having electricity in the village and whether or not, if it ever came, they would pay for it. Their response was positive. I discovered that kerosene, which they used for illumination, was in short supply because of the Indian trade embargo. The District Panchayat[2] sent a limited quota to each village and people paid as much as Rs 50 for half a litre of kerosene, which lasted for only two weeks. This rate gave me an idea of how much villagers were willing to pay to illuminate their homes.

In Barpak, as is the case elsewhere, the monsoon is the season for planting rice. Many farmers in Barpak practice *perma*, a system in which each farmer helps others to sow their fields free of charge in return for help in his own field. Some comparatively rich farmers hire poor people such as local tailors and blacksmiths on a daily wage basis. Thinking that the views of these poor people would provide a good benchmark, I asked them if they would use electricity to illuminate their homes if it became available in the village. They replied that they would pay Rs 40-50 a month for the privilege. I realised then that the desire to use electricity among the villagers was strong and that they were willing to pay for it. The willingness of the villagers to pay for electricity made me confident that I could sell electricity, raise revenue locally and pay off a one-million-rupee loan.

I was happy to learn that people would pay for electricity. For home illumination, however, electricity is used only at night; in the daytime, lights would not be needed and the generating plant would remain idle. There would be no additional revenue unless the electricity generated by the MHP was consumed during the daytime also. I began to explore how electricity could be used. I collected information about how much milling would be possible using daytime electricity. It became clear that grinding corn and other cereals would indeed both consume electricity and generate revenue.

I then forwarded a detailed proposal to the ADBN. The Bank was reluctant to process my proposal because it was an expensive proposition and if I failed to pay back the loan the ADBN would lose a considerable amount of money. The officials at the ADBN suggested that I seek quotations from other companies also. I contacted Kathmandu Metal Industries (KMI), which is owned by Akkal Man Nakarmi, the pioneer of peltric turbines in Nepal. This company provided the lowest quotation, 1.9 million rupees for a 40-kW plant. The general manager of ADBN liked the new proposal based on KMI's quotation and asked me to present a detailed feasibility report prepared by a team of technicians and a loan officer within 15 days. A team of four, including an overseer from the ADBN, a loan officer from its field office in Gorkha, Akkal Man Nakarmi and me, went to Barpak and prepared a detailed study. The villagers did not know that I was behind the study.

LOCAL REACTION

It took a lot of walking back and forth between Barpak and Kathmandu to reach this stage. The ADBN had little experience in providing loans for micro-hydropower development and I was so young and inexperienced that people found it difficult to trust me. After the detailed report was approved, the Bank granted me a subsidy of Rs 491,350 and a loan of 1.1 million rupees. Since I still needed more money, I sold a small plot of land in Kathmandu that I had bought a few years earlier. (Perhaps I am the first person in Nepal who has sold land in Kathmandu to open an industry in a village: everyone else sells village property to buy land in Kathmandu.) At this stage, the villagers had to be told. I told them that not only was I personally involved in the project but that it had been my initiative from the start. Some villagers resented my involvement. They could not believe that I had ventured into something the government itself had abandoned after conducting several studies in 1980s. I was called an ignorant and arrogant boy. However, I stuck to my convictions, and, after nearly four years of hard work, I brought electricity to Barpak in 1992. My dream had been realised.

In 1992 a hailstorm badly damaged the crop in Barpak. Had the devastation occurred in another village the people would have suffered more, but the people of Barpak were able to cope with the disaster because of the village's relatively strong economic base. The construction of the MHP proved to be a great relief for those who had no other source of income to make up for the bad harvest. I did not accept any free contributions of labour as many other development projects do; instead, I paid the workers high wages. I was happy, though, when some people voluntarily transported a few loads of stones from the quarry to the construction site. Villagers also provided encouragement in the form of moral support. Except for the ADBN, no institutions or agencies helped me with the work. I did not get any help from the local VDC either. Without the keen interest of the General Manager of the ADBN, it would not have been possible for me to complete the project.

When the plant came into operation, the villagers were happy. Even those who had been sceptical initially began to appreciate that the effort was indeed worthwhile. Their joy was understandable: no progress had been made in hydropower development after the feasibility studies of the 1980s, when suddenly a young man from the village took the initiative to introduce electricity. Normally people talk about doing a lot of big things, but do not accomplish anything. In this case, they saw results. There was lighting in houses and grinding maize was easier since there was no need to travel to the *ghatta* located at the base of the mountain. The villagers said they were proud of me. During the construction period, I came across two types of people: my peers, who were unappreciative, perhaps because they felt out-classed; and the larger majority, who were grateful for my work.

ECONOMY OF MICRO-HYDRO

I set the price of electricity initially at Rs 15 per month for using a 25-watt bulb and later increased it to Rs 19. For every household in the village, electricity became a cheaper, easier and cleaner way of lighting than kerosene had been. The village could not, however, consume all the power generated, and, in order to sell surplus power, I had to reduce the cost for those who consumed more and paid in advance.

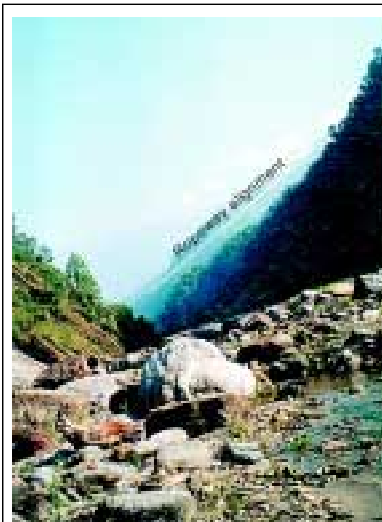
The main problem during the plant's operation was technical. Since no one in the village had any experience in generating hydro-electricity, we damaged two generators in the first two years. They were expensive to replace and put a great financial burden on the plant. With more experience, however the machine operator and I got more used to these technical matters.

As far as financial returns were concerned, I was running at a loss. Even if the electricity charges were increased from 19 rupees to 25 rupees per bulb, I would raise only about Rs 40,000 a month, and I had to pay Rs 10,000-12,000 to my staff and Rs 12,000 to the bank every month. On top of that were the costs of maintenance and repair. I also had to consider the interest on my own investment plus some additional return on it. Had I kept the land in Kathmandu and sold it a few years later, it would have fetched me more money than what I was making from the hydro plant. It became clear that I would have to use daytime electricity for other purposes in order to maximise my returns. The grinding mill consumed only 5 kW and earned me about Rs 25,000 per month, while the 40 kW that I sold for illumination at night fetched me only Rs 35,000 per month. I invested another nine lakh rupees in a handmade paper industry to use the daytime surplus power with technical help from ITDG-Nepal office. The MHP also generated employment for the young people of the village, and encouraged other villagers to invest in rural enterprises. Subsequently, a bread factory, a paper industry, several grinding mills, and a furniture factory, all of which used the daytime electricity were established. People thought about establishing stone cutting and candy industries and I planned to set up an aromatic oil extraction plant. Then, another set of events led us to opt for a ropeway instead.

BARPAK ROPEWAY: FROM IDEA TO REALITY

In 1986, long before establishing the MHP, I had visited Hong Kong and been fascinated by its cable cars. I had wondered when we might have such facilities along the steep trails in Barpak. I had said to myself then that it was not God who had made the cable cars but people who were no different than those in my village. That was the beginning of my interest in ropeways.

Later, when German Technical Development (GTZ) planned to undertake feasibility studies to develop micro-hydro projects in Gorkha, Akkal Man Nakarmi, a member of the study team, invited me to join the group. During the fieldwork, I raised the question of installing a ropeway. I thought that if a ropeway were established, it would change the way of life in my village by facilitating the transportation of goods, promoting the establishment of industries and, at the same time, helping me use daytime electric power. Akkal Man said it was possible to use ropeways in Nepal but asked who would undertake such a venture. I requested that he design a ropeway for Barpak. On my insistence, he prepared a design and cost estimate in 1992.



■ Barpak ropeway alignment

I wanted to pursue ropeway development in Barpak, but this time I planned to inform the local people and get their views from the outset. Having people supporting me would save a lot of trouble. Besides, the villagers had already developed confidence in me. When I talked about the ropeway with them, I found them interested and supportive.

Encouraged by the villagers, I went to meet the former General Manager of ADBN Srikrishna Upadhyaya, who was now a member of the NPC and had more authority than before. I handed over Akkal Man's design and cost estimate to him and requested that he extend any help he could. He assured me that he would get the Canadians to help. Unfortunately, ropeways were not in any government programme so nothing happened. Then I contacted the Director of ITDG-Nepal Bikash Pandey, who was interested in developing techniques to enhance the load factor of MHPs. A ropeway was something that could enhance load factor very easily. When they came to Barpak, I guided Bikash and an expatriate friend through the area and apprised them of my plan. This meeting also came to a dead end.

Then, in 1996, Akkal Man called me and suggested that I meet a Swiss volunteer who was coming to Nepal. Meanwhile, the President of the Federal Republic of Germany, who was on a state visit to Nepal, came to Barpak to observe projects implemented by GTZ. In Barpak, the villagers formed a committee to welcome him and made me the chairperson. The President came and took part in the official rituals, but unfortunately he left before I even had a chance to discuss my new project with him. I decided to take the Swiss volunteer to Barpak with me. He told me that a ropeway was suitable for Barpak and that he knew about second-hand Swiss Army ropeway equipment which was for sale.

Upon learning that ITDG-Nepal had conducted some studies on ropeways, I went to ITDG-Nepal, where I met Bhola Shrestha, who at that time headed its end-use project. I told him about the Swiss volunteer and the ropeway equipment on sale for about 2.5 million rupees, less than half of what a brand-new, tailor-made ropeway would cost. To get detailed information, Bhola examined the report from the Swiss volunteer. Everything looked fine except for funding. The ADBN had expertise in financing and encouraging the growth of MHPs but there was no agency which promoted the installation of ropeways. Because the government had no clear plans or policies regarding the promotion of ropeways, there was no place I could turn to.

On the one hand, I was excited that we could get the right equipment at a very good price, but on the other, I was sad that there was nowhere to look for funds. Acquiring funds for the ropeway seemed impossible until Bhola Shrestha approached the British Embassy in Kathmandu with the ropeway proposal. The British Ambassador generously granted us about 50,000 sterling pounds (about Rs 4,646,895) towards installing the ropeway. This was not enough money but construction began anyway. ITDG-Nepal later managed to provide an additional 600 thousand rupees and local villagers raised another 500 thousand. Still, there were unforeseen expenses such as redoing the ropeway alignment and paying for additional helicopter trips.

With the first hurdle of acquiring funds crossed, we thought that things would proceed smoothly. They did not. I personally had to manage everything in the field and coordinate the agencies involved. I did things like picking up the steel cables from the Birgunj Custom Office, looking after the logistics of everyone who came to Barpak and sending periodic progress reports to the British Embassy. ITDG-Nepal provided technical support and Himal Hydro supervised the construction, which was undertaken by a local NGO Northern Gorkha Development Group (NGDG). I had to coordinate the activities of all three. Working on a tight budget caused many problems. It did not take me long to realise that each organisation involved had its own rules, principles and demands, and that they sometimes conflicted with each other. Getting them to work together was difficult. There was a lot of paper work and a lot of talk but little work. Progress was slow.

Transporting equipment and construction materials from Gorkha to Barpak was a major problem. We had to rely on porters. Russian Mi-17 helicopters, which can carry large loads, were not available so we had to use the Royal Nepali Army's Puma helicopters instead. Since they could not transport large loads, extra trips were necessary; this added expense to an already tight budget. On the construction site, a major landslide occurred while the foundations were being dug, forcing us to shift the drive station and re-align the ropeway path. This, too, added to the cost. Housing the specialist from Switzerland was also very expensive.

We asked ITDG-Nepal to help us with funding to offset the unexpected expenses, but since ropeways were not an ITDG-Nepal programme, the agency did not have funds allocated for them. ITDG-Nepal, which looked after the overall supervision, argued that Himal Hydro should pay for the additional costs because its design had had to be changed. Tensions among the agencies

■ Ropeway in operation

involved grew. I felt it was better to bring the situation under control than let it flare up through finger pointing. I met the general manager of Himal Hydro and requested that he do a complete design and site survey for the ropeway. This organisation invested about 500 thousand rupees of its own. The new design included plans for expanding the ropeway to other villages as well.

For the villagers, building the ropeway was an exciting experience. It provided employment and it was something new. Unlike me, they were blissfully unaware of the many problems we faced.

After the commissioning of the ropeway in February 1998, the villagers asked me to take charge of running it, but I did not have the time. In any case, I thought that my working there as an employee would not look good. I decided to remain an advisor and formed a committee to operate it. My objective was to cultivate the capacities of other villagers; I would be involved only if there was a major problem. The committee consisted of the VDC chairman, villagers who had invested in the ropeway and Dalits from the village. The committee decided on the mode of operation and the fees to be charged.

The ropeway had an immediate effect on the people and the local market. Every day, goods such as rice, paddy, hay and wood were transported to Barpak by the ropeway. The selling price of these goods dropped by about Rs 2-3 per kilogramme as they had become cheaper and easier to transport. Merchandise such as soap became particularly cheap. The cost of sand, which had been five times what it was in Kathmandu, dropped from Rs 8 to just Rs 3 rupees for a pack of four kilogrammes. As a result, several cement houses were constructed. The time taken to transport goods to and from the village became shorter, and the market was now in close proximity to the village. The effect of the ropeway was felt not only in Barpak but also in Laprak and Gumda, two villages north of Barpak. The villagers appreciated the ropeway because their lives had become easier since they no longer had to carry heavy loads on the steep climb between Rangrung and Barpak.

THE ACCIDENT: LEARNING FROM THE TRAGEDY

The ropeway was so popular that it ran day and night. Fourteen months into operation, however, a major accident occurred that resulted in its being shut down. Four people who were riding in the ropeway car died when the hauling cable snapped on 7 May, 1999. I was in Barpak when it happened and felt both very sad and very angry when I heard about it. We had repeatedly requested people not to ride in the ropeway because it was not meant for transporting passengers. But many people argued that since the operators rode in the car during oiling and maintenance, they should also be allowed to. They did not seem to understand that when the maintenance crew rode the ropeway to grease the ropes, the ropeway went slowly and they carried a radio set to tell the operator to reduce speed when the car approached towers. This arrangement was not in place on regular runs when the ropeway carried goods.

Of the four dead, two were from Barpak; the other two were from a nearby village. The ropeway committee provided Rs 10,000 to the families of each victim to perform their last rites. Although saddened by the tragedy, the committee could not afford to pay more.

There was a lot of speculation about why the rope snapped, especially as the combined weight of the four persons who died in the accident was less than what the ropeway normally carried. Some people said that the drive system was faulty and that when the ropeway started moving at high speeds, excessive force had been exerted on the rope, thereby causing it to break. Others argued that it was because of insufficient lubrication. Some opined that the rope itself was not very strong. In fact, the accident occurred because the hauling rope, not the main track cable, snapped. The carrier then accelerated over the track cable before it hit the ground at a very high speed. It was the impact of the carrier striking the ground, not the carrier falling down, that had killed the passengers.

The ropeway supplier had not provided any special guidelines for maintenance. We lubricated the cable and checked the bearings regularly. Sometimes the roller battery on the tower would fall off when the ropeway was running, but operators learned how to deal with this problem. Operating the ropeway did not seem all that difficult.

The ropeway was still paying off old loans, but, considering the amount of revenue it generated, it was certain that the enterprise would be profitable. Excited by the success of the ropeway operation, we had planned modifications and improvements. For example, the location of the upper station had not seemed safe so we had planned to shift it a bit higher. We had also planned to change the operation modality. Tragically, the rope snapped and with it, our dreams.

We plan to rebuild the system, but we will need technical and financial support as well as expert advice to do so. We must also find out how and why the rope broke. This still remains to be done. A thorough investigation by ropeway experts is necessary before we conclude why the ropeway failed. If possible, we must salvage what good remains of the system.

We have already contacted experts. We need to find out what equipment needs to be changed or added, what can be manufactured locally and what needs to be imported. We need to estimate the value of whatever old equipment is salvageable. Then we plan to request interested organisations and people for financial support, whether loans or grants. We might establish a public limited company and float shares, although I am not keen on this option because it will involve too many people and will make it difficult to get things done. I have also contacted various agencies for help.

The Barpak Ropeway should be repaired as soon as possible. The villagers hope it will start operating again. They expect that the repaired ropeway will become a regular part of their lives. Porters, too, are hopeful that it will operate so that they do not have to carry loads up the steep Rangrung-Barpak section. It is backbreaking drudgery they want to avoid while still earning money by carrying goods on the less steep stretches to Gorkha Bazaar.

In 2001, I visited many cable car systems in Switzerland. I learnt a few lessons about how and where a ropeway station should be located. These lessons will be useful at Barpak. When we rebuild the ropeway, we will raise the lower station by 50 metres and the upper station by 300. Both locations are safe from possible damage by flooding and the upper station will also be closer to the village.

I believe that ropeways must transport people as well as goods. Having a dual function improves their utility. To carry people, however, ropeways have to be built with a higher safety factor and this costs more. When the road from Gorkha reaches the lower station of the ropeway in the future, as is planned, it will result in the increased movement of people to and from Barpak. At present, we are interested in getting the ropeway to function as it did earlier. In order to reduce the cost, we will try to make use of local people and resources. We will try to salvage parts from the old ropeway. In Nepal there are many companies which can install ropeways though they lack the confidence to do so.

CONCLUSION

Many Nepali villagers have not had the opportunity to realise how useful ropeways can be in Nepal. Even though there is very little interest in official circles and very few provisions for ropeway development, I feel that the government should promote ropeways by providing long-term loans, electricity at lower rates, and necessary technical support. Proper rules and provisions must be made to facilitate national entrepreneurs and investors who wish to take the risk of establishing a ropeway. My suggestion to those who plan to invest in ropeways is to conduct a sound market survey, find ways of reducing costs without compromising on safety, and look for ways to make ropeway operation reliable and stable.

Entrepreneurs should estimate the load that will be transferred every day and decide whether loads will be carried upwards, downwards or both ways. If these factors are taken into consideration, then a proposed ropeway may be successful. One cannot make quick and easy money by operating a ropeway though it can provide slow but steady revenue over the long term. Ropeway development is also an opportunity to do something for our society by reducing the harsh drudgery villagers face in their daily lives. It is also perfect for showing how private investments can meet the larger interests of the country.

NOTES

[1] When the existing Trade and Transit Agreement between Nepal and India expired in March 1989, Nepal could not import petroleum products via India. For a few months, until a ration system was put in place, the supply system was completely disrupted. Petroleum products were even flown in from Bangladesh and imported from China during the initial days of the embargo. Fuel was expensive and not readily available. Because of the shortage of kerosene, the government opened several depots to sell firewood to consumers in Kathmandu, but the shortage of diesel meant that firewood from the jungles could not be transported to the urban depots. A new Trade and Transit Agreement was signed in 1990 after the restoration of democracy.

[2] DDCs were known as District Panchayats until 1990. They are political units comprising a number of VDCs and in some cases, one or two municipalities. Development planning is carried out at the district level and hence most government organisations have their lowest unit at the district level. DDCs coordinate the development activities of many offices.

CHAPTER 10

Building Barpak's Community Ropeway:

An Engineer's Experience with Low-cost Goods Transport in the Hills

BHOLA SHRESTHA

TECHNICAL EXUBERANCE

Kathmandu was virtually cut off from the rest of the country when, on 19 July, 1993, a disastrous cloudburst washed away several bridges and portions of the Prithvi Highway. Trucks that carried daily necessities like kerosene, salt, vegetables and petrol were stranded on the Highway. With the roads closed, the capital and its residents were practically besieged. Throughout this crisis, Nepal's oldest ropeway continued to haul goods from Hetauda to the capital. Unlike the highways in the affected region, which had effectively been put out of commission, the ropeway had remained intact.

During this critical period, Srikrishna Upadhyaya, then a member of the National Planning Commission (NPC), called Bikash Pandey at the office of ITDG-Nepal. Upadhyaya felt that the fact that the ropeway was still functioning despite the disaster and that expensive highways had been rendered useless was proof that this was an appropriate technology that should be promoted. He suggested that ITDG-Nepal investigate the uses of ropeway technology in Nepal. At that time, I was the manager of the ITDG-Nepal's end-use project, whose aim was to introduce new technologies that would increase the plant factor of MHP.[1] When Bikash informed me about the conversation, I agreed to investigate how ropeways could be developed as end users of MHPs.

I visited Jhimruk Hydropower Plant, where Himal Hydro had built a small ropeway to haul materials to the headworks site of the plant. It was cheaper and also less damaging to the environment than an equivalent length of road. The Jhimruk Ropeway impressed me on two counts. First, the local capacity to build a material ropeway was already in existence. Second, small ropeways for transporting goods had the potential to improve rural access as well as to increase the plant factor of MHPs.[1]

In December 1994, Bikash Pandey and I visited Washbang, a Chepang village in northern Chitawan, to survey a MHP project. On the way, he told me that Akkal Man Nakarmi, who had made significant contributions toward promoting MHPs in the country, had an unrealised dream of developing ropeways in Nepal.[2] He had picked up the idea of Peltric sets when he visited Switzerland,[3] and had developed and promoted them after coming back to Nepal. Peltric sets have now become ubiquitous in the hills of Nepal.

A visit to the Alps to learn about the Swiss approach to developing ropeways seemed the next logical step. In June 1995, Akkal Man Nakarmi and I flew to Austria, where Mick Prince, who had completed his undergraduate thesis on ropeways in Nepal at the University of Warwick, UK, and Reinhold Metzler, a German engineer who had worked in Nepal and who was our escort, joined us. We spent a week driving to mountain communities in the Swiss and Austrian Alps to study and learn from the ropeways there.

During the week-long trip to the Alps, we observed a range of ropeway technologies. Many Swiss and Austrian dairy farmers operated short ropeways twice a day to carry milk to collection centres. These systems were owned and operated by individual families. They were particularly handy during the eight winter months when roads were covered in snow. Because the government provided subsidies to meet part of the cost of investment, the systems were affordable. One system we saw had been constructed in 1947 and still used by an old woman farmer. We also saw small ropeways which had been promoted over roads in the 1920's and 1930's as an economical alternative for transporting goods to small hilly settlements. At that time, remote communities in the Alps faced conditions similar to those Nepali villagers faced in the 1990s. After concluding that short ropeways would indeed be appropriate for Nepal, we contacted companies that manufactured ropeways and winches.

ROPEWAY INITIATIVE BY ITDG-NEPAL

At the time of our visit to Switzerland, ITDG-Nepal, as part of its collaboration with KMTNC's ACAP efforts, had been working for a number of years with the community of Ghandruk located south of Machhapuchre in Kaski District.[4] Every day, a considerable amount of cargo is transported to Ghandruk through Syauli Bazaar, which is about 800 metres below the village. For us at ITDG-Nepal, Ghandruk was an obvious site for installing a ropeway to transport goods as there was a demand and there was a 50-kW community-managed MHP to power it. After a reconnaissance survey was completed in May 1994, Mick Prince conducted a study that included a survey of

European ropeway products and their prices. These investigations revealed to us that the costs of imports were very high, but that the total cost of a ropeway could be lowered if locally fabricated towers and hangers and Indian-made steel ropes were used. In fact, the more local material could be used, the lower the costs would be and the more local manufacturing would receive a boost. If too many components had to be imported, we found, the cost of installing a ropeway would be beyond the reach of a Nepali community in the hills.

In 1996, when Andrew Barnet, the technology policy director of ITDG-UK, visited Ghandruk, village leader Min Bahadur Gurung requested ITDG-Nepal to help the community install a ropeway to replace mules and donkeys, the local beasts of burden which transported goods but also that littered the trekking path to Ghandruk with their droppings. ITDG's research on different ropeway systems and quotations from European suppliers indicated that a ropeway connecting Syauli Bazaar with Ghandruk—a distance of about four kilometres—would cost Rs 10-12 million. This amount was three times the cost of the Ghandruk MHP, which had been built in 1991 for Rs 3.5 million. An investment of this scale was not within the scope of either ITDG's micro-hydro end-use project or the community. Besides, the ITDG-UK office viewed the proposal for a ropeway as a programme of transportation, and hence outside the purview of its organisation in Nepal, whose limited mandate was capacity building within the MHP sector.

In the meantime, Dipak Gyawali and Ajaya Dixit of Interdisciplinary Analysts (IDA), Kathmandu, had completed a study of ropeways for ITDG-Nepal in 1996. They investigated whether or not there was a future for small ropeways to transport goods in the mountains, and in their report, suggested that small ropeways do indeed have a future but only under certain political-economic and institutional conditions. If two alternative but mature industries of Nepal—the suspension bridge and the MHP industries—could be married through the ropeway industry, there would be, they concluded, a bright future for this technology. The merger would cut costs for both industries and expand their markets. These ideas were discussed with many other ropeway experts and enthusiasts at a seminar jointly sponsored by ITDG-Nepal and Butawal Power Company (BPC) in Galyang, Syanja, in mid-April 1996.

Participants were optimistic about the economic benefits accruing from goods-carrying rural ropeways although some were sceptical about institutional modalities. If it were undertaken at all, the ropeway initiative would be a transport programme rather than a MHP end-use programme. Because we lacked a mandate to work on transport and were already heavily involved in the micro-hydropower sector, ITDG-Nepal was unable to take a ropeway project on board. The ropeway initiative within ITDG-Nepal thus seemed to fizzle out in April 1996. But it was fated to end not with a sigh, but rather with a different sort of bang.

SUPPORT TO LOCAL INITIATIVE

In November 1996, Bir Bahadur called me from Barpak asking me to help him build a goods ropeway project in Barpak, itself. Bir Bahadur Ghale is the owner of the 50-kW MHP that provides electricity to more than 600 households in the village. He has earned a name as a successful micro-hydro entrepreneur and has proven himself as a 'can-do' sort of young man. Although just a few years earlier, his power plant had been struck twice by lightning and the generator damaged, he remained undeterred. The generator was brought to Kathmandu for repair, and, to everyone's surprise, the repaired unit was flown back to Barpak on a chartered helicopter flight to get the powerhouse running again quickly. With a loan of over two million rupees and its interest compounding, Bir Bahadur was facing a financial crisis. The revenue generated by the power plant was not enough to pay its operators and had to be increased. During all of Bir Bahadur's tribulations ITDG-Nepal had maintained a long and fruitful relationship with him.

As ITDG-Nepal had supported Bir Bahadur, it had a stake in seeing the Barpak MHP succeed. Barpak MHP was the first project of its scale initiated by a private entrepreneur and ITDG-Nepal could not afford to let it fail. But Barpak MHP was a classic case of a financially weak project where significant daytime power was not being used as there was no demand for its application. As a site for a pilot end-use project, Barpak was an obvious choice. Not only was daytime power unused, the revenue from the sale of electricity for lighting and for running an agro-processing mill would not make the project solvent. The Barpak MHP had to pay off a loan of more than Rs 1.2 million with interest and Bir Bahadur needed help in increasing revenue.

In 1994, ITDG-Nepal had advised Bir Bahadur to set up a paper industry to use the daytime load of his power plant. It became a successful industry that employed 25 people, 18 of whom were women, and had buyers from Kathmandu at its doorstep. ITDG-Nepal provided him with a locally-fabricated electric digestor and advised him about how to market the product. Bir Bahadur was also ITDG's partner in running the service-centre concept of promoting micro-hydro power in Gorkha District and his achievement by far exceeded ITDG's targets. Bir Bahadur was dynamic, energetic and optimistic, and by this time had also gained much experience. He had proven to be a reliable partner in ITDG's end-use project.

Bir Bahadur's request for assistance in initiating a ropeway project in Barpak was compelling. He had already, for example, got Gottfried Rohrer, a retired Swiss ropeway company owner, to complete a survey for installing a ropeway there. Rohrer had been invited to Nepal by Akkal Man Nakarmi to investigate the possibility of building a passenger ropeway and Bir Bahadur had met him by coincidence at Akkal Man Nakarmi's workshop. He had persuaded Rohrer to go to Barpak to inspect the site he proposed for installing a ropeway between Rangrung and Barpak. Rohrer opined that a passenger ropeway was out of question because of the high cost involved he claimed that the investment required did not match the economy of Barpak and instead recommended installing a second-hand system to transport goods from Rangrung to Barpak, the steepest stretch of the walk into Barpak. A suitable unit, if bought at an auction in Switzerland, would cost about one-fifth the cost of a new system.

Rohrer's suggestion was behind Bir Bahadur's repeated calls to me and his request for help in establishing a goods-carrying ropeway in Barpak. Since he had already put forth so much effort, his desire was understandable. Bir Bahadur's initiative matched ITDG's philosophy of helping people who, in line with Schumacher's much-favoured quote, help themselves. Thus, several favourable factors were in place: locally available energy from an MHP; low-cost ropeway equipment; NGDG, which Bir Bahadur himself headed, and a determined young leader with a strong entrepreneurial track record. Furthermore, when completed, such a system would eliminate the burden of the five-to-six-hour walk up the steep Rangrung-Barpak stretch. Each day hundreds of women and men from Barpak and Laprak, a neighbouring village, trudged up and down this steep climb. I decided to support Bir Bahadur's initiative even though the ropeway was outside the purview of ITDG-Nepal.

ITDG's head office in the UK was concerned that the ropeway would displace porters, leaving them unemployed, and that the pylons (towers) would be risky in the fragile Himalayan landscape. We in the Nepal office, however, had a different perspective. Since the ropeway was to be built only along the steepest stretch of an arduous, near-vertical climb and would reduce drudgery for porters that verged on the inhumane, neither they nor mules would be adversely affected. They would still be required to carry goods from Gorkha Bazaar to Rangrung, a one-and-a-half day's journey. Also, because the pylons were to be only six metres high, there would be no major risks.

Since the groundwork—selecting a site, conducting a preliminary survey and identifying the type of ropeway—was complete, the next steps were to carry out a detailed survey and design of civil works, to conduct a feasibility study and, most importantly, to seek financing. In December 1996, Bir Bahadur and I met the Third Secretary of the British Embassy to solicit his support for the ropeway project. When Bir Bahadur introduced his activities and showed pictures of Barpak, the MHP, the Nepali papermaking industry and the bakery, the Secretary was impressed and said he would present the idea to the Ambassador. Dipak Gyawali, Ajaya Dixit and I met the Ambassador at a reception at the British Embassy; he said the proposition was 'interesting' and soon after asked that a proposal be submitted within two weeks. Based on the preliminary cost estimate, I prepared a proposal on behalf of NGDG and submitted it to the Embassy. Soon after, I commissioned Himal Hydro to conduct a detailed survey and design study. A pre-investment study conducted simultaneously showed that the ropeway was financially viable and that its payback period would be eight years.[5] In May 1997, the British Embassy approved funding for the Barpak ropeway project and an agreement to that effect was signed with NGDG. The equipment ordered from Switzerland arrived in Calcutta in July 1997.

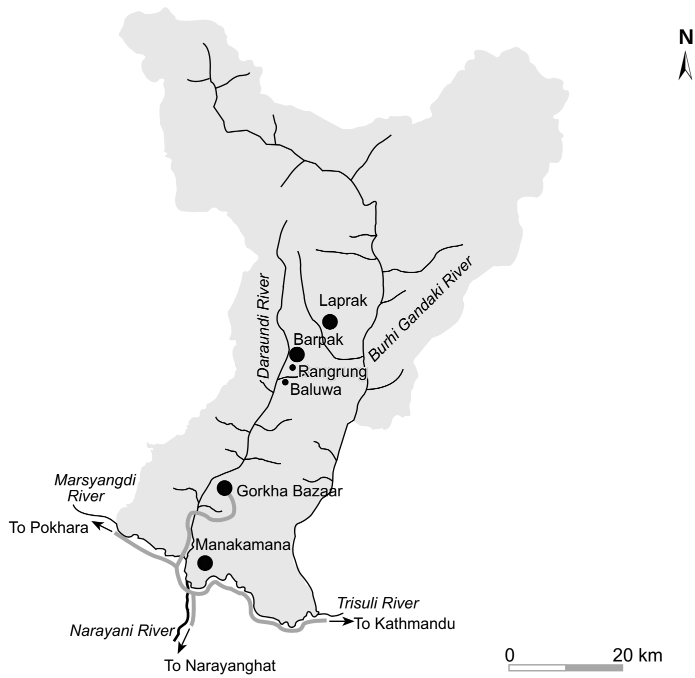
In agreement with the UK office, I was to serve only as an adviser to NGDG, which would itself be primarily responsible for the project. Gradually, however, my involvement increased until it included almost all aspects of project planning and preparation. Estimating the costs of various aspects of the ropeway with Himal Hydro, coordinating the source and supply of equipment with Gottfried Rohrer, and holding various technical consultations all fell into my lap. Bir Bahadur would arrive at the ITDG-Nepal office in Kathmandu early in the morning and would stay till late in the evening as we worked together for almost six weeks. Prior to placing the order for the equipment, it was important to verify its condition. Since travelling to Switzerland would be expensive, we requested Carl Muller, one of our Kathmandu-based Swiss friends for his help. Upon his request, the Nepal-Switzerland Friendship Association got Hans Aschmann, a senior engineer who had worked in Nepal, to inspect the equipment at his personal expense. He informed us that the equipment was in perfect working condition (Annex D).

ECONOMY OF BARPAK AND THE RANGRUNG-BARPAK STRETCH

The village of Barpak, which is inhabited mostly by Ghale Gurungs, is about one-and-a-half walking days (nearly 45 kilometres) north of Gorkha Bazaar, the nearest roadhead and the headquarters of Gorkha District (Figure 10.1).

About 4,370 people live in the 786 houses of Barpak proper, which are spread across a radius of about one kilometre. Barpak is perhaps one of Nepal's largest mountain settlements. Laprak, where another 600 Gurung houses huddle together, is three hours further uphill. More than 80 per cent of the men in Barpak work outside of the village, most in the Indian and British armies and a few in Hong Kong. Women, who remain behind, take care of homes and farms. Although a few local shops supply daily consumer goods to local people, families usually travel all the way to Gorkha Bazaar to purchase rice, edible oil, salt, sugar, kerosene, biscuits, soap and noodles at cheaper prices. Individuals carry small loads themselves, but normally it is porters who carry loads exceeding 50 kilogrammes over the two-day trail from Gorkha Bazaar to Barpak. A tentative estimate showed that, on an average, each household spends about 26 days a year travelling to Gorkha Bazaar to buy daily necessities and carrying them back to Barpak. Shopkeepers and a few wealthy households employ porters or mules to transport goods for them.[6]

FIGURE 10.1:
Barpak in Gorkha District



The local economy is dependent on subsistence agriculture but Barpak is a food-deficient village. Only one-third of the households produce sufficient food to last for a year; the rest meet their needs with imports from Gorkha. In fact, one estimate showed that 1,200 tonnes of goods are carried from Gorkha to Barpak each year (Poudel, 1997). Except for potato seeds from Laprak, local exports to Gorkha are insignificant. Rice and wheat are grown in the flood plains of the Daraundi River below Barpak. Crops cultivated in the flood plain of Daraundi, where many households of Barpak own land, is carried up to the village by family members.

The Rangrung to Barpak stretch is the hardest and the most gruelling of the two-day walk. The steep 1000-metre hill takes five to six hours to climb. In contrast, the trail from Gorkha along the Daraundi River is relatively flat although it occasionally passes along over small ridges. We found that the people were delighted by the proposal to install a ropeway along the Rangrung-Barpak stretch. Barpak was an obvious choice for a goods-carrying ropeway.

While a gravel road from Gorkha was due to reach Baluwa (near Rangrung) in a few years, there were no plans to build a road from Rangrung to Barpak. Even if a plan were made, it would cost about Rs 24 million to build a road. The proposed ropeway would be four times cheaper (Table 10.1) and would have minimal environmental impacts during and after installation. The ropeway would also increase the plant factor of the Barpak MHP. Constructing a ropeway system between Rangrung and Barpak seemed the right thing to do.

SHARING RESPONSIBILITY

The parties sharing the responsibility for planning and implementing the community ropeway project operated along sectoral lines. NGDG was responsible for providing all unskilled labour and local materials worth 10 per cent of the total cost; ITDG-Nepal served as an intermediary support organisation for project preparation, planning and management support; Gottfried Rohrer of Planug Realisation supplied equipment, provided technical advice, oversaw erection,[7] and tested and commissioned electromechanical equipment. Finally, Himal Hydro was responsible for the survey, design and supervision of civil works construction. Of the total cost of the project (Rs 6,407,000), the British Embassy in Kathmandu provided Rs 4,646,895.

After it completed the detailed survey and design, Himal Hydro had two options regarding its role in the civil construction works on site. The first possibility was to supervise the construction of civil works, which entailed providing three skilled staff members on site under the supervision of an engineer, in order to help NGDG carry

TABLE 10.1: Comparison of a road and a ropeway between Rangrung and Barpak

Parametres	Road	Ropeway
Length (km)	8	2
Cost (Rs X 10^6)	24 for gravel road not including the cost of vehicles*	6, including cost of carriages (i.e.vehicles)
Construction time	4 years	4 months
Maintenance cost	High	Low
Environmental impact	High as a road consumes considerable (agricultural) land, requires excavation and blasting, burning fossil fuel and making noise	Low as the only land used is for tower erection, and electrically run motors do not pollute the atmosphere or make much noise
Travel time	30 minutes	15 to 20 minutes
Source of power	Imported fuel	Locally produced hydropower
Load capacity	Flexibility in type and capacity; can carry both goods and persons. Cost justified for only high population density area (>20,000 people)	Goods only at 2.4 tonnes per hour (Capacity could be matched to suit the demands of the lower population density common in the hills of Nepal)

* At eight kilometres times Rs 3 million per kilometre, the rate for green roads in the hills.

out civil construction works. The second option was that Himal Hydro directly construct all civil works with materials supplied by NGDG. The cost of the latter proposal was twice that of the first option, but I, as an engineer, favoured it, since this was a novel enterprise and it was important to have a highly experienced contractor to do a good job. NGDG and Bir Bahadur, however, chose the first option over my objections. With hindsight, I can say that many of the problems we encountered during construction would have been avoided had we let Himal Hydro do the job; but, at the same time, the community would have missed out on a key learning experience.

COMMISSIONING, IMMEDIATE BENEFITS AND DISASTER

The Barpak Ropeway, which was completed at a cost of Rs 6.4 million (Table 10.2), was commissioned on 8 February, 1998, and inaugurated by British Ambassador Barnaby Smith on 3 March, 1998. Soon after it came into operation, a Ropeway Management Committee (RMC) was formed with Deo Bahadur Ghale, a member of NGDG and the individual in charge of the construction of the Rangrung return-station, as the chairperson. The committee had representatives from the VDC and the local community, including one woman. Three operators and a manager were employed to manage day-to-day operations. The Ropeway made an average of 20 trips a day, hauling about three tonnes of goods to Barpak from 10 AM to 5 PM, and generated an average daily gross income of Rs 1,500. The cargo hauled and income generated

TABLE 10.2: Construction cost of the Barpak Ropeway

Description of cost	Amount Rs (10^3)
Route survey and design, construction, supervision of civil works, tower erection, stringing of cable management and coordination during construction	541
Second-hand ZP-300 Swiss Army ropeway equipment, shipment from Switzerland to Calcutta, additional cable from Spain and shipping	1,008
Modification of petrol engine to accomodate electric motor	407
Material for civil works (500 bags of cement, six towers and cable shoes, six sets of stay wires and rods, reinforcement bars)	550
Erection of transmission line	155
Construction tools and equipment	187
Land, preliminary preparation (forest clearance), local materials, unskilled labour	555
Transportation	1,182
Training of operators	22
Erection by Swiss engineer (fee and travel allowance)	1000
Management and administration	200
Contingency	600
Total	**6,407**

by the ropeway is shown in Table 10.3. The operation of the Ropeway reduced the time spent hauling goods from five to six hours on foot to just 15 minutes. Walking without a load on this section saved sweat, hardship and about five hours. At the rate of Rs 0.5 per kilogramme (compared to the other least expensive options of Rs 2.30 per kilogramme by mule and Rs 3 per kilogramme by porter)[8], ropeway users received a fair deal.

Though it was too early to quantify the ropeway's benefits, studies showed that drudgery had been reduced, the prices of essentials had dropped and that porters had not, as some had feared, lost their livelihoods. In addition, new economic activities had sprung up and the energy of the MHP was more fully utilised.[9] About 800 households in Barpak VDC, 600 households in Laprak and a few households in the village of Gumda and beyond—a combined population of over 8,000 people were served by the ropeway. Some 40 per cent of the goods transported belonged to the people of Laprak.

The people of Barpak and Laprak reported that the ropeway reduced drudgery and saved more than a day in commuting to Gorkha and back. Hence, they were pleased with it. The fear that porters would have no work was unjustified. In fact, the increase in the volume of goods reaching Barpak actually generated more work for porters, but reduced the inhumane hardship they had to bear on the five-hour uphill climb to Barpak. Overall, the monthly income of porters rose and the prices of daily commodities fell as more goods were made more easily available in Barpak shops (NGDG, 1998). Bir Bahadur eventually fixed the tariff of the Barpak Ropeway at Rs 0.5 per kilogramme although the initially proposed tariff was Rs 1 per kilogramme.

TABLE 10.3: Income from the Barpak Ropeway

Year	Month	Nepali year	Nepali month	Load hauled (kg)	Income (Rs)
1998	Feb/Mar	2054	Falgun	55,528	27,764
	Mar/Apr		Chait	57,050	28,525
	Apr/May	2055	Baishak	74,310	38,895
	May/Jun		Jestha	170,074	55,653
	Jun/Jul		Asadh	102,650	53,111
	Jul/Aug		Shrawan	45,354	23,465
	Aug/Sept		Bhadra	39,653	27,010
	Sept/Oct		Aswin	45,451	24,080
	Oct/Nov		Kartik	82,584	43,197
	Nov/Dec		Mangsir	152,409	94,003
1998/99	Dec/Jan		Poush	68,480	34,240
1999	Jan/Feb		Magh	60,342	35,121
	Feb/Mar		Falgun	50,042	25,021
	Mar/Apr		Chait	66,520	33,260
	Apr/May	2056	Baishak	70,360	35,180

Source: Earth Consult (2000) and Bir Bahadur Ghale (personal communication)

Villagers found the rate fair since it was the equivalent of carrying a 40-kilogramme load up a steep slope for five hours for Rs 20. More houses were constructed in Barpak because transporting sand and boulders from the Daraundi River and cement from Gorkha Bazaar became easier. In our original study we had not predicted that sand for construction would become a major item of demand. The villagers of Laprak used to carry potatoes to sell in Gorkha Bazaar during the summer; the ropeway made this journey much easier. Some people, like Deo Bahadur, were inspired by easy transportation and introduced sugarcane planting in Rangrung. The harvest was good and was brought to Barpak by ropeway to be sold at Rs 5 per cane. On-the-job experience in planning and organising various components of the project with partners such as ITDG-Nepal and Himal Hydro enhanced the confidence of NGDG members. Local people acquired skills in concrete work, bar bending, tower erection and cable stringing. In addition, the Swiss erector trained three local people to operate and maintain the ropeway.

Transporting about 40 tonnes of construction goods and construction activities during the implementation of the project generated local employment. The ropeway employed six staff members—a manager to handle cash, maintain books, and keep records of the goods transported; two operators; and three persons to load and unload goods and carry out weekly maintenance. The management and operation of the ropeway was the responsibility of the RMC, whose members were nominated through the village assembly. The RMC consisted of two members each from NGDG,[10] the VDC, a women's group, the poor section of the community, shareholders and a group of elders.

There were plans to train the RMC members and help them grow. ITDG-Nepal offered to provide support for the training and building capacity of the RMC, but for some reason NGDG did not seem excited by the suggestion. Support was provided to help formalise the RMC and work out how it could function effectively. We did not, however, have enough time to predict how successful the RMC would be in managing the ropeway before disaster struck in the summer of 1999, from which point the ropeway operation came to a halt after fifteen months of commercial operation.

In a review in 2000, ITDG-Nepal judged the main cause of failure to be 'poor operation and maintenance'. As if this accident and death in May due to human negligence was not enough, in June 1999 the Rangrung Khola catchment experienced a cloudburst which resulted in a flood that completely washed away the return station on the river's left bank. The report's conclusion stated: 'The high intensity rainfall had created debris flow in the Rangrung Khola which undermined the old alluvial fan of the stream and damaged the lower station'.

The local people had not seen a flood of such magnitude in 50 years. In hindsight, locating the return station at the same level as the Rangrung Khola's suspension bridge would have been safer. The upper drive station, however, was safe though it was located near an old landslide which could have rendered it unstable. Old and new landslides seen at the site of the upper station carried with them future risks.[11]

UNFORESEEN DIFFICULTIES

The implementation of a novel venture such as a community-operated goods-carrying ropeway in an area that had never seen such technology resulted in many unforeseen problems, some of which are discussed below.

Power shortage: The problem of the shortage of power came to ITDG-Nepal's notice only in August 1997 after the ropeway equipment had already arrived in Calcutta. Although the installed capacity of the Barpak MHP was 50 kW, actual generation was much lower. According to Bir Bahadur, it ranged between 36 and 43 kW, depending on the availability of water. In August 1997 ITDG-Nepal confirmed that it was even less than this, which meant that operating the ropeway with the existing daytime load would be problematic.

As the existing power output was already overstretched, Bir Bahadur had planned, even before the idea of the ropeway was introduced, to build a second 28-kW plant using the tail water from the existing plant. He had promised that the new plant would be built before the ropeway was installed, but it was not. The second plant was to use a PVC pipe imported from India but it was not supplied on time either.

The reason for low power output was that only one turbine jet was operational. Opening the second jet caused the generator to vibrate because the connection between the generator and its base frame was makeshift. ITDG-Nepal recommended replacing it with a sound base so that both jets could be operated and full power generated. It only came to ITDG-Nepal's notice in November that the owner had followed a different plan and shifted the plant to a site three metres down the river. Work on the generator took place when the Swiss erector was in the village to install the ropeway. The owner used the same makeshift connection and, although power output increased by a small margin, the vibration was not permanently eliminated. These problems with the generator diverted focus from and disrupted ropeway erection activities and required the Swiss expert to make an additional, expensive return trip.

The ropeway used daytime power as it operated continuously from 10 AM to 5 PM. The ropeway motor consumed 12 kW once it was running (and about 18 kW to start up). This new demand significantly increased the plant factor—over its capacity, in fact. Since the plant produced only about 30 kW and supplying power to the ropeway cut, the supply of power to households and other small enterprises, including the bakery, during the day. Only a mill and households in Ward No. 7 received electricity. The supply and demand relationship became unsatisfactory. Although the ropeway had been installed on the condition that the MHP owner would build a second plant so that sufficient power would be available, Bir Bahadur was unable to do so.

Technological: Problems with the line design led to insufficient tension in the cable, which, in turn, resulted in the reduction of its carrying capacity from 300 to just 150 kilogrammes. Consequently, the performance and resultant income from the ropeway declined. Another challenge was the location of the drive station in an area with unstable slopes. After a geo-technical investigation of the drive station area commissioned by ITDG-Nepal, it was recommended that NGDG take slope stabilisation measures before the onset of the monsoon. These measures included improving the drainage on the sidewall and providing gabion support below the drive station; the measures were not, however, implemented. The RMC did participate, but either its members did not understand how urgent these steps were we failed to impress upon them their responsibility. Thus, neither RMC nor NGDG took action when major funding was on offer from the British Embassy. Because the RMC did not mobilise the local contributions upon which support was conditional it received no money.

The plan to upgrade the payload capacity of the system by increasing the height of the cable did not take place for the same reason. When Gottfried Rohrer viewed Barpak Ropeway in early 1999 he was perturbed to find that the operating conditions were poor. [12] The hauling cable was completely dry because lubricant had not been applied for a long time and the cable touched the ground at one point. He attributed these lapses to negligence on the part of the management. As soon as this information was received, at ITDG's initiative, a meeting was held at ITDG-Nepal's Kathmandu office with key persons of the RMC in order to address the problems that Rohrer had identified. A work plan was prepared and responsibility divided, but the committee members did not follow up on their responsibilities. Since ITDG-Nepal did not own the Barpak Ropeway and only served in an advisory capacity, it withdrew from engagement with the ropeway venture shortly thereafter.

Managerial: Poor management and coordination during construction led to delays. NGDG was not able to provide the 10 per cent of the total costs in the form of local contributions in kind (local materials and labour) that it had committed itself to. It could only manage to contribute about three per cent. NGDG was relying totally on paid labour when I reached Barpak in December 1997. I persuaded Bir Bahadur to raise additional cash. With his salesmanship skills he raised about Rs 400,000 for further investment in the project, most of it remittances from overseas Barpakis.

Though it was made clear that the ropeway was not meant for people and a signboard at the driving stations declared that the movement of people was prohibited, Barpak Ropeway was, in fact, used as a passenger ropeway. The management could not stop people from travelling on the ropeway and even fixed the price at one rupee per kilogramme of body weight. On 7 May, 1999, the hauling rope of the ropeway snapped and four people travelling on the ropeway were killed.

REFLECTING ON THE EXPERIENCE

This ropeway was a pilot venture from which lessons must be drawn so that future efforts in this direction are more sustainable. Many organisations and individuals supported the ropeway; but many of the assumptions and values of these well-meaning supporters demand review and reassessment.[13] They include: the cost-reducing approach favoured by many technical NGOs such as ITDG-Nepal; management difficulties characteristic of a society unused to this new technology; and issues of coordination among development partners. The experience at Barpak provides an opportunity to openly assess successes and failures.

Drudgery reduction: The Rangrung to Barpak was stretch a suitable site. Barpak is a large mountain village with a populated hinterland which provided sufficient demand. In one day as many as 28 trips were made. The ropeway was an effective end-use of the MHP. It demonstrated the best use of electric power: saving about 450 hours of labour each day using only 12 kW.[14] However, the actual condition of the power plant needed a more thorough appraisal.

Appropriate technology: Building a road would have cost Rs 24 million and agricultural land would have been lost. In addition, it would have increased reliance on imported diesel and contributed to pollution. The environmental consequences due to landslides would have made maintenance very costly. A ropeway, in contrast, is cheap to maintain and environmentally friendly; besides, it uses locally-generated electricity. This, of course, is true in theory: in practice, inculcating a proper maintenance culture in a community, which has never used such an artefact, is the equivalent of a project by itself. Promoters of ropeways need to be aware of this painful reality.

Cost reduction: To reduce costs, a reliable second-hand ropeway system in good condition was procured, the involvement of expatriate experts minimised, a local construction contractor employed, locally-built pylons used and the community involved. The complete 2.5-kilometre ropeway system with six pylons weighing about 10 tonnes cost one million rupees. Four pylons were fabricated locally as per the original sample and additional cable was purchased from Spain. Unfortunately, cost minimising measures can sometimes result in compromises that can revisit the project later and increase its overall cost. This happened in Barpak with civil works and transportation.

***Communications*:** Good communication among working partners is important. All was fine until August 1997, when work on site began and communication gaps developed. After much effort these gaps were repaired and the revised target met. One serious consequence of this communication gap involved power production.[15] The plant owner was the main person in the community responsible for coordinating with Himal Hydro, the Swiss erector and ITDG-Nepal; but the fact that his attention was divided between the powerhouse and the ropeway had a detrimental effect on project coordination. Until the short-haul ropeway industry in Nepal grows more mature and until wider usage of ropeways in rural Nepal gives birth to more local experience in a wide range of areas, pilot projects should not substitute a novice user group for an experienced, full-time manager.

Field implementation: The absence of clear coordination increased costs. The guide wire locations had to be relocated as they were inadvertently erected in the wrong places. Similarly, cost increased because, after landslides undermined initial efforts, more concrete work was needed to accommodate the drive station in two different sites. In the field, poor progress in civil construction and the relocation of the powerhouse at the time of the Swiss erector's visit hampered installation. His visit itself had to be organised twice as the required preparation during his first visit was far from adequate. Ten helicopter trips instead of five were required to carry the cable drums from Gorkha to Barpak because only low capacity helicopters were available. Himal Hydro, a regular client of helicopter companies, subsequently said they could easily have negotiated a better price if NGDG had asked for assistance.

Skills transfer and capacity building: Even though Himal Hydro is an experienced company, it was its first experience working on a community project in a remote area. Himal Hydro depended on the local community for its unskilled workforc, and transferring basic construction skills to the community turned out to be a more complex task than it had envisaged.

LESSONS FOR THE FUTURE

While it functioned till May, 1999, the Barpak Ropeway served the mountain settlement well: it reduced drudgery and saved time. It also diversified the enduse of the Barpak MHP and improved its plant factor**.** It also provided very limited local employment. Finally, the experience at Barpak provided many lessons, some of which are:

- The Barpak experience has established that rural ropeways are appropriate for easing the hardship of carrying goods up steep hills where there is a large population (more than 5,000) to serve. Its other benefits include savings in time, easy access to goods and economic incentives. Although a ropeway is cheaper than a road, initial investment costs are still prohibitively high for many local communities and pose an obstacle to the widespread proliferation of the ropeway without sensitive, ameliorating government policies.
- Taking a capacity-building rather than a project approach can bring down the cost of a ropeway if done with flexibility and sensitivity. Indigenous capacity building in the fields of MHP and suspension bridges over the last 30 years provides a model for the approach to pursue in ropeway development.
- Local units of self-governance such as DDCs and VDCs should be made partners and be involved in all stages of a project, right from the outset—identifying where they should be built and how much the users should pay for services. Relying on a single charismatic leader to carry out a community project has its benefits but is also risky. The process of community mobilisation and institution building must be initiated as a precondition to initiating a community project.
- Agencies which promote community ropeways must be prepared for the unpredictability and lack of professionalism that is inevitable when a community is a partner. The inherent risks require contingency plans, particularly in relation to backstopping support. Support must be provided in terms of technical information, operation and maintenance, and management.
- Involving local people in the construction and management of the Barpak Ropeway meant that skills were transferred to them. In the process, community confidence was built. But in this case there was constant dissatisfaction, particularly in communication and coordination among the Swiss erector, the local company and the construction committee. Smooth cooperation among actors in a ropeway project is a requisite. This can be achieved by clarifying roles and responsibilities at the outset, which involves significant investment of time in community interactions.
- The level of local expertise available for the design and construction of ropeway works is inadequate. It needs to be developed through working

with expatriate specialists. Once local capacity is established, as happened with suspension bridges over the last three or four decades, the role of expatriate experts can be reduced.

- A clear agreement on the purchase of power and the penalties of default should be drawn up between the ropeway operator and the power plant to an ensure that there is an adequate supply of power.

Geographical factors and high costs do not allow Nepal to contemplate connecting all its hill and mountain settlements by roads. Settlements can, however, be connected with low-cost, environmentally friendly material ropeways. The Barpak Ropeway showed that this was indeed a possibility. Although several factors helped to bring this intervention to fruition, the Ropeway still failed. Its collapse can be attributed to two main reasons. First, since it was not designed to transport passengers, its factor of safety was so low that any accident would be fatal. That people used a ropeway not designed to ferry passengers reflects a lack of technological discipline and weak regulation. Second, given the severe impact of cloudbursts and floods, the local capacity to design and build adequate towers and foundations needs to be developed further. In this particular case, the suitability of the sites for locating the stations was not adequately assessed. The employment of local expertise can help reduce costs but caution is warranted.

NOTES

1 The plant factor is the ratio of energy used to the total energy the plant could produce at full capacity. Load factor is the ratio of the total energy used to the energy that would be produced if the plant operated at peak demand continuously throughout the year.

2 The first Nepali recipient of the Swiss 'Rolex Award for Enterprise' for developing the multipurpose power unit (MPPU) in 1984.

3 A small Pelton turbine coupled with an induction generator with a single shaft to produce 1-3 kW of electric power from small streams. More than 1,000 of these have been installed in Nepal so far.

4 KMTNC (King Mahendra Trust for Nature Conservation), an environmental protection organisation mandated by an Act of Parliament. Annapurna Conservation Area Project (ACAP) began in 1986 with the objective of strengthening linkages between ethics, economics and environment by looking at local communities as both the principle actors and the beneficiaries of conservation undertakings.

5 See Poudel (1997).

6 See ITDG-Nepal (1995).

7 Rohrer arranged for a senior Swiss erector to install the electromechanical equipment and test the ropeway's commissioning.

8 See NGDG (2055 BS).

9 Upon completion of the project, two studies were conducted. One, entitled 'A Socio-economic Impact Assessment of the Ropeway in Barpak' was conducted by a student of the Imperial College of Science and Technology, London, for her M.S. thesis and the other, 'Rangrung-Barpak Ropeway Project Report' was undertaken by NGDG, Gorkha. The figures discussed in the given two reports.

[10] Although Bir Bahadur did not agree to be a member of the RMC, he was instrumental in convincing prominent Barpakis to serve as the chairperson and members of the committee.

[11] See Earth Consult Pvt. Ltd. (2000).

[12] At his own initiative while he was in Nepal on another assignment to carry out preliminary survey for a private cement industry.

[13] Which includes moral support by Toni Hagen, who, waiving five person-weeks of communication, came to Kathmandu with the shipping documents of the dispatch from Switzerland, and advisory support services from Switzerland by Gottfried Rohrer.

[14] The reduction in payload capacity decreased the power requirement to some extent. The use of a capacitor bank provided the cushion for the higher initial starting current the motor required.

[15] During my visit to Barpak in December, I found that the distribution voltage had dropped as low as 150 V.

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CHAPTER 11

Manakamana Cable Car:

Path Breaking Step in Promoting Domestic Tourism

RAJESH BABU SHRESTHA

PILGRIMAGE OF THE HEART

Manakamana (Desire of the Heart) is the name of a popular Hindu goddess who fulfils the wishes of her devotees. Her shrine lies in Gorkha District, where King Prithvi Narayan Shah began his campaign for the unification of Nepal in the 18th century. Located about 12 kilometres south of the town of Gorkha (Pokharithok) and six kilometres north of Mugling, a town on the Prithvi Highway, the temple is situated on a prominent ridge in Manakamana VDC overlooking the Trisuli River to the south and the Marsyangdi River to the west.

The legend of Manakamana Devi goes back about a century and half before Prithvi Narayan Shah to the reign of King Ram Shah (1614-1636) of Gorkha. It is believed that Queen Mahimavati (also known as Lilavati or Chandramukhi) possessed the combined powers of three devinities—Mahakali, the goddess of power; Mahalaxmi, the goddess of wealth; and Mahasaraswati, the goddess of learning. Because of her divine powers, the kingdom's subjects enjoyed justice and freedom from discrimination. In those days a popular saying in the principalities of the Middle Hills of present day Nepal was '*Nyaya na paey Gorkha janu*' ('If you have not got justice, go to Gorkha'). Only the queen's devotee Lakhan Thapa knew that Queen Mahimavati possessed divine powers. A religious preceptor (*siddha*) of Bakarang Village, Lakhan belonged to the clan of Thapa Magars which had received blessings from the sage Gorakhnath.

One day King Ram Shah saw his wife sitting in the form of a goddess amidst other goddesses. Perhaps he should have kept his vision a secret, but he mentioned it to her and it became the cause of his death. The king was cremated at the confluence of the Daraundi and the Marsyangdi rivers. As was the custom then, the Queen agreed to commit *sati*, or self-immolation on the funeral pyre of her dead husband. Lakhan Thapa was extremely distressed by the Queen's decision, but she promised him that she would re-appear near his house.

A few months later, a farmer who was ploughing his field struck a stone, chipping it. Blood and milk began to flow from the fracture and the farmer he could not stop it. Lakhan Thapa was informed of the incident and summoned to the palace to explain what had happened. He immediately understood that, Queen Mahimavati, the goddess incarnate, had kept her promise and reappeared Lakhan Thapa rushed to the site and worshiped the stone. With his *tantric* power, he managed to stop the flow of blood and milk. He decided to venerate the stone as the embodiment of the Goddess, and because she had returned in fulfilment of his wishes, the shrine came to be known as 'Manakamana Devi'. It is said that the present temple was erected at this very spot.

The two-storey pagoda-style temple stands on a square pedestal. The temple's entrance is on the western edge of a large square between two old trees, two stone pillars and a sacrificial pillar. The descendants of Lakhan Thapa serve as the priests of Manakamana temple, carrying out religious rituals and duties. The present priest is a 17th generation descendant from Lakhan Thapa's clan.

Thousands who seek Manakamana's blessing flock to the temple every year to have their wishes fulfilled. Devotees take a vow (*bhakkal*) to visit the temple in order to make their unfulfilled wishes materialise. If their desires are fulfilled, they must make a follow-up visit to the temple no matter how difficult it may be. According to legend, visiting the temple three times will fulfil one's wishes. In the past, accessing the temple necessitated walking a three to four hours up a steep trail from Khaireni Bazaar on the Gorkha-Mugling Highway. The hike was a challenge for the young, and almost impossible for the old, disabled and unfit. Many could only dream of visiting the temple.

The lack of hygienic food and clean drinking water along the way compounded the difficulties of the pilgrims. In the summer, extreme heat made climbing unpleasant, while in the monsoon, the trail became muddy and slippery and hiking risky. Regardless of lowland the journey to get Manakamana's blessing (*darshan)* was, thousands visited the temple every year. It was estimated that there were around 207,000 worshippers annually before the cable car was installed. After the arduous walk, the sense of achievement and exhilaration made pilgrims forget all the troubles they had faced. For many families, though, a visit to Manakamana was just a dream until the Manakamana Cable Car was installed. Infirmities or disabilities no longer keep potential pilgrims away. As using the cableway requires comparatively little effort and time, all can pay homage to Manakamana Devi.

INITIATION OF THE CABLE CAR

Helping devotees visit the temple with ease had been in the offing for a long time, but it was not until Gorkha-born business entrepreneur Laxman Babu Shrestha, chairman of the Chitawon Co-E Group, proposed the idea that the plan for constructing a passenger ropeway to the temple began to gain momentum. By installing the cable car, he made it possible for physically disabled, elderly and infirm devotees to pay homage to Manakamana Devi. Soon the temple and the region became accessible to everyone who wished to visit. The religious significance of Manakamana Devi and the fact that so many devotees were deprived of *darshan* were Shrestha's main motivations.

Shrestha was confident that the cable car would be an economically viable venture. His dream of installing a cable car system came true in 1997, when a contract was signed between Chitawon Co-E Group and Doppelmayr Company, a leading cable car system manufacturer in Austria which has installed more than 8,000 ropeways around the world. The company provided the technical assistance needed to install the system. The feasibility study took about one year and the loan finalisation took about six months. Financial closure was achieved in a year and a half and immediately after wards the construction started. Ten months later, commercial operation began. Information about the cable car system and the initial financial projections is provided in Annexes E and F.

This cable car is the first of its kind in Nepal. His Royal Highness (Late) Crown Prince Dipendra Bir Bikram Shah Dev inaugurated the enterprise on 24 November, 1998, at which point regular operation started. His Majesty (Late) King Birendra Bir Bikram Shah Dev awarded Laxman Babu Shrestha the state award the Suprabal Gorkha Dakshinbahu for his entrepreneurship.

The bottom station of the cable car is 94 kilometres from Pokhara, 36 kilometres from Narayanghat and 102 kilometres from Kathmandu. The system is 3.02 kilometres long. The bottom station is located at Kurintar on the Prithvi Highway at an elevation of 258 metres above sea level, while the top station is below Manakamana temple at an elevation of 1302 metres. The time it takes to cover the distance from bottom to top varies from eight to 15 minutes, depending on the speed of operation. The system is sensor sensitive, and because it is fully automatic is considered safe. Nepali personnel were trained to operate the system and have now gained substantial experience in handling complications and in directing rescues if and when the need arises.

A total of 600 pilgrims can be transported in an hour. There are thirty-six six-person gondolas to ferry people and three freight carriers to transport the goods of local people as well as the sacrificial goats that pilgrims bring. Because the cable car does not transport any construction equipment or commercial goods, the business of local porters and mules has suffered no ill effects. Since the beginning of its operation in 1998, over two million pilgrims have used the cable car to visit Manakamana. Devotees and tourists from Nepal and India and from abroad visit the temple.

Though the bulk of the equipment came from Austria, local components were also used. The Butawal-based Nepal Hydro and Electric Company, for example, fabricated the towers and the yokes as per the specifications of Doppelmayr. This arrangement provided a chance for local industries to manufacture high-quality products that meet international standards and thus enhanced local capacity. The rough terrain between the two stations and the need to cross the Trisuli River made transporting the towers by mules impractical, so helicopters were used for the heaviest of loads. Local porters and mules did, however, transport other equipment required to construct the towers and station buildings. This helped create jobs for local porters and owners of mule caravans.

Because the number of devotees has increased ten-fold, the demand for the local products of the Manakamana region has also increased dramatically. The cable car has made the region accessible in all seasons, whereas in the past pilgrims visited the temple only in the winter. As a result, local business efforts have been extended throughout the year. With improved and easy access, a wide range of visitors with diverse interests visit the temple: it is not only Nepalis but also Indians and other foreigners who make the trip. The increased flow of tourists is not limited to Manakamana temple alone; the whole region has the potential to develop cultural, village based eco-tourism.

OVERCOMING FINANCING HURDLES

The total capital investment in the project was 430 million rupees, making it the largest investment by a private company in the field of tourism and transport in the history of Nepal. Given the country's uncertain political climate, it was a high-risk investment. Its success has been an eye-opener in terms of demonstrating that passenger ropeways are a viable means of alternative transportation over remote mountainous terrain. The people involved provided overwhelming and encouraging support. The government, for its part, was not supportive. Since the cable car was an innovative venture, it was expected that the government, in order to encourage other private companies to invest in similar projects, would accord it special consideration in terms of registering it and providing it with exemption from taxes. Such support was not forthcoming. The investment was not treated as innovative, it was not exempted from taxes and rebates normally provided to official development projects were denied.

In contrast, the support and cooperation provided by financing companies and local banks was encouraging. The past record of Chitawon Co-E Group proved beneficial in gaining the prompt collaboration and assistance of financial sector. The risk factor was a major concern as the project was the first of its kind in Nepal and there was no track record. After hearing the details, Nepal Bank Ltd. (the lead bank), Karmachari Sanchaya Kosh (Provident Fund), NIDC (whose loan was later assumed by Nepal Bank Ltd.), and Nepal Bangladesh Bank Ltd. agreed to finance the project with a consortium loan. Despite their lack of experience in lending money for this type of project, the bankers demonstrated trust, faith and courage, all of which were instrumental in seeing the project to fruition.

Manakamana Cable Car demonstrated that the Nepali private sector has the capacity to invest in and manage a complex infrastructure project. It also showed that funds for investment can be generated locally and that Nepal does not always need to depend on foreign loans or bilateral funding. Ropeway projects will create opportunities for generating an internal base, as well as an opportunity to channel foreign aid to those priority sectors with the greatest need. By creating a suitable investment climate, the private sector can make productive use of idle but abundantly available local funds in order to build infrastructure projects which meet the needs of the country. The long-term benefits to the country are self-evident.

The project was evaluated on the basis of the facts and details that we provided the banks in our techno-economic feasibility study. The economic aspect of the project depended on the flow of passengers and the projected growth after the cable car was installed. Data on the number of people travelling along the traditional route from Anbu Khaireni were collected. Serious thought was also given to pricing. On the one hand, the company had to consider how much Nepali devotees would be willing to pay, while on the other, the loan had to be repaid. A price of Rs 250 per passenger was set. This price was charged till the fourth year of operation. From the fifth year onwards the price was increased by 10% to Rs 275 to cover inflation.

From the first year of operation Manakamana Darshan started repaying the interest and principal of its loan. This is an achievement in itself because many banks often face difficulties in collecting repayments. In fact, the lead bank told Chitawon Co-E Group that Manakamana Darshan has been one of its most successful investments.

OVERCOMING BUREAUCRATIC HURDLES

Many challenges had to be overcome in the field during the construction phase. The highest priority was given to the safety and convenience of the passengers and to reliable service. As the difficult terrain limited access to the sites selected, erecting towers posed a considerable hurdle. Helicopters were used to lift and erect towers. This provided hands-on experience in new ways of construction. Modern-day communications helped in placing orders and procuring items at short notice. The response from Doppelmayr was prompt and professional.

The latest technology available was used and sensitive sensors were placed at various locations to detect the most minute of faults, which are indicated on panel boards located in the top as well as in the bottom station. Nepali engineers, technicians and labourers carried out the installation and make periodic check-ups and carrying out regular maintenance according to the recommendations of the manufacturer. They operate the system and conduct day-to-day maintenance including checks before operating the system. The management of the enterprise is the responsibility of Nepali professional staff and local jobs have been generated.

In sharp contrast to the prompt and professional responses of Doppelmayr, while importing equipment, Chitawon Co-E Group faced delays and unnecessary hassles at the hands of HMG/N's Customs Office . Another challenge stemmed from the fact that there was much uncertainty with regard to the government's policy and regulations. In fact, the government did not even have a policy governing the cable car and ropeway industry. We requested exemption from duties on the machinery imported from Europe on the grounds that the ropeway industry was the first of its kind and highly suitable for Nepal from the point of view of tourism as well as the country's geography. We demonstrated that the system was environmentally friendly and non-polluting and that damage to the natural environment would be minimal compared to that caused by road construction, but HMG/N did not respond positively.

In the absence of a clear-cut formulation of acts, rules and regulations no one at the Ministry of Finance (MoF)could decide in a timely fashion what to do when we applied for permits when the equipment had only just arrived at Birgunj, experts had already reached the site. Despite our vigorous lobbying, it took more than four months to get clearance for the release of the equipment. While it sat in Birgunj Customs Office for over two months, we had to pay remuneration to the foreign technicians though they had nothing to do. Not only were technicians annoyed, they threatened to leave the country and take assignments elsewhere. This was the most frustrating experience in the entire process of project execution.

We took a stand with the government and finally succeeded in getting the cable car machinery categorised as a duty-privileged item. Though we ourselves did not secure any duty breaks, we were satisfied that at least we had made it easier for future investors. An important lesson is that the government should act promptly to ensure that it maintains an investment friendly business climate. Regulations and acts should not be made *ad hoc*, whenever the need arises, government officials should be in a position to tackle issues in a timely manner and to make enabling decisions. Much homework needs to be done before formulating regulations; the opinions of investors, for example, must be sought. That the Ministry of Finance (MoF) bases many of its decisions on immediate revenue generation is understandable, but too frequently its perspective is short-sighted. Benefits to the economy will be robust if revenue is assured on a long-term basis; this should be the new strategy of HMG/N. Ropeways can be developed as an industry by giving attractive incentives to potential investors.

GARNERING LOCAL SUPPORT

The cable car system to Manakamana was a new initiative for Nepal in that it was the country's first passenger ropeway. At first, both local villagers and city dwellers were sceptical about its viability. The idea of installing a cable car to the temple also raised concerns that the social and environmental sanctity of the locality might be negatively impacted. Locals worried that the cable car would take away their livelihoods and that an influx of external businessmen would pose a threat. People feared that the cable car would, in particular, take away the jobs of mule-train operators. Such concerns were understandable. With no experience of cable car system operation to draw upon, it was natural that questions were raised. Within a few months after operation began, however, it had become clear that such concerns were unfounded.

The company has attempted to maintain congenial relations with local residents. The cable system does not haul goods that are transported by mule caravans. In fact, the company discourages the transportation of all goods. Cable car tickets are valid for one week in order to encourage people to stay long enough to benefit local businesses. The company also solicits suggestions from passengers and their feedback is used to help improve services. Safeguarding the environment and local traditions was given high priority to ensure that neither the local economy nor the way of life, culture or traditions of villagers were harmed. The ropeway itself is environmentally friendly: the system, since it runs on electricity, does not emit any poisonous gas. In the process of installing the cable car, several trees posed a threat to the safety of the gondolas and passengers and had to be cut down. The company compensated villagers for every tree it felled. The plots where the towers rest were purchased from local landowners. The company has also planted 30,000 tree saplings in the region.

In any business venture, profit is the primary motive; at the same time, however, a business must be aware of its social responsibility. A company can pursue genuine business interests while still providing benefits to the community and the region where it is located. Keeping in mind local concerns, the company offers a special tariff to locals (Rs 50 instead of the regular fare of Rs 275). A lunch break of about one-and-a-half hours was introduced to ensure that local hoteliers have sufficient time to cater to pilgrims. The company has also promoted development programmes and education. The company provides two VDCs, Darechok at the bottom and Manakamana at the top, with a sum of Rs 500,000 annually. This amount is expected to meet the development needs of those villages. The company also provides regular supervision to ensure that the funds are utilised well.

LESSONS FOR PROSPECTIVE ENTREPRENEURS

The success of Manakamana Cable Car shows that ropeways can be a suitable and easy means of moving people in hilly regions. Building ropeways is a good business investment but also helps to transport goods and provide local jobs. A ropeway induces people to travel and thus, by opening possibilities for tourism and new businesses, promotes economic activity. At an intangible level, a ropeway, by providing exposure to different people, can help generate new ideas too.

Manakamana Cable Car shows that investment in this sector has not only encouraged business prospects but has also helped develop a particular region by creating opportunities for local inhabitants. If the government formulates a suitable policy for registration, gives tax exemptions to facilitate importing equipment, and provides subsidies, more Nepali entrepreneurs will invest in ropeway projects. Both roads and cable cars are effective means of transporting goods and people. What makes a mode practical and fruitful depends on where it is implemented. Practicality and suitability should form the basis of the choice. Building roads in the hills of Nepal involves many problems: the practice is highly capital dependent and involves many indirect costs such as forest cutting, inducement of landslides, carbon emission from vehicles and recurrent maintenance costs. Road building also requires the acquisition of a lot of land.

A cable car system, on the other hand, requires little land for installation and is environmentally friendly. The cost of maintenance is lower than that for roads though operation and maintenance must be of a high standard in order to meet safety considerations. Furthermore, a ropeway can be built faster than a road. The choice is obvious for Nepal: ropeways can transport people as safely and much more cheaply than roads can. Although Chitawon Co-E is a civil contractor with the expertise and institutional capacity to build roads in any part of the country, it believes that cable car transport will eventually be a more viable option in the hills of Nepal as it ranks better in terms of cost, environmental considerations, job opportunities, development of domestic and foreign tourism, low maintenance costs and longevity.

The future is what we make of it, and Nepal has immense potential in various areas of resource use. The Himalaya and the country's cultural mosaic provides the basis for the greater promotion of Nepal as a tourist destination. A large number of tourists visit Nepal to enjoy its natural beauty and cultural diversity. Many come to trek or to venture to the country's remote settlements, but find that poor access makes it difficult. Installing a cable car system could increase accessibility and thereby boost tourism and the associated local opportunities. In addition, convertible foreign currency would be generated. Ropeways offer another prospect in their linking of mountaintops with valleys. Many of the herbs grown on mountain ridges are used to produce *ayurvedic* medicines, some of which have become very popular in Western countries. Ropeways would make transporting such products easy and, with suitable backup from the government, local producers would have access to new markets.

Both industrialists and the government need to explore the possibility of introducing ropeways as a new form of transport. This focus makes sense because ropeways can be daytime end-users of hydropower produced from the country's rivers. Manakamana Cable Car is a viable and environmentally friendly investment. Its benefits are wide; in fact, even the government receives more revenue from the increased business. An effective partnership between the government and the private sector will create more awareness about the need to formulate constructive policies and regulations that make it easy to install such systems throughout the country for the benefit of all.

CHAPTER 12

The *Ghirling*:

Arrested Development of Nepal's River Crossing Technology

AJAYA DIXIT AND MADHUKAR UPADHYA

HISTORY OF THE *GHIRLING*

This chapter reflects on the current status of the indigenous technology of the *ghirling,* its impact on people, its socio-economy, and the opportunities it has created for people living in villages separated by major rivers and their tributaries. Himalayan rivers are full of rapids that make them impossible to ford or punt across in dugout canoes even during non-monsoon months. To cross these rivers people once used simple rattan ropes. A *ghirling* uses this same technology but has improved upon it with the use of steel cables and pulleys.

■ Fording a turbulent Himalayan river in Bajura District

This essay is based on a reconnaissance visit made to the Trisuli River in the section from Baireni, Dhading District to Mugling, Chitawan District, as well as on a review of literature, secondary materials and discussions with different development workers who have used *ghirling* in the course of their work. The stretch along the Trisuli River was chosen because it has experienced rapid changes over the last 30 years. The *ghirling* has been one factor behind this change. In turn, the *ghirling* itself has been affected by these developments and has undergone some modernisation.

A *ghirling* is a rope or cable hung across a fast-flowing river and used to cross it. This technique has been in use in many parts of Nepal for a long time and still continues to serve many villagers. Though a *ghirling* is risky and very uncomfortable to operate, in many villages, there is no alternative, especially during the monsoon. Although people often sustain injuries while using *ghirling*, the state has paid very little attention to improving this technology by making it more efficient and safer. Where donors have been involved, suspension foot-bridges have replaced *ghirling* but the *ghirling* itself has mostly remained in their blind spot. Today, swollen streams and rivers isolate many villages during the monsoon, and some rivers are impossible to ford even during the dry season. This brutal fact of life in the mountains has had significant consequences for modern development. Ironically policy studies on transport, not even the transport sector profile study, mention *ghirling.*[1]

Despite this formal neglect, *ghirling* are widely used in Nepal, a country where high mountain ridges and deep river valleys form an integral part of the landscape. Fast-flowing and unpredictable streams and rivers are impediments to the movement of goods and people. Crossing rivers has been a major challenge since early times, as much for rulers, who wished to maintain lines of communication and transport logistics for military and administrative purposes, as for villagers, who needed to communicate with kith and kin in widely scattered hamlets. Accounts of how people crossed riverbanks in the past are sketchy. According to Regmi (1988), the Gorkhali rulers of about 200 years ago had devised arrangements to maintain the main artery of the kingdom, the east-west track that connected Kathmandu with Dhankuta and Ilam in the east and Doti in the west.

These tracks, along which troops, military supplies and official mail (*hulak*) were moved, crossed all the major rivers and streams of the country. Climbing up and down the mountains over the spurs was much easier than making river crossings but, the Gorkhali rulers did introduce ferryboat services wherever possible. Travelling across Nepal consisted of little more than a perpetual cycle of climbs, descents, and river crossings. Crossing rivers caused the intolerable delays that characterised internal transit in Nepal. Where flow was swift, *targhat* (rope bridges) and *sanghu* (bridges of wooden logs) were used to cross rivers. *Sanghu* were used in the winter, whereas *targhat* were used during the monsoon.[2] Regmi (1988) quotes Norman Hardie's (1957) account of *targhat* in the Arun Valley in eastern Nepal as follows:

> *The structure, about one hundred and fifty feet long, was of suspension design and the ropes supporting all the weight were made from green bamboo sticks, which had been split and twisted together to form a rope of about one inch in diameter. At intervals of four to six feet, very flimsy bamboo or creeperstrands were attached to the main ropes, and these strands in turn supported one round wooden pole, on which the traveler must walk.*

Targhat are still in use in many isolated parts of western Nepal where steel ropes have not yet been introduced. In some places people would hang a rope across a river and slide across it in a basket.[3] Though simpler than a *targhat,* this arrangement is more risky. Landon (1928) summarised the difficulty of transport in Nepal and noted that all transport in the hills is carried out on human shoulders. A good road in Nepal, he claimed, would remain a practical impossibility due to the vast difficulties presented by the mountains. The major trail running from east to west required the labour of a myriad of men and was a constant drain upon the treasury of Nepal. Jung Bahadur (1846-1877) sanctioned three *lakh* rupees for broadening the artery between Ilam and Doti; the labour used was probably slave or unpaid (Landon, 1928). In 1956, the late Toni Hagen photographed villagers crossing the Arun River by hanging from such a rope or swinging in a rattan basket suspended from it.

Although people all over Nepal travelled between villages and towns on mountain trails, very little is known about the conditions of these trails or the difficulties that travellers experienced. From Landon's written account of missionaries and traders who frequented some of the more important paths, we can make some inferences about the conditions of the trails and the difficulties associated with travelling across the mountains from one place to the other.[4] Besides the east-west paths that connected Kathmandu with Doti, Dhankuta and Ilam, there were four strategically and economically important paths (referred to as 'roads' in the travelogues of missionaries) in Nepal. Two of them went south of Kathmandu, through Pyutar and Chitlang, to Hetauda. The other two took off north from Kathmandu to Kerung and Kuti in Tibet. The tracks to the south crossed the Mahabharat and Chure ranges before descending to the plains of the Tarai and were not, therefore, difficult to travel on. Travelling north, in contrast, was difficult and, in many places, dangerous. The trails took a person through the Middle Mountains, the High Himalayas and sometimes to the Trans-Himalayan region. The way was scary: trails were narrow, passed steep cliffs and crossed many streams and rivers flowing hundreds of metres below. Two Christian

■ Villager crossing the Arun River pulling himself hand over hand on a rattan rope (1956)

■ Crossing the Arun River in a basket sliding along a rattan rope (1956)

■ Villager crossing the Karnali River on a rattan rope (1988) missionaries, Father Grueber and Father Dorville, who visited Nepal in 1662, recorded the tremendous precipices they passed while crossing Kuti Pass on their way to Kathmandu. Many of the trails that passed through the High Himal were hacked out of cliffs. In places the trails consisted of mere footholds supported on iron and wooden beams driven into the hillside.[5]

One traveller described the route to Kuti across the Himalaya in the following manner:

> *... passing through a fearful gorge where the road crosses the river not less than 15 times. Thrice by iron suspension bridges, and 12 times by wooden bridges, some of which were 60 paces long. At one point the rocky sides of the gigantic chasm were so close that a bridge of 24 paces spanned it. At another, a path was supported along the perpendicular wall of rock on iron pegs let into the face of the rock. The path of stone slabs covered with earth was only 18 inches wide, 1/3 of a mile, and one thousand five hundred feet high above the roaring torrent (Landon, 1928).*

The difficulty in walking these trails was not only limited to physical stress; it also required mental courage. Landon's following paragraph shows how strong one's nerves needed to be.

> *The very narrow track lies along the edge of precipices and is continually turning the corners of extremely lofty mountains. Often the yawning gulfs between the rocks are bridged by narrow and trembling constructions of sticks and undergrowth. The traveler shudders to see underneath him immense sheer precipices and to hear the noise of the water tumbling at the bottom among stones. There is one specially difficult point which reduces timid or inexperienced men to terror, and the more they fear long slopes downward over an abyss, and is the more slippery from the dripping waters which continually wash and polish it. It is true that holes have been hacked out upon its surface where a traveler is able to place, if not his entire foot at least the ball of it. But Father Georgi does not seem to think that this much reduces the terrors of the passage. The river Nohotha is spanned by iron chains. Here people cross in safety upon the footway of the bridge grasping, on the right hand and on the left, two cables which are riveted into the rock at each end, but the oscillations of this rough bridge are fearful-especially when there is added to them the vibration caused by persons passing at the same time out of the step. Then says Father Cassien, one can scarcely endure the terror. So terrible, he says, is the crossing of some of the*

chain bridges that many travelers are blindfolded and bound to a plank, which is slung to the cables and maneuvered across by a local expert.

Nepal's transportation infrastructure as it is described above remained fairly unchanged throughout the 19th century. However, with the extension of railway tracks in India along the Nepal-India border during the last decades of the century, conditions began to change. It became easier and quicker for Nepalis to travel east or west via India.[6] The travel time from Kathmandu to Morang, for instance, was reduced from twelve to five days via the new route. The growth of railways along the border, while it brought relief to travellers, also stifled initiatives in developing in-country transportation. No serious attention was paid to innovations in Nepal for quicker transportation across the Middle Hills until 1951, when the Rana rule ended after 104 years. According to Regmi (1988), the Rana rulers chose to remain sequestered from the rest of the world and took advantage of the country's difficult terrain to secure the nation's isolation. Innovations, in general, were discouraged. The Rana family believed that the British would annex Nepal if the country developed economically and pursued its policy of isolation with determination.[7]

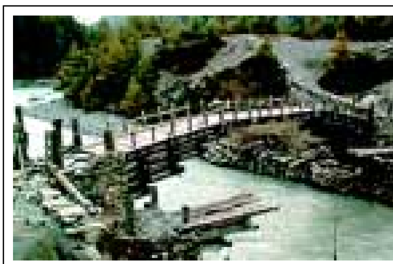
It was not possible for the people to remain sequestered. They had to move to maintain family and business connections. *Himal* (1989) provides an account of the number of people on the move: 'more than 3 million hill dwellers are on the move over the Nepali trails at any time during the trading season from October to May'. As they commute, they have to cross many rivers, which, in the early 19th century, was

■ Suspension bridge built with chains in Baglung District done by means of simple rope bridges that spanned streams. According to Joshi and Chitrakar (1989) temporary crossings were built with bamboo ropes, twisted vines, and matted fibres and lasted through the rainy season. Strong iron chains built by local blacksmith using local ore were stretched over important crossings to span gorges more than 250 feet wide.[8] The name *chaksam*, which is the name of a village in the upper reaches of the Budhi Gandak River to the west, indicates a place where men speaking Tibetan at one time. Forged cast-iron chains used to support temporary footbridge across gorges. The presence of bridge with links as good as those forged in the early 20th century is testimony to the enterprise as well as the skill of the ironworkers of the 15th century.[9] Where available, chains bridges gradually replaced rope bridges, bringing about a remarkable improvement in river-crossing technology. Some chain bridges are still in use in Baglung; they are maintained by local blacksmiths.

Timber cantilever bridges were another improvement over rope bridges, but were constructed almost at the level of the water and thus were often swept away or rendered useless by monsoon floods. During eighteenth century they were rarely found south of the Himalaya.

In the early 20th century Rana rulers imported suspension bridges from Aberdeen, Scotland and installed them at key locations along principal trade routes. The bridges were shipped in parcels, carried over mountains on the backs of porters and installed at important crossings. The first such bridge was probably the one built by Bir Shamsher (1885-1901) in Kulekhani (Sharma, 2056 BS), but views differ. According to Joshi and Chitrakar (1989) the first government bridge was built in 1907 in Khurkot over the Sun Kosi River between Sindhuli and Ramechhap. More bridges were built when the 52-mile long cart road between Birgunj and Bhimphedi was completed in the mid-1920s. The road crossed Churiya Khola and many other streams; about 15 major steel bridges and over 50 wooden bridges capable of carrying six-tonne loads were built. The government of the time pursued a policy of replacing all fords, ferries, rope bridges, and cantilever bridges along major trails with suspension or lattice girder bridges. Two iron girder bridges, one over the Bagmati River to connect Kathmandu and Patan and one over Nakkhu Khola were, also built.[10]

A modern short-span trail-bridge, which uses traditional skill and optimises local materials, is a hybrid between a traditional chain bridge and a Scottish suspension bridge.[11] Suspension bridges introduced steel ropes to Nepal and, in many places, replaced *targhat* ropes. The



■ A new timber cantilever bridge on top of an old damaged one resultant crossing was called a *ghirling* and became the favoured means of crossing for many communities in the hills and mountains. People improvised by using pulleys to slide along the steel rope. This was a purely local innovation.

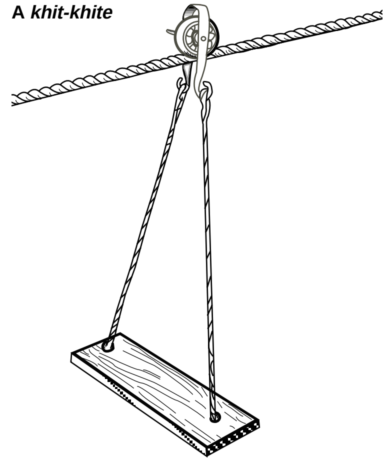
When the Prithvi Highway was completed along the left bank of the Trisuli River in the mid 1970's, it became easy for people living on the left bank between Galchhi and Mugling to commute. Those living on the other side of the Trisuli experienced difficulties. Later, when the road was widened to two lanes, shops, restaurants, lodges and a market for selling vegetables and fruits, emerged for the people who lived along the highway. Villagers who lived on the other side of the river were unable to benefit from these opportunities because there were no bridges or other links that facilitated crossing the turbulent Trisuli to reach the highway.

With no support from the government, the villagers along the right bank built their own means to cross the river. Private entrepreneurs also built *ghirlings* for transporting stones from the quarry on the right bank to trucks on the highway on the left bank. Along this stretch of the Trisuli River the first *ghirling* was installed in 1978 while the most recent one was installed in 1994. In the 60-kilometre stretch between Baireni and Mugling, there are 18 *ghirling*, two boat crossings and two improved crossings for measuring river discharge. The Department of Hydrology and Meteorology collects data on discharge and sediment concentration using these new crossings in the Trisuli River. The station consists of a cable supported on metal towers and an electrically-operated cable car attached to a winch to measure the velocity of flow.

GHIRLING: TYPES AND OPERATION

A *ghirling* consists of a steel cable stretched across a river and anchored at suitable positions on opposite banks using stones, logs or trees. A carriage is mounted on the cable and, using wheels or a pulley, is allowed to run along it. *Ghirling* are classified into three types depending on the type of carriage used. In the first type, the carrier consists of a pulley or wheels enclosed within a simple housing from which a small wooden plank hangs by two ropes like a swing. This simple device, called a *khit-khite,* is meant for transporting a single person (Figure 12.1). The passenger sits on the plank, with his/her feet hanging in the air and holds the pulley housing firmly on either side of the cable to ensure its position and to keep it from rattling. To begin his/her journey, s/he lets go off the cable in front of the pulley and the force of gravity causes the person to move forward. While sliding towards the centre of the river, the rider has to make sure that his/her hands are always behind the pulley, which, because it runs very fast, can slice fingers inadvertently placed in front of it. The speed of a *khit-khite* cannot be controlled. The momentum ceases usually just beyond the middle point of the sag, when the cable goes uphill. From that point onward the rider has to pull the cable inch by inch against gravity. This is tiresome and risky because if the person fails to pull, the *khit-khite* rolls backwards. The sick and old do not have the strength to use a *khit-khite*. Many families living on the right bank of the Trisuli River along the Prithvi Highway keep one or two *khit-khites* for use by their members.

FIGURE 12.1:
A *khit-khite*

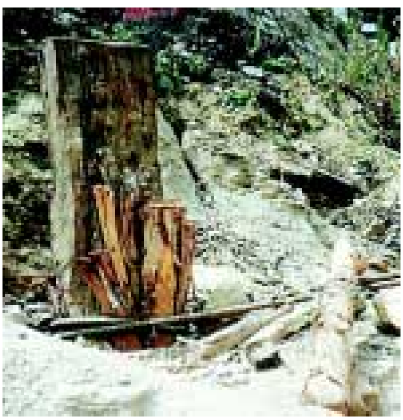


The second type of *ghirling* has a box-like carrier attached by a hanger to wheels which rest on the steel rope. This type can carry four to five persons at a time. Its typical method of operation involves the passengers sitting in the carriage and sliding down to the midpoint of the rope, at which point they haul themselves up to the end station by hand. They are sometimes helped by someone on the bank, who pulls a second, smaller rope. Since most cables are strung without much tension, the sag in the middle is great and so, accordingly, is the effort needed to pull the carrier. Since an operator usually runs this type of *ghirling,* the sick and old can use it as well. It is also safer because the box usually hangs on two pulleys. Passengers pay the operator each time they cross. Although the principle of operation is the same as that of a *khit-khite*, pulling it is harder.

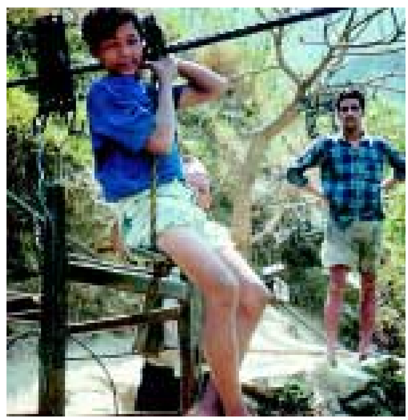
The third type of crossing consists of a guided raft or boat attached by a rope to a cable suspended across a river and fixed at opposite riverbanks. Using a paddle, the boat is moved across the river along the suspended rope, which prevents the boat from being swept away by the current. This arrangement has a large passenger capacity and is used to transport both people and goods. Its use, however, is restricted by the nature of the river, which must be relatively calm at the fording point. Unlike a *ghirling*, a boat allows its users to transport goods to the desired location along the river bank. With or without ropes, boats, especially dugout canoes are used to cross major rivers with goods despite the risk due to their instability. In the Sun Kosi River in Sindhupalchok District, people use modern vinyl rafts to transport goods to their villages on the river's bank as far downstream as Ramechhap.

A *ghirling,* though itself limited, is an improvement on a dugout because it is quicker, safer and more convenient. Since a *ghirling* is suspended, the river's flow does not affect it; and since it can be installed at a higher elevation, a person does not

■ A girl crossing a river on a *khit-khite*



■ A rudimentary anchor at the bank



■ A boy prepares for his journey

■ Halfway across

■ A g*hirling* consisting of a steel cable box and pulley

have to spend time descending to and climbing up from the river. But, as mentioned above, the *ghirling* does have limitations. Some efforts have been made to improve *the ghirling,* especially the box and pulley arrangements. In many places, carriers made of steel have replaced wooden boxes. The growth of the industry that manufactures window shutters and grills in places where electricity is available has made this innovation possible. Likewise, double pulleys have replaced single pulleys, making *ghirling* more stable. Because iron pulleys of the required size are not readily available in villages, villagers use the discarded ball-bearings of old bicycles to improve their *khit-khites*.

Box-type *ghirling* use the discarded pulleys of heavy equipment and cranes. Another improvement some *ghirling* use is an additional rope attached to the carriage that allows people in the carrier, at the end of the line or on the banks of the river to pull the rope, thereby helping

■ A mother and her children in a *ghirling* box

■ Bringing wheat harvest home in a dugout canoe on the Sun Kosi River in Ramechhap District

the carriage move along it. Other *ghirling* use a pair of cables to increase support for the carrier and provide the balance needed to carry a greater load.

The steel cable and other parts constitute the major costs of both *ghirling* and suspension bridges. While a *ghirling* has only one main cable, suspension bridges have two, as well as steel supports and components. In almost all cases, DDCs or other organisations have provided free cables to communities which ask for them; old cables from suspension bridges are often what is given out. Local material and labour can be used to construct a *ghirling*. In fact, villagers often volunteer labour to install a *ghirling*.

Even in areas where *ghirling* have been built, people often demand a suspension bridge. A bridge is desirable for several reasons: loaded *doko* (wicker baskets) need not be pulled, many people can cross at the same time and mules and goats that carry loads can also cross.[12] Needless to say, a suspension bridge is also much safer than a *ghirling*.

SOCIAL IMPACT

Our preliminary study of *ghirling* along the Trisuli River shows that they do generate local level benefits. The *ghirling* serves as a social link. Crossings improve social interaction between villages on opposite sides of rivers and have ended the isolation of those on the far side. In the study area, the number of people who use a *ghirling* daily to cross the Trisuli River ranged from 30-40 to 200-250, depending upon the season. On a daily basis, school-going children formed the largest user group. They can commonly be seen carrying a wooden *khit-khite* in their backpacks along with their schoolbooks. Without *ghirling* they would have to walk many hours every day

■ Modern suspension bridge, Baglung District

to reach school. In most sites where *ghirling* are located, the nearest suspension bridges are located a few kilometres up or downstream.

A *ghirling* can also, in a very limited way reduce the distance between producers and a market. With markets more readily available, villagers can get better prices for local produce. Without a *ghirling*, it takes much more time to travel to a market via the nearest suspension bridge. Economic incentives are one main reason villagers use *ghirling* despite their risks. At eateries and shops along the road, farmers often get ten, twenty or even as much as forty per cent more money for local farm produce than they would in a village *haat* bazaar. The prices of other goods they need, such as footwear and clothes, are likely to be similarly ten or twenty per cent cheaper in shops along the road than in village shops.

ACCIDENTS

Despite the fact that little maintenance is carried out on *ghirling* and that there is significant passenger traffic, there have been relatively few fatal accidents. In fact, only three sites have reported serious accidents. The *ghirling* constructed by Agriculture Fertilizer Company and Hetauda Cement Factory to transport stones from a quarry broke three times (in 1994, 1995, and 1996), but no one was injured. In other cases, two people were killed when they fell from *ghirling* into the Trisuli River and two more died when they fell from *khit-khite*. Two others who fell into the river survived and swam ashore. The *ghirling* does have its share of problems. It has no safety features such as brakes. The major perils associated with using a *ghirling* is the risk of getting one's fingers caught between the cable and the pulley, the risk of falling in the river due to the sudden stoppage of the carriage and the difficulty in crossing during a heavy rainfall or when there are strong winds. The loss of fingers is the most common injury. In village of Mastar in Dhading District, for example, 30 of the 300 people have lost fingers and the village has earned the unfortunate appellation of a village of amputees.[13] Despite these risks, *ghirling* are used regularly and provide quick access to villages on the right bank of the Trisuli River. For many villagers the benefits outweigh the risks, especially in the absence of alternative systems for crossing rivers.

MANAGEMENT OF CROSSINGS

The members of a community, who live on the right bank of the Trisuli in the vicinity of a *ghirling* take responsibility for its operation and maintenance because it is important for them. The *ghirling* is considered the property of the village that uses it and the villagers themselves fix any damage. No formal body is responsible for its maintenance; instead, villagers set up *ad hoc* groups whenever problems emerge and donate some funds for its repair. Villagers who live along the highway help, but their role is limited to providing security for the left-bank tie-up post. Only when major damage renders a *ghirling* non-operational do other villagers help. The arrangement for boat crossings is different. One or two villagers are responsible for operating a boat, and a fee is charged for crossing. A percentage of the total fees collected is paid to the VDC as revenue while the rest is the operator's income. A similar arrangement is also being replicated for the operation of *ghirling*. While local villagers are not charged for using a *ghirling*, villagers commuting from adjoining hamlets are charged two rupees per crossing. The local people help them make the crossing.

IMPROVING THE *GHIRLING*

Some efforts have been made by private as well as public enterprises to improve the *ghirling* to make it safer, more energy efficient and more dependable. Others have promoted the use of boats as a safer means to cross rivers. Boats are useful in calm stretches of a river but are risky during the monsoon when rivers are swollen. Four significant innovations are the wire bridge (*tar pul*) of Eco-Systems Nepal, the improved *ghirling* of ITDG, the natural-force ferryboat of Royal Nepal Academy of Sciences and Technology (RONAST), and the auto wire bridge proposed by the Robotic Club of the Institute of Engineering (IOE). These are described briefly below.

Wire road and wire bridge (*tar bato* and *tar pul*)

Eco-Systems Private Limited, a Kathmandu-based company established in 1996, first began promoting the *tar bato* (wire road) as an inexpensive, safe, and all-weather form of transport for people and goods in plain areas. The *tar bato* is an improved

■ Model of a *tar bato*

version of the *ghirling* in which ropes are used to pull a carrier along a spring rod stretched between two points. The carrier has a well-designed wire-bike and comfortable chairs. Depending upon local needs, multiple chairs can also be used. The system can be operated by human power, an electric motor or a gas or diesel engine. It can climb a gentle gradient of 35 metres for every kilometre which makes it suitable for reasonably level areas. On a level area, a carrier on a *tar bato* can carry

■ *Tar pul* in operation over the Trisuli River

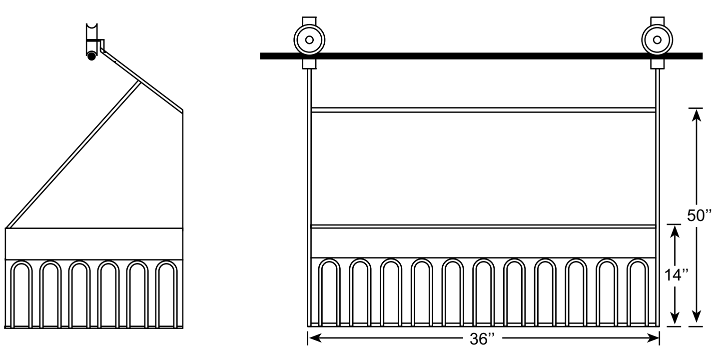
50 to 100 kilogrammes and travel at a speed of about 10 kilometres per hour. In a manually operated system used for transporting cargo, a person can pull up to 4,000 kilogrammes at walking speed. They have not yet been used in Nepal to carry goods, but banana farmers in countries like the Philippines have used them for decades. A *tar bato* can be used in the Tarai as well as in valleys, where the transport costs of farmers who currently use tractors or pickup trucks can be reduced substantially.

When a *tar bato* is modified to cross a river it is called a *tar pul* (wire bridge). In use in Nepal since 1996, a *tar pul* uses ropes to pull chairs suspended from a pair of spring rods stretched across a river. Chairs replace the boxes used in *a ghirling*. As of May 2004, 25 *tar puls* had been installed in Nepal, mainly in the districts of Kavrepalanchok, Udayapur, Lamjung, Myagdi, Chitawan, Tanahu, and Gorkha. The average cost of a *tar pul* is about US$ 12,000, which, in most cases, were donated by NGOs, individuals, and charity organisations. In some places, local VDCs also contributed. To install a *tar pul* users request Eco-Systems to conduct a survey, which they must pay for themselves. Eco-System then conducts a survey, prepares a design and estimates the cost of construction. Villagers generally arrange to pay 10 to 15 per cent of the cost, and then, on their own, find a donor to support the rest of the cost. Eco-Systems also helps raise funds through its contacts in the US, Canada and Europe. Since its successful introduction, the demand for *tar pul* has been very high. Its proliferation has been limited by the lack of funds available. Many requests have had to be turned down due to the lack of donors.

Improved *ghirling*

ITDG-Nepal has also improved the traditional *ghirling*. The improved arrangement consists of two pillars that support the wire and a box with a double pulley that slides on the rope (Figure 12.2). Nylon rope is attached to drive the box on either side.

FIGURE 12.2:
Improved carriage

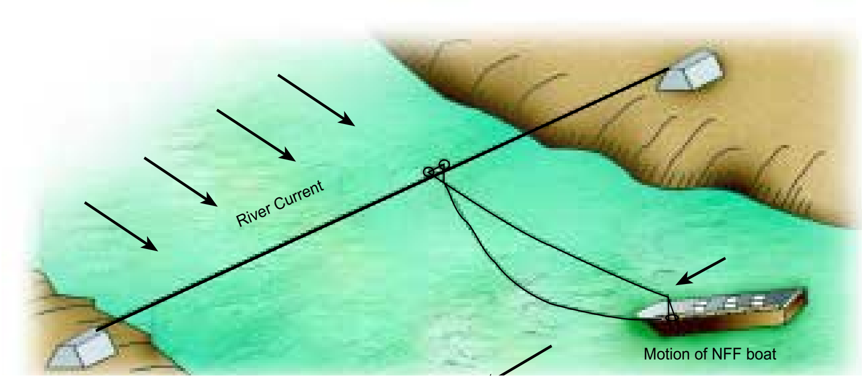


Both single and double wire types are used. The improved *ghirling* have been installed in five different locations at an approximate cost of Rs 2,500 per metre.

Natural-force ferry boat

RONAST initiated a project to design and build a natural-force ferryboat (NFFB) system in 1988 with support from Japan's ATCHA and the Open University. The objective of this project was to develop a transportation system safer than *ghirling* and dugout canoes. The ferryboats were intended to transport passengers as well as goods across a river using the energy of flowing water. The pilot project was implemented in the Trisuli River. The boat is maintained in the correct direction by using ropes suspended from a cable. Besides moving passengers, it allows local people to market agricultural

FIGURE 12.3:
A perspective view of the NFFB system



■ Natural-force ferry boat in operation in Ghatbesi, Trisuli.

produce in large quantities: as the time of travel is reduced, vegetables reach markets with no decline in their quality. NFFB were installed in Ghatbesi, Dhading District, and Gaighat, Tanahu District.[14]

Auto wire bridge

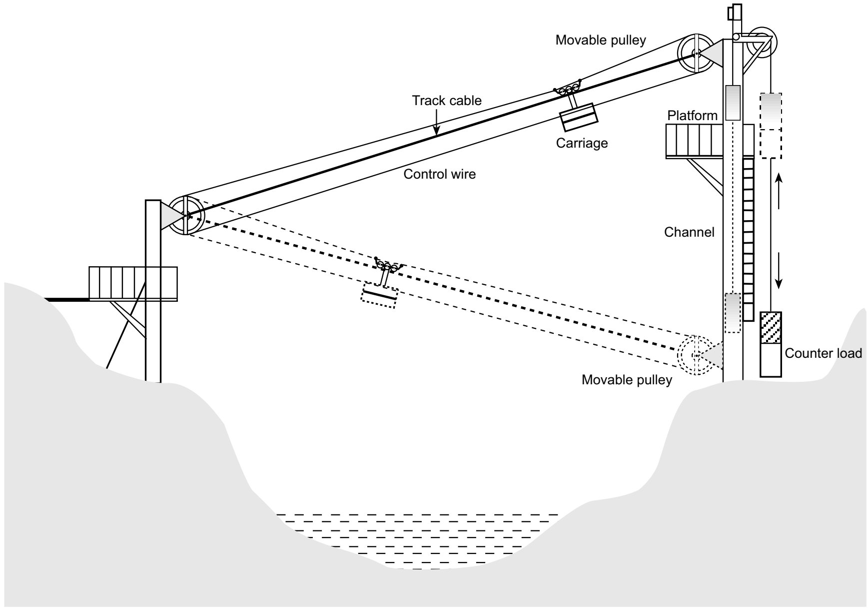
Another improvement has been proposed by a group of student members of the Robotic Club of the Institute of Engineering in Pulchok, Lalitpur. The group has been experimenting with a *ghirling* operated by gravity since 2001. For the track cable, the group intends to use a spring rod instead of a cable. The proposed auto wire bridge is aimed at ferrying passengers and goods across a river using the force of gravity. It is being designed in such a way that the children, the elderly and the disabled can operate it.

The proposed auto wire bridge consists of two posts of unequal heights rather than the level anchors of all other forms of river crossing and bridges. A tall post is erected on one side of a river and a short one on the opposite. The height of the spring rod at the shorter post is fixed, whereas the height at the taller post can be adjusted using a mechanism with a vertical channel in order to create a gravitational force in the required direction. A pulley facing the river, to which the spring rod of the bridge is attached, slides up and down in the channel with the help of a counter-weight suspended through a roller on top of the post (Figure 12.4). The weight of the counter-load can be increased or decreased in order to move the sliding pulley up and down.

When the counter-load moves downward, the sliding pulley moves up, as does the spring rod attached to it. Once the spring rod is higher than the height of the short post on the opposite bank, the suspended rod becomes angled downward towards the opposite bank. The carrier then moves toward the other bank under the force of gravity. Once the carrier is on the other side, the operator reduces the weight of the counter-load by releasing a lock with a control wire. When the weight of the counter-load decreases, the sliding pulley becomes heavy and moves downward. The rod, in turn, shifts to a height lower than the height of the short post on the opposite bank and angles downward in the opposite direction back toward the tall post. In this way, the height of the rod at the tall post is changed to angle the rope in the desired direction and help the carrier to move using gravity. If the carrier does not reach the opposite end due to friction or wind, a rope attached to the carrier can be used to pull it to the bank.

The prototype is yet to be tested in the field. According to the Robotic Club, the system can be used for a span of between 30 and 100 metres[15], thereby making it useful to cross narrow rivers.

FIGURE 12.4:
Proposed auto wire bridge (schematic)



CONCLUSION

Despite their ancient origin and widespread use, *ghirling,* have not received as much attention as other modes of transportation that arrived on the scene much later in Nepal's history. As has been the case in other development sectors, the transport sector has also suffered from a lack of appreciation of the potential of local people to find innovative solutions to local problems. Villagers had developed local ways of moving about the country but modern development paid no attention to such indigenous systems and instead introduced alien ideas and resources without a thought to their adoption or adaptation by the people. In the process, the social carrier of the *ghirling*—Nepal's average Ram Bahadur Gaunle—became marginalised. Though not a comfortable means of crossing rivers, a *ghirling,* because it is inexpensive and easy to build, is an important alternative, especially when no other means of transport is available.

In the hills, streams or rivers often separate farmland and villages. Accessing markets, schools and health posts also frequently requires crossing rivers. Even during times of heavy flow and floods, villagers have to cross rivers to carry out everyday activities like farming, shopping, attending school, visiting health posts and transporting farm produce. Where roads exist, one can travel long distances in order to get to a bridge to cross a river, but there are no roads in most places. It is unimaginable that in the foreseeable future, roads, of whatever type, will connect every village in Nepal. Hundreds of thousands of villagers will keep using simple devices such as the *ghirling*. In fact, it will remain an important part of rural transport for decades to come.

This brutish aspect of life in rural Nepal has not elicited sufficient sensitivity or sympathy from Nepal's officialdom. Despite introducing the concept of agriculture roads in the Agriculture Perspective Plan (APP) and subsequently, establishing DoLIDAR in 2000, the task of improving rural access remains grossly neglected. The events in Basmadi Village in Makawanpur, where more than 100 students could not attend school because their *ghirling* over the Rapti River snapped, is a manifestation of such a neglect. Without the *ghirling*, the residents of Basmadi have to walk four hours to reach Hetauda. When no help came from officials to re-install a new *ghirling*, the villagers of ward no 7, 8 and 9 of the Basmadi VDC started voluntary work to rebuild it, and managed to get some help from the Hetauda Cement Factory. They are reported as being committed to complete the installation of a new *ghirling* in one week and to begin commuting.[16] Unfortunately, the absence of governmental support to facilitate such local spontaneity means that the life of the majority of rural population continues to languish in depravation.

The good news is that the potential of the *ghirling* has recently received attention from a few private companies and INGOs, some of which have started work on designing and building improved forms of *ghirling*. Some of the designs are still beyond the capacity of villagers to install on their own and will make them dependent on outside support. Improvements must be incremental if they are to suit the local context that must adopt and adapt to such technological improvements.

Improved and standardised *ghirling* can provide a solution for overcoming difficulties associated with river crossing in many localities. It is not a new technology; on the contrary, it has been in Nepal for a long time and people do not have to come to terms with it. Indeed, a modern ropeway is only a mechanically energised *ghirling* with additional safety features. *Ghirlings* need to be modernised and made more efficient, safer and more reliable if they are to improve local transport in the hills of rural Nepal and have a positive impact on lives and livelihoods. It behooves Nepal's official planning bodies to widen their horizons to incorporate the humble *ghirling*.

NOTES

1 See HMG/N (1988)

2 A *sanghu* is a small temporary wooden bridge used during the winter but taken out for safety before the onset of the monsoon. It is built and maintained by local communities along main tracks. This type of wooden bridges was replaced by stronger cantilever bridges. Francis Hamilton has described *targhat*

as 'bridges of ropes made of rattans connected by cords of tough grass'. See Regmi (1988) for details.

3 Ropes are used to gain access to inaccessible cliffs. Eric Valli, a Swiss filmmaker, documented one such use in Lamjung District in Western Nepal, where rope ladders (*parang* in Nepali) are used to negotiate cliffs to collect the honey of wild bees. Similar ladders are also used in Myagdi District to collect honey. The technique of using a rope ladder to access difficult landscape dates back many centuries.

4 For details, see Landon (1928).

5 *Ibid.*

6 In the second half of the 19th century, the British Raj in India began expanding transport and communication system in order to reduce widespread famine. Roads and railway links were extended. Most railway links connected port cities with the interior of India so as to be able to export raw materials to British industries. At the same time, railway lines were also extended to North Indian cities close to the Nepal boarder. A railway line to Nepalgunj Road on the Indian side was opened in 1885. Assam Bihar State Railway opened its Purnea sections from Kusba to Forbesgunj in 1890. Jainagar and Raxaul were connected in 1897 and 1898 respectively (Regmi, 1988).

7 After Messrs. Martin and Co. of Calcutta surveyed the approximately 23 miles of road between Birgunj and a place called Bichako, it submitted a tender for the construction of a light railway from the border to Bichako. The government, however, was reluctant to connect the Indian system with these new areas. It did not allow the railway to penetrate the country farther than Suparitar near Bhimphedi. Prime Minister Chandra Shamsher favoured implementing this proposal with proper safeguards as it would have reduced the high price of imported rice, the main staple food of the people of Kathmandu. It seems that security concerns were most important than economic efficiency for Nepal (Landon, 1928).

8 Joshi and Chitrakar (1989) suggest that 'without the help of surveyors and engineers, the villagers would chose the spot where the river cuts the steepest, where the banks were stable. The indigenous chain link bridges used no mortar or cement, and required no tempered steel cables manufactured abroad.'

9 For details, see Landon (1928).

10 The tracks that connected Kathmandu with the Tarai and the ones that lay on the trade route to Tibet were improved with strong bridges. Iron-lattice girder bridges were built over the Karra River at Karra, the Samari River at Samari near Suparitar and over the Bhainse River. Iron-plate girder bridges were built at Sirsiya and over the Kiyasod River. Bridges over the Dhobi and the Bhimphedi rivers were also built at the same time. Wire rope suspension bridges were built in Chobhar, Sundarighat, Khokana, and Indrayani. Other bridges were built: three over the Sun Kosi, two over the Kaligandaki at Ridi and Ramdighat, one over the Gandak at Trisuli, one over the Tamor at Dhankuta, and one each over the Marshyangdi and over the Lishankhu at Dolakha. Bridges were built over the Chepe, Daraundi, Tadi Ankhu, Rosi, and Likhu rivers. Two stone bridges were built over the Bagmati at Pashupati and at Gaurighat. Another improvement in bridge construction involved using iron beams and stone walls. Such bridges were built at Bhimukteshwar and at Bajra Jogini. Pile bridges were built over the Barhwa and Sirsiya rivers and over the Jhanjh River near Hazmania, as well as at Shankhamul and at Dostea. Wooden bridges were built at Kageshwari over the Betravati River, on the way to Pyuthan at Balkhu, at Dakshinkali, over the Kalinadi River between Bhadgaun and Sanga, at Lamjung near Manbyasi, at Labsey below Benighat, and between Taulihawa and Soharatgunj. In some places strong wooden bridges replaced old-fashioned cantilever bridges. See Landon (1928) for details.

11 Currently two types of suspended trail bridges, long-span (120 to 350 metres) and short-span (65 to 120 metres), are built in Nepal. Every year, about 200 bridges of different spans are built by at least ten agencies. The number demonstrates that the demand is high. Helvetas plans to support the construction of an additional 900 bridges in the coming years (Helvetas, 2001).

12 Mules, mountain goats, and yaks are used to haul goods. Yaks or *jhoppa*, are used at high altitudes. Mules are used to cover longer distances at lower altitudes. Goats are used at both elevations. A mule or a *jhoppa* can carry about 50 kilogrammes, whereas a goat can carry just 10 to 15 kilogrammes. One major advantage of yaks and mules is that they can cross rivers which flow fairly rapidly, but goats cannot. If there is no bridge over a river, goats must walk longer on the same side of the bank until they reach a fordable section and can cross to reach their destination.

13 See *Himal Khabar Patrika*, 2002. Accidents are also common in other places, too. *Kantipur Daily* reported that on 18 July, 2004 three persons drowned while crossing the Mahakali River after the rope snapped.

[14] Personal communication with authorities at RONAST. The initiative was supported by ATCHA and Hoso Daigaku (Open University) at Saitama. Also see *Himal* (1989) for a discussion on the above initiative.

[15] Personal communication with the members of the Robotic Club, IOE, Pulchok.

[16] For details, see *Kantipur* 2 August, 2004.

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PART III Conceptual Reflections

CHAPTER 13

Galyang Goals:
A Synopsis of the Generic Ropeway Beast

DALE LEE NAFZIGER

On 17 and 18 April, 1996, I participated in a seminar held at the Andhi Khola Hydro and Rural Electrification Project's (AHREP) office in Galyang, Syangia, to discuss ropeways in the context of rural electrification. While listening to presentations covering a broad spectrum, I realised that although some facets of ropeways are site-specific, many characteristics are of a generic nature. Below I summarise some of these traits as well as provide my own insights with an eye toward the future of the ropeway.

A discussion of ropeways is similar to the proverbial story of six blind men describing an elephant: at a cursory glance, the treatment of ropeways seems quite straightforward, but a more intimate exploration makes it abundantly apparent that what is observed first is, in fact, only the tip of the iceberg. In order to treat the subject effectively, it is necessary to delimit it. One must ask oneself what, specifically, is being discussed: ropeways for the rural areas, ropeways for transport, ropeways for garbage disposal, ropeways that are technically feasible, ones that are economically feasible, or what? Only once the precise topic is identified can a fruitful discussion ensue.

It is, furthermore, quite futile to discuss ropeways *envacuo*, i.e., without regard for broader integrated rural development. There are very few examples in history of technology that is self-propagating and self-perpetuating, and the ropeway is certainly not one of them. One must consider what existing development efforts will be enhanced by the construction of a ropeway and what infrastructure needs to be added in order for that ropeway to stimulate more development. The Hero bicycle, the Usha sewing machine and the TV dish antenna aside, the successful introduction of technology in Nepal requires doing considerable homework beforehand and careful nurturing afterwards. This is particularly true in the case of the humble ropeway because its successful introduction and propagation requires overcoming a significant social bias that equates road building with development. The prejudice against ropeways becomes particularly obvious when one realises that ropeways are by no means a neglected sector in terms of planning and policy. In fact, every major political party in Nepal promotes the development of ropeways or electric transport in its party manifesto and the Sixth, Seventh and Eighth National Five-Year Plans also include provisions for ropeways under 'other modes of transportation development'. In real terms there has been little progress beyond this hypothetical framework. In the Nepali context, it is profitable to commence our discussion of ropeways in a generic sense by considering what factors are responsible for the chasm between ropeway policy formulation and effective implementation.

One point noted in the AHREP seminar is the political economy of Nepal: political parties parade ropeways on a pedestal during times of national crises but just as conveniently wash their hands of them as soon any given crisis is averted. The promotion of the Hetauda-Kathmandu ropeway when the Trade and Transit Treaty with India lapsed in the spring of 1989 is just one example. I hasten to add that Nepal's 'pile of dirty laundry' is minuscule compared to the USA's attempts to mobilise an 'alternative energy sector' in response to the Middle East oil embargo in the early 1970s.

Another political-economic factor widening the gap between the formulation and effective implementation of policy is the fact that ropeways are administratively situated under the government-owned NTC within the MoWT, which is dominated by the DoR. This institutional framework stacks the odds against ropeways, which are unjustly overshadowed by their big brother, roads.

A third reason ropeway policy is not implemented is the limited number of case studies which exist. While these studies do provide evidence that ropeways can be operated effectively on a community basis, they do not demonstrate the commercial viability that attracts private investors. A colleague rightly pointed out that this is the case with just about every type of village-level infrastructure in Nepal. Perhaps what is needed to rectify this unfortunate situation is a dose of creative marketing or a re-education of potential investors. It is my observation that in Nepal investments offering quick returns but with gross long-term negative consequences are spontaneously generated, whereas environmentally friendly options are generally supported only when a financing institution sees an opportunity for promoting its name.

For example, each morning as I ride my bicycle up the Pulchok hill to the office, I face an increasing onslaught of large vehicles crowding Kathmandu's already overburdened road network. In addition to ICIMOD and UNDP staff vehicles and school buses transporting students in firetraps with smoke belching out the back, taxis, each with the name of its respective patron finance institution painted on it in large bold letters, asphyxiate me. Clearly, organisations with cash-laden investment coffers do not lend gratuitously, as you well discover if you try to obtain financing support for just about any type of environmentally-friendly investment. Nepal's banks operate on a different wavelength from that of sustainable development. It is no surprise, for example, that the search for partial in-country funding for the Khimti Hydropower Project was a failure. In my opinion, some very slick marketing is needed to convince Nepal's banks that there are viable options for investment which go beyond putting more advertisement-laden taxis on the road.[1]

The bad press given to ropeways, whether deserved or not, also widens the gap between policy and its implementation. Allegations regarding the pilferage of materials transported via ropeways make ropeways seem unreliable. Rumours that trucking cartels have the means of actively discouraging ropeway development, whether true or not, portray ropeways negatively and scare away potential investors.

Experience in Nepal has demonstrated that not all manufacturers of ropeway equipment are created equal. In some case studies, for example, significant cost savings during the initial installation have been forfeited by even greater expenditure during operation due to the premature failure of system hardware. Furthermore, even with reliable equipment, proper repair and maintenance requires significant investments of institutional time and resources that are not always easy to make. These lessons have rendered implementation difficult.

Finally, a practical issue contributing to the gap is the substantial cost of a reliable winch machine, which has to be imported. Whether a ropeway is one-kilometre long or ten-kilometres long makes little difference to the overall cost, as the major expenditure is an essential piece of foreign equipment unlikely to be produced locally in the foreseeable future.

Given the long list of potential drawbacks, what can be argued in defence of ropeways? First, experience in Nepal has demonstrated that the cost of a ropeway is nearly always less than that of an equivalent length of motorable road. Besides, the straight-line path adhered to during ropeway design and installation means that a ropeway connecting two places is considerably shorter than any road connecting the same two places. A direct corollary of the ropeway's shorter length is that it has fewer adverse environmental and financial impacts: expenditure of foreign hard currency is less on a ropeway than on the most competitive motorable road alternative.

A further point supporting ropeways is that there appears to be little correlation between ropeway construction and loss of employment for porters. Evidence suggests that constructing ropeways only on the most difficult stretches of any given footpath relieves drudgery for porters but does not deny them employment on easier portions of the trail.

A final point in defence of ropeways is that although some hardware must, for reliability's sake, be imported from abroad, ropeways employ fairly simple technology. The existing national pool of technical experts should, therefore, be able to develop and implement this technology with a minimal infusion of external expertise.

Having expended considerable words on the relative merits and demerits of ropeway technology, I wish to change the topic somewhat and, looking toward the future, discuss how ropeways might be given a just hearing in the Nepali context. Earlier in this paper I touched upon a point generally accepted in development circles regarding the 'critical mass' of infrastructure required for any technology to be self-perpetuating. It is clear that the technology of ropeways in the Nepali context, has, by no stretch of the imagination, evolved to this point. There is, however, a fairly well-developed MHP industry in a country whose development, some contend, has stalled. It seems possible to 'piggy back' ropeway development onto the existing MHP industry, thus invigorating the latter and giving it a new life, in the same manner that micro-hydro did for electricity about two decades ago. I believe that such creative thinking needs to be encouraged if ropeways are ever to receive a fair trial in Nepal. Beyond considering such a conventional option, even more novel brainstorming might be appropriate. One participant at the AHREP meeting suggested, for example, that ropeways be used to transport waste out of Kathmandu. This proposal never caught on but, perhaps modified somewhat, should have.

Although creative thinking is a necessary catalyst if we are to evolve from the primordial ooze, the AHREP seminar participants agreed that beyond mental gymnastics, significant and direct stimulus is also needed to move the development of ropeways in Nepal forward. One painfully obvious constraint is that very few pilot efforts capable of providing reliable data—either positive or negative—currently exist in Nepal. More than speculation, there is a *bona fide* need for trials to address technical uncertainties as well as to explore innovative management methodologies. In addition to providing opportunities to debug technical and managerial glitches, such case studies would also provide conclusive cost-comparison and energy-savings data. What long-term energy savings would, for example, accrue to the nation if a ropeway such as that from Hetauda-Kathmandu were operated on a reliable basis? Speculation could fill pages, but we need facts.

In commencing novel work on ropeways, some parties will benefit and some will lose. The potential benefits of ropeways must, therefore, be sold to lobbies or cartels that initially opposed ropeway development. Resorting to bold thinking, can it be proposed that the Nepal trucker's association be granted honorary shareholder status in any newly formed ropeway organisation? Such an audacious idea represents the type of thinking that will be necessary at the national and district levels if ropeways are to stand a fair trial.

Considerable effort in motivating locals is also required. For example, when conducting a preliminary ropeway study for AHREP a few years ago, it was necessary to dispel the threat that some merchants perceived existed. Another example of motivation involves Butawal Power Company's efforts in the late 1980s to introduce a novel electricity tariff within the AHREP distribution area. To sell the unique facets of the project, including the tariff, a team of eight community motivators—five young men and three young women—from the surrounding villages were selected in 1988 and provided with six months of on-site training. Following the training, one of the motivators' first tasks was to go door-to-door explaining the AHREP tariff. Their job was not easy, but I believe that they were highly influential in encouraging local people to accept electricity rates quite different from the tariff *modus operandi* most Nepali are familiar with. Similar motivational efforts at the national, district and local levels will be essential if ropeways in Nepal hope to ever receive a fair forum.

In summary, despite the constraints noted above, I concur with the general consensus of the seminar that ropeways do indeed appear to have a future in Nepal. At the very least they deserve a fair trial. What is needed most at this juncture is vision brought into practice through pioneering efforts or, in plain words, some visionary individuals and organisations must be willing to put scepticism on the back burner for a time and think in terms of calculated risk. Today, at least two ropeways function in Nepal—Manakamana Cable Car and Bhattedanda Milkway. Their success indicates that pioneering efforts within Nepal do exist. Only case studies can provide the firm data which demonstrate conclusively that ropeway technology is appropriate as an agent of transformation in the process of developing the country. At the end of the day, it just may be that the beast we assumed was generic, may instead be like Hanuman incarnate, back to his old job of moving the traditional Himalayan load with a slightly new technological twist.

NOTE

[1] This observation was true partially at the time. Now with the implementation of the Piluwa Khola and Chilime hydropower projects with in-country funding, things might have changed—Editors.

CHAPTER 14

Gaun-Besi Ropeways:
An Alternative Future?

DIPAK GYAWALI AND AJAYA DIXIT

MISSING MIDWIFE

In Nepal, the first modern ropeway was built in 1924 but not until over a quarter of a century later was the construction of the first serious goods-transporting road, the Tribhuban Highway, launched. Nepal's traditional ropeway—the ubiquitous *ghirling*—boasts an even longer existence extending back into the mists of Nepali history. In spite of its head start, ropeway technology has languished, while roads and highways have become a semiotic synonym for development. And this reversal happened despite the obvious benefits of ropeways in hilly terrain; despite the comparatively high cost of roads, both in terms of finance and the environment; and despite the boost that ropeways would have given to the exploitation of Nepal's hydropower potential. Instead of pursuing this soft and clean energy option, Nepal's development planners and decision-makers of the last half century led the country along a non-renewable path dependent on imported petroleum that drains the country's foreign exchange coffers.

The shortcomings of road-based transport should have impelled the pundits of development, both local and foreign, to examine the history, problems and prospects of ropeways in Nepal from the perspectives of a range of disciplines. Unfortunately, the logic of development aid—on which Nepal became dependent not only for the money but even for the initiation of projects—runs on conservative bureaucratic lines and this necessary introspection never happened. Moving boldly away from explored into uncharted territory is not part of the ethos of foreign aid (Gyawali, 2004). It is widely recognised that Nepal's development efforts are hampered by the lack of transport facilities, and that the conventional approach of building roads in the hills is too expensive to be sustainable. Within the aid establishment, however, this recognition has not been matched by the drive to search for alternatives. In fact, the ropeways installed in Nepal in recent years were either financed and implemented by the private sector (chapters 6 and 11) or, if by the aid industry, as unintended consequences or unconventional ventures (chapters 8, 9 and 10).

While the foregoing chapters have presented a rich repertoire of case studies, this last chapter offers theoretical reflections on the implications of these experiences. What lessons do past efforts, both successes and failures, suggest? In contemplating the diffusion and stabilisation of ropeway technology in Nepal on a wide scale, where should we start? By asking such questions, this book is, in a broader sense, about advocacy—the influencing of policies, attitudes and behaviour in order to change the way things are and replace them with something better in the future. Alternative technologies are, by definition, innovative technologies that meet new societal challenges, as opposed to entrenched ones ruling the roost. They need effective social carriers, or at least a climate conducive to the activism which enables new developments to emerge.

The collective authorship that produced this volume hopes to stimulate potential social carriers of ropeway technology in Nepal to look afresh at this alternative mode of transport, which includes both traditional Nepali *ghirling* and modern versions. These groups include investors and policy makers, teachers and activists, researchers and public opinion-makers, all of whom can give meaning to ropeways and *ghirling* and ensure that a broader consensus emerges about the need to integrate them with the broad Nepali aspiration to a life free of drudgery. As the case studies demonstrate, an alternative technology such as the ropeway is likely to be stillborn if no set of nurturing midwives steps forward.

In a previous study (Gyawali and Dixit, 1996), we had unequivocally argued that 'the ropeway as an industry *has* a future in Nepal *provided* a number of steps are taken to address existing institutional (societal) constraints'. The subsequent 'action research' in Barpak as well as the work of the various experts included in this volume not only reinforce our conclusion but help us to tease out the further ramifications that this path of transport development entails. As a result of the additional eight years of snail-paced research and reflection invested in answering questions about ropeway technology, the study itself turned into a discourse about the fundamental issues which underlie the development of transport, and specifically of electro-based ropeways, in Nepal.

This chapter draws out the lessons suggested by the case studies, discusses the problems of sustainability, compares ropeways with roads, analyses who the social carriers of this technology might be, and explores the policy terrain on which the social carriers' battle for alternatives has to be fought. We look back, ask questions, and, in the later sections, reflect on possible answers.

DRAWING LESSONS

Transport in Nepal's hills has evolved from the traditional rope *ghirling* of medieval times to the steel cable suspension bridges, modern ropeways and green, brown and black roads of the present. The most striking feature of this development is the yawning chasm between what villagers need or aspire to and what central authorities think is useful. In this book, those who reflected on the history of ropeway transport in Nepal (Chapter 5) as well as those who reviewed national plans and party policies (Chapter 2) lament that HMG/N does not have a ropeway policy. This was true in 1964, when the NR was built and sadly continued to be the case in 1997, when construction of Manakamana Cable Car began (Chapter 11). The government and its central political leadership may be confused about how to deal with ropeways, but villagers seem to relish them, whether they are the rudimentary *ghirling* of the informal sector or the more sophisticated Bhattedanda Milkway and the goods-carrying Barpak Ropeway. What accounts for the huge gap between the people's aspirations and the mindsets of planners? The lack of vision among Nepal's planners stands in stark contrast to events in another mountainous country, Switzerland.

This land-locked alpine nation has developed a multi-modal transport system where trunk highways serve as the main arteries feeding a rich network of ropeways (Chapter 1) that branch off into the mountainous hinterlands. In the Alps, these transport technologies have reinforced each other, whereas in the Nepal Himalaya roads have smothered ropeways. What powers are behind the political economy of roads and what vested interests underlie that economy? An old study (Wuest and Herzog, 1983) concludes that the NR was unable to function because it was sabotaged by the truck owners of Nepal, who profited from operating on the Tribhuban Highway to supply the capital city with daily necessities. The two authors further suggest that if a reshaped ropeway is to function, operators must co-opt the truck owners into becoming stakeholders so that they, too, have a vested interest in seeing it run properly.

In the case of the NR, however, truck owners couldn't be budged. Despite the fact that the ropeway came under the jurisdiction of the government-owned NTC and despite the inclusion of supposed users in the governing board (viz. the fertiliser-transporting parastatal Agriculture Inputs Corporation, the NTC, and the Salt Trading Corporation), companies continued to prefer to move their goods by truck. They favoured trucks even though transporting goods by ropeway was cheaper (between Rs 312 to Rs 343 per tonne) than using trucks (Rs 518 per tonne).[1] The loading and unloading charge for ropeway usage was only one rupee per bag so this cost, though given as an excuse, was obviously not a deciding factor. While an external 'conspiracy' theory may in part explain the dismal state of affairs of the NR, its internal weaknesses cannot be overlooked either.

As the above numbers suggest, marketing should not have been a problem for the government-owned ropeway; however campaigning was not pursued vigorously. Instead, in discussions with the staff, one heard the constant 'captive market' refrain, viz. that 'HMG/N should order its various departments to use only ropeways'. The total operating cost of the NR (not including its cost of depreciation) was about Rs 6.2 million per annum; its income, Rs 3.4 million, was only about half of that. Two obvious reasons for the books being in the red were overstaffing (salaries accounted for about 130 per cent of the income) and poor capacity utilisation (the NR operated an average of 37 hours per month instead of at least ten times more). Political interference and frequent changes in management have been cited as other contributing factors.

In sharp contrast with this apathy, the dynamic response of the same official apparatus during a crisis was nothing short of miraculous. In the aftermath of the 19 July, 1993 floods in Central Nepal, which washed out sections of both the Tribhuban and the Prithvi highways, Kathmandu was cut off and isolated. The Hetauda-Kathmandu Ropeway also lost two towers along the bank of Rapti River and was non-functional, even though a few months before the disaster, the government of France had helped replace the traction rope up to Bhainse. With the help of the army, however, the system was restored in 24 days and ran its full contingent of 212 carriers from 6 AM to 6 PM for 15 days transporting vegetables and other goods to the beleaguered capital city. The system then operated from 10 AM to 5 PM till the Prithvi Highway reopened. After that, the official promises to provide more support to ropeways evaporated and the system lapsed back to being its old inefficient self.

This 'enthusiasm-depression' cycle seems to have been a repeat of the events of the 1989 economic blockade of Nepal (also called the 'trade and transit impasse' by diplomatic puritans). In July 2004, heavy monsoon rains again damaged both the national highways out of Kathmandu. However, the added tragedy this time around was that there was no NR to revive: it had suffered official euthanasia—ironically at the hands of the very same political forces whose election manifestos promised promotion of ropeways (Chapter 2). Indeed, even the talk of alternative transportation has ceased in the official circles; instead, the discourse has moved toward finding three billion rupees to build yet another highway for Kathmandu.[2]

In sharp contrast with the official indifference, villagers express zeal for ropeways. Villagers on the 'wrong side' of highways—on the other side of a turbulent river—have devised their own *ghirling* or *khit-khite* (Chapter 12) and often conduct their daily business using them even at the risk of amputating their fingers. The development apparatus led by the Nepali state with the support of the international aid bureaucracy has been unable to bridge the gap between central apathy and rural enthusiasm for ropeways. This observation begs the serious question: why?

In analysing the problems of the NR, the inescapable conclusion is that institutional will within the Nepali state is lacking during normal times, unlike during a crisis. One expression of the official devaluation of the ropeway is its position within the governmental framework (Figure 5.3, Chapter 5). The MoWT is primarily concerned with building and maintaining roads in Nepal: its DoR is one of the largest technical departments in the country and officials who handle roads are right at the very top of the ministerial hierarchy. The size of the budget and internal allocations within the Ministry (Chapter 2), also suggest that the government's overwhelming concern is with roads. In the decision-making structure of the Ministry, ropeways are located at the bottom, with far too many levels to climb for any of their problems to find salience at the higher echelons.

All three of the non-Nepalis (Barnaby Smith, Toni Hagen and Dale Nafziger) who contributed to this volume argue for taking risks in development, for taking one step backwards to re-conceptualise Nepal's transport policy in order to secure more effective rural access rather than to opt, in a knee-jerk fashion, for conventional roads. This is undoubtedly good advice but, unfortunately, the aid bureaucracies of donor countries have resisted such arguments. To Nepal's detriment, except for the relatively egalitarian United Mission to Nepal, the most conservative donor agencies are based in the countries with the longest histories of development aid and engagement in Nepal.

Even some of the more innovative studies on transportation conducted by the various bodies of the UN (Chapter 3) have resulted in no follow-up; evidently, despite the obvious benefits of ropeways those higher up are not ready to take the plunge. It is not only the Nepali bureaucracy that is risk averse; conservatism transcends the international divide. And as long as development is led by the bureaucracy rather than by the real market at the national economic grassroot level (not the level of international hyper markets like Enron that the international aid bureaucracy tends to favour), risk taking will be anathema in the aid business, whether it is run nationally or internationally. Maybe the real difference between the Swiss example and the situation in Nepal is, ironically, the handicap of the conventional aid paradigm.

What does a shift from the bureaucracy-led development model to one that is genuine and competitive market-led entail? Does it mean that the bureaucracy has no role? Quite the opposite. A policy regime that is one-legged is inherently unstable, even if it leaps from a bureaucratic one to a market-dominated frame (Gyawali, 2003). A three-legged framework is more stable and it allows space for all three players—the state, the market and social auditors—to engage in contestation. The development of ropeways in Nepal by the local market will require balancing the exuberance of developers with the cautionary voices of egalitarian activists, and ideally the state should provide that adjudicatory equipoise.

Again, the Swiss example (Chapter 1) is instructive in this regard. High-capacity and high-profile tourist ropeways must follow strict safety regulations and be licensed by the Swiss federal government, while the rules governing smaller ropeways are lax and cantons and municipalities can license them. However, even the smallest ropeways have to be entered in a topographic cadastral map by the SFFSO to prevent their becoming unforeseen hazards for aircrafts and helicopters. Furthermore, not only the private sector but also the Swiss Army builds ropeways. Indeed, Toni Hagen mentions that the Swiss Army could have erected in 19 hours the ropeway that took four months to construct in Barpak. When a mountainous state with villages and highways threatened perennially by avalanches and landslides develops the capacity for such a high-speed response, it provides a great sense of security to its citizens. A facilitative bureaucracy in Nepal would think along these lines rather than simply about expanding its tender bidding and contracting empire in the roads sector.

Both the Barpak and Bhattedanda ropeways illustrate the question of safety. They were built to boost the local economy by carrying goods rather than people, and were thus designed with low safety standards. But people started riding in them anyway despite the admonitions of the operators. The villagers can hardly be blamed for thinking that a modern contraption from the Swiss Army could be any less safe than their traditional *khit-khites* (Chapter 12). And it is also true that the Khimti goods carrying ropeway was designed (technically and operationally) to also carry construction crew.

The question in Nepal has thus become whose risk perception is to carry the day. Logically and conventionally, design engineers and operators should decide. Once operations start, however, local perceptions easily take over, especially if engineers and their agencies have no nearby presence. Was it better to let the pregnant woman die in childbirth in her village because the Bhattedanda Milkway was not meant to carry passengers or to take the risk and send her on the milk carriage to the roadhead from there to a city hospital? Because there was a happy ending to that story (the baby was delivered safely and both mother and child were in good health), those taking the risk, and those permitting it, can feel vindicated.

However, what if there had been an accident as there was in Barpak? Even though Bir Bahadur argues (Chapter 9) that the load of the people at the time of the accident was less than what the carriage normally carried, the blame game can be initiated by many sides for a variety of social purposes. A reticent Swiss aid bureaucracy can feel vindicated that it refused to help; a risk-averse INGO can reinforce its belief that MHPs and not ropeways is what promoting alternatives in Nepal should continue to comprise; and the all-powerful road bureaucracy can continue to dismiss ropeways as it has for the last fifty years, with the additional arguments of safety (conveniently ignoring the fact that deaths on highways are far numerous, making road technology relatively more dangerous).

The question of whether local or external perceptions should be accorded precedence is highlighted in the different ways a local entrepreneur and an outside researcher approach the problem of rural access. The Nepali entrepreneur who implemented Manakamana Cable Car (Chapter 11) talks of making dreams a reality, of making important holy spots more accessible to those who would otherwise be unable to pay homage to the goddess, of being as sensitive to local concerns as practicable. A Norwegian researcher who studied Manakamana (Bleie, 2003) is, on the other hand, more cautionary. Bleie also rightly highlights the undercurrents of tension among various segments of the local population. Some of them relate to decisions where to locate the passenger station of the ropeway, which are similar to the 'roadhead politics' familiar to those who implement highway development programmes.[3] The researcher argues that building the ropeway has promoted mass tourism and eroded the fundamental idea of individual spirituality implied by religious pilgrimage. This view contrasts very sharply with the view of the entrepreneur, who feels that the cableway has actually increased spiritual wellbeing because people, especially the old and the infirm, who would never have been able to do so otherwise, are making the journey and feeling morally uplifted for having done so.

Of course, one could make the point that instead of driving and taking the cableway, walking to Manakamana on one's knees, preferably all the way from Kathmandu, is, as it is involves greater hardship, spiritually more meritorious than riding on a cable car. In mountaineering, too, 'making do with less', especially bottled oxygen, is more valued by solo mountaineers than by safety-conscious expeditions ladened with expensive gear. But just as an individualistic perception of risk does not apply to mountain climbing organised by trekking companies or permitted by most government agencies, the ascetic form of spirituality mapped by the outside researcher onto Manakamana does not apply to normal householders.

Pilgrimage entails a range of penitentiary stances depending on one's capacity to challenge and overcome one's physical and emotional limitations. In Hinduism, as in many other religions, pilgrimage begins with simple obeisance and extends to performing intricate painstaking rituals over days, even years. Were it not so, a Nepali entrepreneur could argue that no true Christian would go to church in an automobile; he should instead walk, lumbered with a heavy cross on his shoulders, after having given away all his possessions to the poor, as Christ commanded his disciples do. The point is that Manakamana Cable Car and the Prithvi Highway do not prevent an ascetic-minded pilgrim from physically chastising himself by walking all the way, using neither ropeway nor bus. But the convenience these infrastructures provide does allow the infirm to worship.

A government cannot prevent users from seeking ease and comfort, but it can stop misuse and iniquity while facilitating new innovations. One example comes from the Barpak experience. How safe is safe and who should decide? Given the bad history of failed development, villagers were not willing to trust the government to implement an MHP or a ropeway scheme (Chapter 9); but they were, at the same time, willing to accept its authority. The Barpak village entrepreneur pretended that his technicians represented HMG/N's Water and Energy Commission (WEC) in order to get his survey underway. In the Nepali context, this issue boils down to the question of dispassionate regulation versus micro-managed implementation by state agencies; the former is desired and the latter resented. How does one assure that a regulator does not turn into a rent-seeking, inefficient monopoly? More significantly, if a government is to provide some degree of regulation and guidance, what measures can be taken to assure that new initiatives and pilot project ventures do not fail disastrously?

SINS OF UNSUSTAINABILITY

Christensen and Koukios (1997) help us examine these questions in the context of the sustainability of renewable energy enterprises and their pithy conclusions have relevance for those who strive to promote ropeway technology in Nepal. They argue that even though oil is the cheapest and most convenient source of energy for many purposes, many soft energy projects that could compete with oil at current prices have failed to take root, that is, to become self-sustaining and self-generating.

Drawing from the lessons of several demonstration projects been implemented in rural areas of various Greek islands, they conclude that many well-meaning ventures have systemic problems that have nothing to do with the prices of competing forms of energy. They highlight 'seven deadly sins' related to the implementation of local soft energy systems; three relate to pre-existing conditions, two are characteristic of the projects themselves, and two follow physical implementation.

In this section, we will examine these seven sins—and their corresponding seven virtues—and see how Nepal's different pilot projects for ropeways fare in these terms. Villages located on remote hilltops are like mid-ocean islands whose political economies are a function of how far they are from the mainland. In Himalayan hamlets, it is the extent and degree of verticality which determines what can and cannot be done with respect to development.

First sin: irresponsible money

On the Greek islands of Halki and Naxos, large institutions such as the EU, UNDP, FAO and OECD, as well as the Greek government, initiated ambitious wind, solar and biogas projects. Even though these projects were begun with the noble motives of using renewable energy and promoting sustainable development, they were either eventually abandoned or functioned only as long as external funding was available. The problem was not one of insufficient money but rather of its inverse: too much money flowing too freely from remote sources through planners and initiators with no long-term commitment to on-going operations. Christensen and Koukios conclude that this sin should be replaced by a counter virtue: flows of money for demonstration projects should be structured to diminish the power of elite groups who are not responsible for operation and to augment the influence of those who will be responsible for continuing operations.

Pilot projects, whether those in Bhattedanda, Barpak or Manakamana, are often carried forward on the shoulders of unconventional enthusiasts with a mission. They conceptualise a design, rummage around for funding sources, and implement their project with heroic zeal. Those that receive these artefacts as *koselee bikas* (or ‘development gifts’) are brought in only after the project has been commissioned and only to carry out operation and maintenance. Beyond some labour contributions, they are uninvolved with the bulk of the funding; in fact, even the money required for effective operation and maintenance, which has to be raised from tariffs, is often not agreed upon before deciding to implement a project.

The result of the donor’s initial largesse is that the recipients assume money will continue to flow in later stages, too. By the time the truth dawns on them, it is often too late to prevent the project from running aground. Only Manakamana Cable Car managed to avoid the fate of poor maintenance and that was because it was a fully commercial venture whose investor was solely responsible for the viability of the project and the repayment of the bank loans. A similar case could be made for the construction ropeways of Jhimruk and Khimti (Chapter 6), which served the purpose for which they were designed and implemented. In the future, some framework for matching loans taken by village communities to benefit from ropeways, as is done with micro-hydro stations, might be a responsible way of avoiding the irresponsibility inherent in the *koselee bikas* model.

Second sin: dysfunctional institutions and policy

Wind turbine projects were initiated in Aperathau and Mykonos, but one operated for only a short time only and the other never got off the ground. They had been implemented within an institutional context moulded by entrenched non-renewable technologies such as diesel generation, which monopolised the supply of electricity on these islands. All problems regarding equipment and construction were defined by institutional policies and practices devised in terms of what such non-renewable energy technologies demanded, and little thought was given to the dissimilar requirements for the operation and maintenance of wind turbines. The renewable energy projects were also pushed forward by local political ambitions, which boiled down to securing as much money as possible from public sources. Neither politicians nor power system managers had any idea of what was needed to install or operate the renewable project. This sin can be rectified if substantial, systematic attention is devoted to identifying and modifying dysfunctional, anachronistic policies, institutional arrangements, and professional practices associated with older technologies.

The Hetauda-Kathmandu Ropeway functioned within an institutional environment dominated by road construction. Its management was, in a sense, confined to the outskirts of decision-making. Governmental policy-makers at high levels came from the road sector and naturally focussed their attention on the DoR. For its growth and sustenance, the ropeway needed its own set of policies and planning principles; it could not, unfortunately, blossom in an institutional environment dominated by roads and vehicles. It is too late by several decades, but it is still worth speculating: what the status of ropeways in Nepal would have been if, for example, something similar to the Alternative Energy Promotion Centre had been set up after the energy crises of the 1970s if and Nepal's ropeways and their promotion had been brought under its jurisdiction? Displacement of petroleum by indigenous hydropower would have been its major policy priority and the performance of the NR would have been judged by how many litres of imported fuel per freight tonne it displaced every year. If it had had such policy backing, the NR would probably still be running today.

Third sin: engineering and economic ideologies

Both engineering and economics have entrenched ideologies—'economies of scale' for the former and 'price incentives' through favoured taxes and subsidies for the latter—which foster designs that lean towards gigantism. When coupled with another belief in 'technological utopianism' or the unquestioned faith that equipment will function as designed, they produce rusting white elephants unable to survive in their social and environmental contexts. Another related dogma is that, at the project level, engineering-economic analysis points out what is rational use of energy and what is not. In reality, however, the key issues in making energy choices centre are a matter of perception with regard to national vulnerability to global changes, balanced regional development, balance of external trade and environmental health. Rectifying this sin requires identifying and dealing with ideological blinders and associated professional practices that continue to foster dysfunctional approaches to the implementation of soft energy systems.

This sin applies to most of the attempts between 1972 and 1992 to examine the possibility of constructing new ropeways in Nepal (Chapter 3). Much of the official thinking among aid donors and Nepali planners could not transcend the macro framework of regional transport. This myopia was born of their ideological commitment to the macro picture, which prevented them from seeing the tremendous potential for *gaun-besi* (valley-bottom to ridge-top village) ropeways. Despite the need for and possibility of installing such small-scale ropeways in Nepal's Middle Hill villages, they concentrated their attention and resources on trans-district systems like the proposed Surkhet to Jumla or Chatara to Bhojpur ropeways despite the obvious problems with the existing Hetauda-Kathmandu scheme. Even on the smaller scale, this proclivity can be seen—with hindsight—in the Barpak case (chapters 9 and 10), in which planning dominated by engineering and economics missed many of the villagers' motives for operating a ropeway. Ironically, like Jonathan Swift's big fleas being bitten by smaller fleas on their back, even the powerful economic ideology of privatisation in vogue in the 1990s failed to see the potential benefits of privatising NR instead of letting it rust away. With its ideological power, the entrenched technology of roads overwhelmed the new competitor.

Fourth sin: technical disintegration

In Halki, near Rhodes, renewable energy projects were initiated with a view to promoting a showcase for tourism that included the rehabilitation of buildings, sewerage and water supply, and transport. Each project was treated separately and designed using technologies that were fashionable in sophisticated urban settings, with no thought for the constraints imposed by locally available (or unavailable) resources. Even though money was plentiful, the projects quickly ran into natural resource constraints: water was scarce and high-flow shower heads, large-volume flush toilets and oversized sinks soon ceased functioning. This sin could have been avoided if the designs for the technical systems had been made locally suitable after conducting an integrated technical analysis of resources, technologies, environmental relations, and economics.

Chapter 8 describes how the eventually successful Bhattendanda Milkway had to fight internal battles within the watershed management department against the dominant view that dairy issues had nothing to do with soil conservation or rural transportation. However, more than to Nepali ropeways *per se*, this sin applies to the many failed 'integrated rural development programmes' (IRDPs) of the 1970s and 1980s that promoted micro-hydro and soft-energy systems without integrating them with alternative, soft transport systems such as *gaun-besi* ropeways. This failure happened in districts where, as the case studies in this book describe, *gaun-besi* ropeways were later successfully implemented.[4] IRDPs promoted horticulture and livestock programmes for rural development without a thought of how to get those products to the market. The result was that apricots and tangerines were left to rot or fed to cattle. Integrated with *gaun-besi* ropeways, both agricultural programmes and under-capacity MHPs would have performed much better.

Fifth sin: social disintegration

When plans and designs for hardware are developed without explicit and early considerations of the society that is expected to operate and maintain the system and to live with it, projects will be abandoned or forced to shut down. Operators are often an afterthought, brought in only at the handover stage after all the crucial decisions from design to implementation are already a *fait acompli*. To avoid falling victim to this sin, the design and development of systems must be integrated with the design and development of effective social capacities—institutions—for the operation and maintenance of the systems.

With the exceptions of construction, industrial and private tourism ropeways (chapters 6, 7 and 11), centrally planned ropeways suffered from this sin. Training user groups to operate and maintain ropeways was not seriously pursued early on; it was taken up with some urgency only as the commissioning of the projects drew near. In the case of the Hetauda Cement Factory Ropeway and privately-owned Manakamana Cable Car, training was part of their in-built respective operations. The sin of social disintegration was not perpetrated by these projects. In the case of both the Bhattedanda and Barpak ropeways, however, the learning curve was quite harsh for the communities concerned.

Sixth sin: project learning disability

Evaluations of pilot projects by their advocates and managers often obscure, hide or ignore errors. The dynamics behind the evasion are the imperative to proclaim Project #1 a success so that Project #2 can be funded. But the failure to recognise and publicise mistakes only ensures that errors will be needlessly repeated. A virtue to strive for, therefore, is to evaluate the results of demonstration projects not just in terms of the hardware constructed but also in terms of whether an effective organisation is developed. Without a local body that is both able and motivated to engage in critical self-evaluation and learning, renewable energy projects are doomed to remain pilot schemes that fail as commercial schemes.

While this is a generic sin committed by most pilot projects around the world and Nepal is no exception, ropeways, with the publication of this book, can hopefully be spared this accusation. The various case studies have ensured that the difficulties encountered, the mistakes made and the lessons gleaned are now part of public discourse. Hopefully, the lessons will form part of the sector's common learning curve.

Seventh sin: policy learning disability

The last sin is committed by those who fund projects and is the same as that of project managers: the refusal to be open about errors and devise corrective measures in order to avoid repeating them. Technical modernisation at the local level involves introducing new and renewable energy technologies. It demands that policy makers at the high end develop the ability to listen to critical evaluations of demonstration projects. Ideally, this assessment should be rooted in internal self-evaluations, but if that proves too incestuous, external reviews should be encouraged. To promote learning, both types of review should be published, widely distributed and discussed at the system level.

In advocating and promoting ropeways as a sensible alternative for transportation in the hills of Nepal, it is hoped that the critical self-evaluation that this book provides will stimulate Nepal's development community, which includes government departments, aid agencies and academics, to take a fresh look at this technology. An early entrant in this venture was USAID, which enjoyed some success in constructing ropeways in the early sixties before it backed out of infrastructure building to take up the software aspects of development. Without constant engagement in such a specialised venture as ropeways in its various phases, its difficult lessons are not learnt and concomitantly the capacity to use them is not built. While planning its various rural development activities in the 1980s, USAID did not consider ropeways in part because the technology's broad supporting context of specialists and institutional memory had disappeared. Today we see that *gaun-besi* ropeways could have complemented the highways and feeder roads of any integrated rural development package in the region from Rapti to Mustang but they did not.

A similar learning disability seems to have been shown by the French, who tried to help rehabilitate Nepal Ropeway (Chapter 5) and by the EU as well, to whose credit goes the Bhattedanda Milkway. While is not known whether the EU conducted the kind of critical self-evaluation that Christensen and Koukios call for, Chris Patten did voice strong support for extending the project deeper into the hinterlands (Chapter 8). Unfortunately, this much desired support does not seem to indicate that an introspective evaluation, which went beyond the regular techno-economic concerns into institutional issues, was carried out. As the drama of the collapse and subsequent revival of the Bhattedanda Milkway described in the case study indicates, the sustainability of such an innovative venture depends on the capacity of local people to take initiatives to tackle issues beyond the functioning of the equipment as per its design. Inculcating the seventh virtue requires a rethinking of local development institutions, their composition and their roles.

ROADS, ROPEWAYS AND SYMBIOSIS

The debate about sustainable transportation has to begin by reflecting on the fact that both roads and ropeways are what is nebulously called 'infrastructure'. By its very nature, infrastructure is something that is felt by the society at large to be a much-needed item but cannot be justified, at least in the initial stages, as commercially feasible. This is because there is an 'economic externality' involved in infrastructural artefacts: the costs incurred and the benefits accrued cannot be reflected in the market prices of different economic actors. There are other more technical names to describe this anomaly: 'social overhead capital', 'the underlying capital of society', or even the Marxian concept of 'base versus superstructure'. These are all terms which capture the idea that transportation infrastructure and its economics lie under everything we do.

Infrastructure provides a wide range of benefits that often cannot be fully assessed in order to extract a fair tariff from those provided with its services.[5] Due to this externality, there is a need to tax activities that result in losses (environmental, social, national security, etc.) and to provide subsidies to activities that promote the welfare of and help maintain harmony in society. This factor drags infrastructure into the politics of competing choices among different values in a complex society. To understand the larger political economy of rural transportation, which includes ropeways, it is important to address not just costs and benefits that can be measured but also those benefits, such as environmental and rural wellbeing, that cannot easily be quantified but which really count for the people. The following quote captures the dilemma of applying the logic of pure economic efficiency to a Third World rural situation:

> *All other things being equal, peasants respond to prices. The problem is, all things are rarely equal in the Third World. …It is now clear that farmers will not respond to price increases unless they have access to a good transportation infrastructure: better prices mean nothing to those farmers if they cannot get those products to the market. In addition, farmers need input that may not be available on a free market. Among these are affordable credit, cheap land and labour, and subsidised seed and fertiliser. (Rapley, 2002)*

Weizsacker (1994) describes how this dilemma has been addressed in the developed economy of Germany and how sensible future development needs to be conceptualised. He argues that the market economy makes no sense without transport since it is transport that brings competing goods and services to customers as well as customers to goods and services. Over decades, indeed centuries, much has been invested in developing the package of artefacts that make up the transport infrastructure of Germany and other western European countries. These physical pillars include railway networks, autobahns, electrical systems and the industrial capacity to manufacture vehicles. Social support comes from research and administrative competence provided through universities and research laboratories that ensure the smooth operation, replacement and improvement of road and vehicle technology. Today, Germany's road and railway systems are well developed and the debate, thanks to public awareness about greenhouse gas-induced global warming, has turned toward the hidden environmental costs and energy efficiency of these two transport modes. The reason for dwelling on this point is because of its relevance for Nepal when we compare roads and ropeways, Nepal's rail equivalent.

Weizsacker's research shows that, in terms of primary energy consumption per kilometre, a road-based system is less efficient than a (mostly electric) rail network by a factor or three or four (See Table 14.1). Furthermore, there are large hidden subsidies to roads which railroads do not get. For instance, railways (especially under new privatisation schemes) are expected to pay full price for fixed costs, whereas for roads (and especially for the vehicles driven on them) there are all types of tax and compensation benefits that actually pay for owning a car and driving additional kilometres. This hidden subsidy is responsible for the perverse situation that the Western world faces today: for many food items sold in big city department stores, more energy has gone into transporting them (mostly by petroleum consuming road freight vehicles) than the calories in the food itself. Lettuce imported to London from Los Angeles, for example, requires 127 calories of fuel for every calorie of food. Iowa State University researchers have shown that fruits and vegetables travel an average of 2,500 km within the United States from the farm to the dining table. In 1997, the UK exported 270 million litres of milk but also imported 126 million litres; this paradoxical exchange contributed significantly to the nation's 'food miles'.[6]

In order to shift to a more sustainable model of prosperity, Weizsacker argues that the meaning of 'productivity', which has remained conceptually stuck with the

TABLE 14.1: Comparison of energy consumption and CO_2 emissions between roads and railways for passenger and freight transport

	Carrying passengers (PJ per 10^9 passenger-km)	Carrying freight (PJ per 10^9 freight tonne)	Emissions (kg CO_2 per 10^9 freight tonne)	Damage from accidents (10^9 DM)	Damage from air and noise pollution (10^9 DM)	Environmental damage from construction (10^9 DM)
Road	2.10	2.60	1.40	46.00	15.00	19.50
Rail	0.50	0.30	0.05	1.00	0.50	12.00

Note: PJ = Peta (10^{15}) Joules = million GJ; DM = Deutschemark *Source: Weizsacker (1994)* early Industrial Revolution definition as 'an increase in *labour* productivity', needs to be redefined. This is because it has increased by a factor of twenty since 1850 and has already peaked; further gains are likely to be only marginal. What is now needed to meet the challenges ahead for humanity, he argues, is '*energy* productivity', which can improve by a factor of two with simple measures, by four with considerable effort and by up to sixteen times with significant political commitment. Furthermore, he argues, increases in energy productivity are politically and economically viable if they are designed with the large and mostly ignored informal economy of the Third World rather than industrial use in mind.

The idea of addressing the transport needs of the vast informal economy of the Third World has special relevance for the development of ropeway technology in Nepal. Whatever access villagers in Southern countries have had to markets has been due to cheap dirt roads and equally cheap two-stroke engine vehicles. This technological combine has allowed swathes of geographical space, dubbed the *desakota* region by some scholars,[7] to be occupied by a population that is neither fully rural nor wholly urban. Improving efficiency in this area, or targeting investments to develop transport on the basis of renewable energy, would translate into globally significant macro-economic gains in trade as well as reductions in carbon dioxide emissions. While the nature of Nepal's database does not allow for conducting an exercise similar to Weizsacker's for Nepal, we can compare the technologies of roads and ropeways to derive a picture of what a prudent macro-economic policy in this sector might look like.

Nepal remained almost a roadless country until the early 1950's and even today, many hamlets and communities are several walking days from the nearest roadhead. In the last 50 years, the country has developed a network of about fifteen thousand kilometres of roads (Chapter 2) that connect Kathmandu to major district headquarters and district headquarters to each other and to external markets. Seventeen out of the country's seventy-five districts, to say nothing of the hundreds of hamlets in the villages of these districts, still do not have a single road. Even in districts that do have roads, it takes a villager several hours of climbing up and down steep terrain to reach them. Many villages in the hinterlands of highways or their feeder roads will never have cars rolling up to their doorsteps. Roads to many hamlets are just too expensive to build, too difficult to maintain and near impossible to replace if a major landslide were to carve off a section of the hillslope.

The only hope of villagers in such places is a technology such as the short-haul Bhattedanda or Barpak *gaun-besi* ropeway that is cheap enough for villagers to build and operate. The road to Bhattedanda, for example, serves a few thousand farmers. For the tens of thousands in Bhattedanda's hinterlands, this road is inaccessible; moreover, there is no possibility of feeder tracks being built to connect them in the foreseeable future. Without this infrastructure, hinterland farmers will not be able to make the transition from subsistence farming to cultivating high-value crops or to take advantage of the market by engaging in the development of small-scale enterprises.

Are ropeways an alternative to roads, and if so, how do they compare? The chapters in this book indicate that the underlying ethos in the above question is itself wrong. Nepal's history of introducing long-distance, multi-stage ropeways under government tutelage shows that such ropeways have not been able to compete with national highways. Roads, or rather the vehicles that ply on them, allow more flexibility to users in terms of time allocation, the shape and volume of goods to be transported, as well as a choice in making intermediate stops. On the other hand, recent successes with short-haul village ropeways demonstrate that, at the local-scale, it is roads that exhibit technical and institutional rigidity while ropeways show significant flexibility.[8]

Flexible technologies improve the risk resilience of villagers, while inflexible ones render them vulnerable. The correct answer to whether or not ropeways are an alternative to roads is that ropeways occupy an important niche between porters and highways, and that they complement—but do not replace—highways and major feeder roads. They do not rob porters of their livelihoods but support their efforts by reducing drudgery. It is only over the steepest stretches that ropeways are installed; porters are still needed on flat stretches. In fact, more are needed when economic activities promoted by ropeways are intense. *Gaun-besi* ropeways make a trunk highway much more economic by opening and serving the deep hinterlands. They are an important alternative to building roads over difficult terrain to isolated villages or to mountain project sites with low population density and little future economic activity. They help remote communities end their isolation and increase their commercial transactions with external markets.

Road building in the Himalaya is an expensive activity. Table 14.2 shows that even the cheapest hill 'green road'[9] costs twice as much per kilometre as a ropeway (which our case studies show cost about Rs 1.5 to 2.0 million/km), and that normal, single-lane gravel roads cost four times more. One has to consider the additional fact that the distance between two points in the hills is, in the case of a ropeways, almost as the crow flies whereas for serpentine roads is, on average, three times longer. Furthermore, the cost of a ropeway includes the cost of carriers while the cost of a

TABLE 14.2: Cost of constructing and maintaining hill roads in Nepal

S. N.	Type of road	Construction cost [10^6 Rs/km]	Full cost of maintenance [10^6 Rs/year]
1	Single-lane metalled	12.50 - 15.00	2.00 - 3.00
2	Single-lane gravell	7.00 - 8.00	1.40 - 1.60
3	Green	3.00 - 4.00	0.60 - 0.80

road does not include the cost of the vehicles plying on it. This means that the initial investment cost of making a hill hamlet accessible to a market by a road could be six to twelve times more than the equivalent cost of installing a ropeway.*

As with the cost of initial investment, the cost of road maintenance in the Himalaya is also much higher than it is in other areas of the world. The steepness of the mountains, the fragility of their geology, and the intensity of monsoon cloudbursts all take a heavy toll. The DoR has a 'rule of thumb' understanding that proper, 'deluxe' or 'full' road maintenance constitutes annually about 20 per cent of the overall capital investment especially, in years of heavy monsoon rainfall.[10] The actual cost can be much higher, ranging from over half a million rupees per kilometre for green roads to almost three million rupees per kilometre for metalled highways.

DoR classifies road maintenance into six categories: routine, recurrent, major, periodic, and emergency. Routine maintenance includes general works such as the cleaning of side drains and shoulders and the removal of any obstruction using manual labour.[11] Recurrent maintenance comprises patching potholes and repairing side drains, retaining walls, railings and shoulders. Major repairs include the construction of retaining walls, off-road catch drains and check dams, as well as surface correction. Periodic maintenance is carried out every five to seven years and includes resurfacing and reconstructing structures. Emergency maintenance is often carried out after disasters such as landslides and floods.

The allocated budget is never enough to carry out all the required maintenance activities or to achieve full maintenance. Nepal is far from meeting the initial capital cost of building roads; it expects this money to come as aid or loans. This expectation contrasts sharply that in Switzerland (Chapter 1); where the entire national highway system is funded through a retail tax on petroleum that doubles its price.

To defray some of the cost of maintenance, tolls are collected along certain stretches of roads in Nepal. However, there is no well-established government policy of raising funds for maintenance from the use of a road itself, and the amount of money currently generated is too little. For the Prithvi Highway, along the 84 km stretch between Naubise and Mugling, for example, a toll of Rs 25 and Rs 35 for light and heavy vehicle respectively has been imposed. The amount collected over six years is shown in Table 14.3.[12] The average expenditure works out to approximately Rs 0.18 million per kilometre, which is much less than the DoR's estimated requirement for minimal maintenance. Beyond Mugling to Narayanghat and Pokhara, the government has to allocate additional resources directly from the central coffers even for routine

* The estimate is for ropeways that carry goods. If designed to carry passengers as well, a ropeway would still be three times cheaper to construct than an equivalent road. The cost of a ropeway is also highly site specific.

TABLE 14.3: Road tax collected

Year	Amount (Rs ×10^3)
1995/96	15,732
1996/97	14,989
1997/98	14,705
1998/99	15,380
1999/20	15,560
2000/01	29,962
2001/02	20,093
2002/03	20,941

Source: Roads Board, Nepal. Figures rounded to nearest thousand.

maintenance. The Mugling-Narayanghat Highway, which was damaged in the monsoon of 2003 and suffered severe problems during its rehabilitation, highlights the fundamental challenge that road building faces in the Middle Hills of Nepal.

The lack of funds results in poor quality maintenance and a resultant decline in quality. Most roads deteriorate in five to ten years. Seriously degraded stretches cannot be repaired without external assistance, especially when they are damaged by landslides or river cutting. To generate the resources needed to maintain a paved road properly, which includes resealing it every 5 years, about 900 to 1,100 vehicles must drive on it each day and pay a fee of Rs 25 or more. This is because, in order to comply with the local self-governance requirements, users (i.e. DDCs) themselves must fund the maintenance of feeder and district roads. If a heavily trafficked national highway such as the Prithvi Highway requires additional government funding to cover its maintenance costs, what possibility is there that the users of small infrequently traversed roads can meet those costs?

The annual routine maintenance of a gravel road, which does not include major repairs to structures damaged by landslides or slope failure, costs about Rs 22,000 per kilometre. Routine maintenance of the eleven-kilometre gravel road in Bhattedanda connecting Tinpane with Chhabeli (Chapter 8) costs about Rs 242,000 per year. This amount can be generated if 26 vehicles use the road each day and pay Rs 25 per trip, the same amount charged to travel on Prithvi Highway. The actual number of vehicles which traverse this rural road daily, however, is just five to ten. Clearly, poor hill hamlets by themselves cannot afford even the most basic upkeep of the roads that connect them to towns.

In addition to high cost of maintenance, roads invite other problems, too. Once a road connects a village to the market, it is outsiders who begin to operate trucking services because very few, if any, local entrepreneurs have the capital, knowledge or skills necessary to do so. Truck owners then monopolise transportation services and fix fares and schedules to suit themselves. Villagers have to pay to keep truck drivers and owners happy if they wish their goods to be transported. Outsiders thus siphon off the hard-earned money of villagers; and farmers, who are the actual road users, lose out. It is often argued that a road provides market access to agriculture products and, as an obvious corollary, helps farmers earn more. But this simplistic economic expectation is undermined by the harsh reality of a village road's political economy. In their conventional implementation, roads, ostensibly planned to help farmers, in reality, end up hurting them economically.[13]

Ropeways, on the other hand, if properly planned, enable villagers to take advantage of the market rather than the other way around. The type ropeway we discuss and advocate in this volume—the *gaun-besi* ropeway—will not replace roads but exploit them more fully by increasing traffic to and from remote hamlets. Ropeways are cheaper to build and maintain than roads are. The operators of the schemes described in the case studies calculate that the annual costs of simple maintenance (which includes greasing, tightening and cleaning) amount to no more than one per cent of the capital costs. The cost of full-scale operations, maintenance and insurance against natural disasters is estimated to be between five and ten per cent, a figure which compares very favourably to that for single-lane gravel roads built in the hills.

Besides these financial advantages, *gaun-besi* ropeways also demonstrate significant macro-economic advantages in terms of Weizsacker's 'energy productivity' concept discussed above. While it is difficult to duplicate for Nepal the exhaustive analysis shown in Table 14.1 for Germany (primarily due to the absence of equivalent sets of data), the case studies do indicate that Nepal would enjoy a national energy advantage if it used ropeways. The Hetauda Cement Factory saves two million rupees annually by using its industrial ropeway instead of trucks (Chapter 7). The case study that comes closest to making a reasonable comparison between the two transport modes is that of construction ropeways (Chapter 6 and Annex A).

In constructing the Khimti Hydroelectric Project, a two-kilometre ropeway (capable of being dismantled and used elsewhere) was chosen over an eight-kilometre road. Taking the 22,000 tonnes of goods carried per year of construction as the benchmark, the cost per tonne (including construction as well as operation and maintenance) was three times cheaper for the ropeway (Rs 459) than for the equivalent road (Rs 1,387). The energy cost of the ropeway—to run a 77-kW motor eight hours a day for 340 days a year—was 9.5 kWh per tonne, which is about 34 MJ per tonne of goods transported. The energy equivalent for transporting the same amount of goods by road—with five trucks operating 10 hours a day consuming two litres of diesel per hour—works out to 53 MJ/tonne. This suggest that transporting goods by ropeway is almost two times more energy efficient than transporting them by roads.

The corresponding result for Weizsacker's study of Germany is that electric railways are eight times more energy efficient for freight and four times more energy efficient for passengers than road transport. The higher efficiency results for Germany may be due mostly to economies of scale. This logic implies that the more Nepal transports goods by ropeways instead of roads, the greater the nation's overall energy efficiency will be. It is difficult to carry out a similar comparison for the other case studies presented in this book since neither the type of goods nor the roads and ropeways are readily comparable. In any case, certain issues need to be factored in, especially when discussing national policy, if convincing comparisons are to be made. They are discussed below.

Conceptually akin to the idea of 'food miles' discussed above is the fuel needed to lift goods from the *besi* at point A (e.g. Rangrung) to the *gaun* at point B (e.g. Barpak). Fuel has to be transported to point A from afar, a process that in itself requires a lot of energy. That source is the fuel depot in Amlekhgunj for energy within Nepal, and Barauni, India, or the Gulf countries for energy outside of Nepal. The energy used to power the Barpak Ropeway, however, is produced in Barpak itself. When these hidden costs are included in comparative equations, the energy efficiency of a ropeway economy becomes even more attractive than that of roads.

In comparing roads to ropeways, it is essential to analyse rough equivalents, e.g. *gaun-besi* ropeways should not be compared to highways and the flexibility and diversity of traffic they cater to but instead to single-lane gravel or green roads. While metalled highways do provide greater flexibility than small ropeways, properly-operated green roads do not have those benefits. Movement on green roads is restricted: there can be no heavy vehicles at any time and no vehicle movement at all during the rainy season. If these restrictions are violated, their maintenance costs shoot up dramatically. This inherent limitation is an important factor in the comparison, because, except during squalls, ropeways are not put out of commission during the monsoon. Furthermore, in calculating total costs, the costs of vehicles and energy are internalised in the case of a ropeway but external in the case of a road. For the former, one 25-kW MHP can operate eight to ten (or more) hours per day lifting goods from Rangrung to Barpak. For a road, there would have to be several vehicles, each of, say, 60 to 90 kW, operating on a stretch of serpentine green or gravel road connecting the two places. Should not such material limitations of a technology be factored into the overall planning analysis?

Another key issue is the period of rural development, which begins with ropeway installation and continues until the ropeway's goods-carrying capacity is exhausted by increased demand. When that happens, the ropeway will have paid for itself several times over. In the case of a road, however, even when the volume-of-goods transport flow which would overburden a ropeway is reached, the volume of traffic will still not generate enough money to meet maintenance costs.[14] The limited number of case studies show that this time is much shorter for ropeways. This comparison points to one of the most important lessons of the case studies and this book: *gaun-besi* ropeways are a *prelude* to roads, a transport planning complement which would herald road construction only if the traffic of goods and the local economy reached a point that would justify it.

SOCIAL CARRIERS

Introducing a ropeway into a village that has never used such an artefact is not merely a technical problem but also a significant social challenge. One main reason ropeway technology has not become an indispensable part of the Nepali economy is that no one has ever tried seriously to introduce it. Who should try? And what are the social and political factors that govern the diffusion of this technology? Businessmen will not become ropeway entrepreneurs unless proper rules and regulations and infrastructural support are in place to encourage them to invest. The government could invest, but has not. It is simply an administrative institution that responds to the political pressures of the day: it does not have the visionary or missionary urge to propel it in the direction of innovation. If the government by itself is unlikely to provide a conducive environment for ropeway development and the private sector is hesitant to take risks, who will?

The vision of ropeway technology in Nepal needs to be promoted, pushed and implanted into various levels of decision-making by social catalysts motivated by long-term, altruistic concerns such as social equity, sustainable energy policy and environmental justice. There is a dire need for joint ventures of visionaries and risk-taking entrepreneurs in the sector of new and alternative technologies because no technology can embed itself in a society without an appropriate social carrier. The problem lies in identifying who are, or could be, the social carriers of ropeway technology in Nepal and what challenges they will face. Cardwell (2001) articulates the problem clearly:

> *At the heart of technology lies the ability to recognise a human need, or desire (actual or potential) and then to devise a means—an invention or a new design—to satisfy it economically. Having done so, the model or prototype has, usually, to be scaled up and adapted to becoming a marketable item. The process of turning the full-scale product into something that satisfies market requirements of safety, cost/profit effectiveness and customer acceptance is a difficult one. … The public have to be told about the new invention and, having been told, to be persuaded that it is worth having. This is not easy: old habits, old loyalties have to be disposed of, fears have to be allayed, the protective conservatism and inertia of most people have to be overcome.*

Cardwell goes on to argue that a basic requirement for a technology to progress is that people be receptive to new ideas and inventions, from whichever quarter they may come. Europe's great inheritance was Roman law, a rational system of thought consistent with the ethos of science, which helped shape the character of Medieval Europe after it was freed from the rule of religion. Indeed, it was rules governing property rights, commerce and insurance, together with a guaranteed minimum degree of individual freedom for all to travel, to learn, to change jobs, to experiment and to invent, which enabled entrepreneurs to invest in the development of technology. Invention also requires a suitable system of training and education in order to supply the skilled technicians without whom there would be no technology.

A simple historical incident emphasises the need for an appropriate world view. After the Indian army built the Tribhuban Highway in the 1950s, Kathmandu Valley became accessible to vehicular traffic but it had no trucks. Interviews with old timers indicate that one member of the royal family, the second brother of King Mahendra, did eventually import twenty-five trucks to transport goods,[15] but then discovered that there were no Nepali truck drivers to be found. The drivers he hired were mostly Sikhs displaced from Pakistani Punjab after the partition of India in 1947. The single event of choosing a particular technology—trucks—was the most significant factor responsible for the growth of the small but diligently prosperous Sikh community which exists in Kathmandu today. Half a century later, truck owners and drivers from Nepali communities have replaced the Sikhs and form a strong political lobby in the transportation sector.[16] The popularity of hot-water solar panels and biogas plants in Nepal offers another instructive lesson. In the 1970s, the Swiss appropriate technologist Andreas Bachman, who worked in Balaju Yantra Shala, helped promote the skill and capacity of local Nepalis to design and construct both these technologies. Gradually the market took over, and solar panels now dot Kathmandu's landscape. Similarly, the promotion of biogas plants in Nepal is largely a market-led venture, pushed by social catalysts both Nepali and foreign.[17]

What the above stories indicate is that behind every technology choice, a constellation of forces, each with its own set of interests, is at work. These forces generate their own pressures on the body politic and precipitate their own set of wholly unforeseen consequences. This section of our essay develops the argument that ropeways have to be approached, as other new technologies have been, from a 'social-construction-of-technology' perspective. One obvious set of social carriers of this technology is industrial interests, who would find in ropeways new avenues for expanding their market for the provision of goods and services. These include, as mentioned before, the micro-hydro and rural electrification industry as well as the suspension bridge profession.

Other social carriers might be innovative hoteliers who have identified scenic hilltops as sites for constructing resorts or meditation centres that value aesthetically pleasing but isolated surroundings. Their objective of preventing free-for-all, haphazard growth is met better by the restricted access that ropeways provide than by roads. Government agencies such as telecommunication, radio and TV stations, meteorological or space observatories as well as the army need to locate themselves at strategic vantage points that are not frequented by mass commercial interests. These agencies, too, would be ideal social carriers of ropeway technology as if they are a single purpose user of a hilltop site, it would be prohibitively expensive to build a road and practically unjustifiable financially in view of the limited national budget.

The numerous porters in Nepal who live a life of drudgery, carrying goods either commercially or for themselves, would also welcome ropeways introduced to save them from backbreaking climbs. It is estimated that at any one time on a non-monsoon day more than three million people are walking the trails of Nepal Himalaya carrying some kind of load.[18] Even securing daily necessities like drinking water and carrying out essential tasks like grinding corn entail uphill-downhill trudges. The hope of finding a partial solution (because fully obviating the need for portering is impossible) to such drudgery would turn villagers into supporters of ropeways. Ropeways would not do away with portering altogether—as helicopters have done —but would complement porters' efforts only in the most labour-intensive and time-consuming sections, the steepest stretches referred to in rural Nepal as *mutu phutne ukalo* or *naakai chhune bato*.[19] Porters, however, are an amorphous group who by themselves, are unable to catalyse change. Since porters have been marginalised and rendered fatalists by the market and the political processes in Nepal, not until activists organise them into a coherent voice will they have the collective strength to bring about change.

To catalyse the interests of the fatalistic masses as well as of potential investors, what is required are NGOs and citizen-based groups who work for rural development and for whom alleviating the drudgery of rural life and securing better market access for rural produce are prime concerns. If a proper coalition is formed among civil society, ropeway entrepreneurs and enterprises engaged in electrification and tourism, the ropeway as an industry could be championed in Nepal. Advocacy by such a coalition would include lobbying the government to introduce laws conducive to ropeway promotion, building a suitable institutional support mechanism with banks, and redefining the meaning of national interest in transportation as comprising clean energy provision and foreign exchange savings.

What are the difficulties an NGO which promoted ropeways would face? Bijker (1997), in his analyses of the developments of the ordinary safety bicycle; bakelite (plastic), which revolutionised the insulator industry; and the fluorescent tube, which transformed the lighting industry, argues that the success of a particular technology is determined by the social construction of that artefact. He asserts that a technology is successful not so much because it 'works' but because it has been accepted by 'relevant social groups'. Furthermore, before that can happen, a certain pattern of interchange has to be established among a technology, its inventors or promoters, and the society at large that has to internalise it. Technological change is as much a social process as a demonstration of mechanical proficiency; a successful engineer is also an economic, social and political wizard.

In considering the means to promote ropeways, it is instructive to use Bijker's framework, which is part of what is known as 'social-construction-of-technology' studies, to understand how an artefact becomes a successful technology. Bijker argues that the character of technical development is trial-and-error and evolutionary rather than instrumentalist and goal-oriented. Technological change is a social process permeated with the politics which economic power entails. Because various factors have to coalesce if an artefact is to be embedded within a society as a valuable technology, its introduction entails an element of uncertainty. One cannot be completely sure that its benefits will accrue primarily to the targeted group. Just as a technology can be used by the powerful to further their interests, it can also be exploited by the less powerful. A good example is how environmentalists use scientific data and the Internet to champion their cause. Similarly, space research has produced new material and equipment that have been found useful in fields as diverse as hospital care and mountaineering. Part of the social construction of technology is the ascription of multiple meanings to it, meanings that acquire stable connotations only after a period of social engagement.

Bijker asserts that introducing any technology entails an ensemble of relevant social groups that see themselves as benefiting from or being marginalised by that technology. If these opposing groups enjoy 'interpretive flexibility,' a kind of socio-technical democracy, they begin to give meaning to the artefact in their own ways by defining new uses for it. Even those who would, in a straightforward design sense, be marginalised by the technology look for new ways to cope with its introduction. Over a period of time, 'closure' is achieved as a consensus emerges about the dominant meaning of the artefact. An example in Nepal is the two-wheeled tractor (also called a power tiller) designed by the Japanese as a practical answer to the mechanical ploughing of narrow terraced fields. Over a period of time, Nepali consumers of this technology changed its use: the mini-tractor, instead of replacing bullocks for ploughing, has become ubiquitous as a goods-transporting taxi, especially in small cities like Bhaktapur.[20]

A similar redefining of the meaning and purpose of a technology by grassroot users can be seen in Western India's hard rock areas, where diesel pumps are used to pump groundwater. While engineers and loan giving agencies insist that threehorsepower (HP) pumps are sufficient, farmers insist on buying (irrationally, in the view of the planners) ten-HP machines. Further investigation, however, has shown that in actuality, farmers are far from irrational: they use the over-capacity equipment for a few months to pump groundwater, but during the rest of the year, when irrigation is not required, the machine is slightly modified and fitted onto a makeshift chassis to become a perfectly functional (and unlicensed) rural truck.[21] Users, it seems, turned out to be their own planners and economists better than their formal, urban counterparts were for them.

In our case studies of different ropeways, one issue that has not, and will not in the immediate future, achieve closure is whether ropeways should be used to carry goods or people. Since passenger ropeways demand a higher safety factor, and hence are more costly than goods-carrying ropeways, planners and designers familiar with Nepal's rural poverty argue against building them (Chapters 10). Users in Nepali villages, however, have a different idea (Chapter 12). They assess their personal risks in, and benefits from, riding a goods-carrying ropeway with respect to traditional *ghirling* and judge them to be no more risky. Both in Barpak (Chapter 9) and in Bhattedanda (Chapter 8), users have found the risk worth taking and, despite protests by managers and engineers that goods-carrying ropeways are not designed for passengers, enjoy the effortless ride up to their villages anyway.

The answer that may emerge with the closure and stabilisation of ropeway technology in Nepal perhaps will be a hybrid: ropeways may need to incorporate both passenger and goods transport functions. Such solutions will require major design as well as operating procedure innovations by the entrepreneurs who promote ropeways. Bir Bahadur in Barpak (Chapter 9) has already been forced to innovate: he introduced restrictive procedures like higher prices for passengers and the signing of risk disclaimers. When his damaged ropeway is repaired, how to accommodate the demand for passenger services is bound to be his primary design question for the hardware experts as well as the management gurus.

Bijker argues that the closure and stabilisation of a technology happens as the dominant meaning of an artefact emerges and the 'pluralism' of other possible values to users decreases. It results in its achieving fixity of meaning, which in turn reflects the playing out of power within the 'technological frame' of the 'socio-technical ensemble'. For the safety bicycle, closure and stabilisation even required an act of parliament to decree that the bicycle was a means of 'carriage' and hence entitled to a place on the road. Bijker's 'technological frame' is analogous to the 'paradigm' of Kuhn (1970): it refers to the set of current theories, tacit knowledge and design methods as well as to users' practices and to the substitution functions that those engaged within the ambit of the technology see as problem-solving. This structural environment, in which the further development of the artefact will take place, is where economic and political negotiation among relevant social groups occurs.

In the resultant dynamic interplay, there is initially no single dominant group, no single or identification of the problem, and no single structuring of a solution. Resources are available to a range of actors, all of whom pursue different innovations, modifications and uses. Over time, one dominant group is able to insist that its definition of both the problem and its solution be accepted. This group will also control many of the resources which society allocates for improving the technology and for further problem solving. In the late 1940s, when Toni Hagen (Chapter 1) reflected at the fork in the transport development path in Nepal, the sector still enjoyed 'interpretative flexibility' and Nepal could have had more ropeways and hydropower and fewer roads and oil imports.

Unfortunately, the scale tipped in favour of roads, thereby marginalising the ropeway and its development. Reversing the process today means fighting what Bijker calls the 'obduracy' of entrenched road technology. That battle will have to be spearheaded by what he calls 'low inclusion engineers', often a younger lot who are still willing to question the basic socio-technical frame, identify presumptive anomalies and enrol new social groups to politicise technological choices.

Other scholars who study the introduction of new technologies make similar arguments about the importance of recognising the social construction of those technologies if they are to be successfully embedded among users in a society. McLaughlin *et al.* (1999) describe how management notions of identifying user needs and incorporating them into technological systems bear little relationship to the contingencies, variations and cultural mediation that users introduce during final implementation. Systems could not be black-boxed during the stabilisation process because users repeatedly re-opened the artefact to explore new uses and interpretations not foreseen by planners and designers. Instrumentalist approaches to management, which are based on assumptions about an organisation's goals and mission statements, are translated and transformed at the level of the organisation's base membership. McLaughlin *et al.* recommend that considerable organisational labour—or investment in social software—be incorporated in securing the sustainability of a technology. This can be done by allowing end users to be actively involved in the process of embedding a new technology in the daily lives of communities or corporations.

Sachs (1992) describes the power of users in ensuring the success of one technology over another. In studying how cars conquered railways in Europe, he argues that the culture of the rising middle-class bourgeoisie reinforced a 'technological design gradient' which favoured individualism over common means. Thus, the cinema gave way to television, the laundryman to washing machines and the railway to cars. With the railway, the passenger was constrained by fixed schedules and routes, with the car, the *nouveau riche* felt freedom in space and time. They did not have to share the same space with the lower rungs of society, and enjoyed the additional bonus of a sense of speed.

Similarities exist between the predominance of the car with the large-scale growth of groundwater pumps in India. Access to groundwater reduces agricultural risk, which is particularly high in command areas where the supply of water by canals is not very reliable. Increasing reliability of canal water supplies requires the collective action of the upper and tail-end land owners. By using pumps, however, individual farmers, particularly wealthy ones, can begin the gradual process of agricultural intensification and accumulation of assets independently of others in the same realm of space and time. Innovative farmers, farmers with exposure to new ideas and sufficient land on which to test them (i.e. wealthy farmers) were the initial adopters of pumps despite declining water levels, pollution and other negative externalities. The net result is that groundwater irrigation is booming in India (despite severe environmental consequences) while surface irrigation systems are stagnating and experiencing large financial losses.[22]

In steps which reinforced the sense of independence among the new bourgeoisie in Europe, banks provided investment capital, governments embarked on infrastructure (highway, etc.) building, and designers raced to produce faster engines to cater to the increased demand. In Germany, the industry also took up a nationalistic anthem: if we don't race forward with the development of faster cars and better highways, our industry will suffer and the French industry will take over the abandoned market territory. The net result of the infrastructural support for the car by the state was the relative marginalisation of railways and the rending of the social fabric held together by foot traffic.

This transformation of the European landscape was made with much insidious social violence, but both before and after the transformation the society was, and remained, European. In other socially less-prepared cultures, cars have been described as 'Trojan machines' that force the people to subordinate themselves to unaccustomed time rhythms, to absorb an alien industrial work ethic, to accept increasing levels stress and to regard these changes as normal or even as 'progress'. Ullrich (1992) describes how, if cars are seen as exosomatic organs, they have to be considered together with their attendant infrastructural network of technical, social and psychological conditions, without which they do not work. He writes:

> *For an automobile to be truly used, one needs a technological infrastructure composed of networks of streets with petrol stations, refineries, oil wells,*

> *workshops, insurance, police and ambulance services, lawyers, automobile factories, warehouses for spare parts, and much more besides. And on the psycho-social side, one needs people who will conform to all the installations and facilities and institutions and who can function within them. And so one needs streets, conscientious petrol station and garage repair owners, and in general, the expert and diligent industrial worker, which in turn means schooling, disciplining and yet more schooling. Every industrial product like this brings with it its corresponding requirements and they can only function with their associated infrastructure and the psycho-social preparation of the people.*

In such a bewildering complexity of infrastructural and psycho-social conditions, how does one assess the value of a technology? We have tried, in a rudimentary way, to compare the values of roads and ropeways in the preceding sections, and have seen how riddled with uncertainty and risks the process is. The intrinsic uncertainty means that different protagonists—or different social carriers—can use different convictions and interpretations to bolster different cases. In such a contested context, Schwarz and Thompson (1990) use the Cultural Theory framework to deconstruct technology assessment. Their arguments reinforce those of Bijker, Sachs, Ullrich and McLaughlin *et al.* that the existence of social solidarities in addition to managers are crucial to the success of a technology. The four organising styles of Cultural Theory consist of the managerial hierarchy, the individualist entrepreneur, the critical egalitarian social auditor and the fatalist conscript. Each has its own view and definition of what technology means. The conclusions of Schwarz and Thompson are summarised below:

> *Cultural Theory, as we have seen, sets up a fourfold scheme of cultural pluralism, based on four distinct social contexts and their concomitant moral commitments and strategies. It is a pluralism, moreover, that is essential, in the sense that each cultural bias – towards market solutions, towards hierarchical solutions, towards egalitarian solutions, and towards fatalist acceptance – is not viable on its own. Individualists, for instance, need the hierarchists to enforce the law of contracts, the hierarchists need the fatalists to sit on top of, the egalitarians need the inegalitarian excesses of the individualists and the hierarchists to criticise, and so on.*
>
> *So this notion of an essential, but strictly limited, cultural pluralism can be used as a conceptual tool for recognising the divergences in social assessment—of technologies and policies—by those who make up the arena in which our technologies (along with everything else that makes the social world go round) are hammered out. We can visualise this four-fold scheme as a cultural overlay that can be*

superimposed on the sociale kaart so as to provide a deep explanation of where all the features on that map come from (and to alert us to the possibility that some may have been excluded). Our central argument is that, whenever a policy debate is characterised not just by technical uncertainty but by structural uncertainty as well, we should analyse it in terms of this cultural overlay.

Schwarz and Thompson argue that there is a need to resist superficial and patronising 'fixes' that treat structural uncertainties in the social embedding of technologies as merely technical. In the early stages of the development process, no one *can* know much about the outcomes and their uncertainties, but each social solidarity constructs its perception of risks and benefits in its own way. Schwarz and Thompson argue that the hubristic technology assessment that we have become used to needs correcting by introducing the idea of flexibility (or inflexibility) to cope with obstacles to sustainability when they cannot be fully anticipated. This means that, when there is a persistently polarised debate and an ominous clash of contradictory certainties among different social solidarities regarding the benefits or costs of a particular technology, it is important to search for those voices that have somehow been shut out of the debate. Unfortunately, these are often those of the silent users and the questioning social auditors.

POLICY ARENA

The ropeway lies in the blind spot of Nepal's economic planners and managers. If this policy myopia is to be treated, what remedies are needed? Nepal's small and medium hydro development sector has witnessed an intense debate that provides some obvious lessons. One of them is the role of the catalystic social auditor who contests policy terrain. The obduracy of road technology and its entrenchment in the transport policy arena suggest that change will not come from within that sector and that critique from outside is needed to force us to look at alternatives. The potential social carriers of ropeway technology in Nepal identified in the previous section need to be catalysed into action. The experiences highlighted in this book indicate that the task may be easier than imagined.

It is said that nothing succeeds like success, and the *gaun-besi* ropeway model has already demonstrated its technical and economic viability. This lesson should make the task of those promoting ropeways as an alternative much simpler; proposals that complement hill roads with powerful economic synergy should be easier to sell. Policy advocacy might need to be pluralised to match the similarly pluralised social terrain: each of the four social solidarities of Schwarz and Thompson's pluralised categorisation above needs a slightly different message and a different policy nudge.

The individualist market must be shown that there is profit to be made in this venture. Knowledge about successes must be disseminated to more 'Bir Bahadur Ghales' in different villages. And more village leaders should be made aware that the meagre funds that flow from the centre (HMG/N provides five hundred thousand rupees annually to each VDC) can be more effectively spent on ropeways than on ill-designed roads that get washed away in the very next monsoon after they are constructed. Another source of funding for rural development is found in districts where hydropower plants are located. New HMG/N hydropower policy, a result of the activist campaigns for alternatives in the aftermath of the ill-fated Arun-3 project, requires that ten per cent of HMG/N's royalties from electricity produced be siphoned back to the region and district which produces it.[23] Locals can probably be convinced to invest some of their own resources as well to establish ropeways if relevant industries come forth with pilot ropeway ventures. Successful examples such as Bhattedanda and Manakamana ropeways are more effective than mere exhortations alone.

Also catalysing entrepreneurs and leaders into action may be 'clean energy' groups which promote activities that fire the imagination. For instance, Bijker explained how the bicycle was stabilised as a technology when improvements in its utility and safety were counterpoised with bicycle races that caught the public imagination. The victory of the car over railways in Europe was also won in the minds and hearts of many with car races such as the Grand Prix. Similar is the story of the bicycle with races sponsored to cater to the individualist urge for competition. If, as Toni Hagen mentions, the Swiss Army could set up a Barpak-type ropeway in nineteen hours, would it be possible to have competitions (sponsored by Nepali and international ropeway manufacturers) to have competitions errecting modernised and reliable *ghirling* in the Nepal Himalaya? Might such publicity also attract the support of Nepal's village leaders, local politicians and the fatalistic masses, the drudgery-ridden porters?

Social auditors also need to catalyse the hierarchic government machinery to engage in alternative ways of thinking. In a country that is unable to recover even a portion of the normal maintenance costs of irrigation and highway infrastructure (to say nothing of capital recovery), any avenue that would lessen the burden of the government should be welcome. To avoid the environmentally damaging drain of foreign exchange to buy petroleum imports associated with road construction, it is sensible to promote *gaun-besi* ropeways fuelled by Nepali hydro energy. Table 14.4, which shows the sales of petroleum products in Nepal during the FY 2002/03, provides some insight into what a national commitment to replace non-renewable petroleum with indigenous hydropower would entail.

Less than a quarter of the country's population had access to grid-supplied electricity in 2004 even though more than ninety years has passed since the first hydroelectric power plant was built in Nepal. Grid expansion to scattered hill settlements is difficult and small hydropower plants do not have many productive end uses. Ropeways provide a powerful way to increase the productivity of isolated hydro systems (as well as of the national grid) and thus to assure that more Nepalis have access to affordable electricity. If the political actors in the country commited themselves to a renewable energy policy, then they could tax petroleum products with the express objective of building a fund for ropeways as well as small and medium hydropower development and rural electrification. There would be two fundamental assertions in such a move: first, it would be a concrete national commitment to developing the country's renewable hydropower to replace imported non-renewable petroleum; and second, it would signal the transfer of urban surplus to marginalised rural areas.

While the consumption of diesel in Nepal has declined in recent years due to Maoist-engendered violence and a transport slowdown, the consumption of both petrol and LPG has shown an annual increase of fifteen to twenty per cent. If a one per cent tax were levied on all petroleum products and the money allowed to accrue in a 'renewable energy replacement fund' that included other possibilities such as hydropower or rural electrification or ropeway development funds, the sum raised from consumption during the FY 2002/03 would amount to 255 million rupees. This is equivalent to the capital required to construct almost fifty Barpak or Bhattedanda type ropeways annually. If the government were heavily committed to a renewable energy policy and levied a five per cent tax on non-renewable petroleum products, a billion and a quarter rupees could be raised every year.

Another catalysing policy advocacy activity could be a study of metal and manufacturing industries in Nepal (as they pertain to MHP, *ghirling* and ropeways) in relation to past practices of sales and import taxes as well and to the new VAT. The

TABLE 14.4: Generating internal resources for replacing petroleum with indigenous hydropower

Petroleum product replacement tax	Unit	Sales in FY 2002/03	Retail price	Renewable replacement amount	
			Rs per litre; per kg of LPG	Rs $\times 10^3$	
				1 (%)	5 (%)
MS (motor spirit)	Kilolitre	67,456	54	36,426	182,131
HSD (high-speed diesel)	Kilolitre	299,973	31	92,992	464,958
SKO (super kerosene oil)	Kilolitre	348,683	24	83,684	418,420
ATF (aviation turbine fuel)	Kilolitre	52,840	33	17,437	87,186
LDO (light diesel oil)	Kilolitre	610	28	171	854
FO (furnace oil)	Kilolitre	14,502	24	3,480	17,402
Sub total				234,190	1,170,951
LPG (liquefied petrol gas)	Tonne	56,079	37	20,749	103,746
Total				**254,940**	**1,274,698**

Source: Prabhat 2060, Bulletin of the Nepal Oil Corporation, Kathmandu December 2003 and personal communication purpose would be to demonstrate the efficacy of value-added to Nepali skills by this proposed ropeway-MHP-suspension bridge combo industry if it is saved from double taxation. A Nepali entrepreneur who has invested in ropeways made this argument (Chapter 11). The Hetauda-Kathmandu ropeway proved to be very useful during disasters. If it is no longer needed for Kathmandu, would it be more useful elsewhere? One Nepali entrepreneur has, in fact, proposed to dismantle its different sections and use them in other parts of Nepal.[24]

One argument this book makes is that we need to re-think rural development in terms of accessibility rather than just in terms of roads built. Such a re-orientation requires that national plans and economic surveys describe rural population in terms of their access to markets. In addition to indicators such as health posts or teachers per thousand population, official reports should speak of hamlets as being so many hours away from markets. Such initiatives need to be actively pushed and promoted if they are to become even faintly feasible.

Unless someone pushes *gaun-besi* ropeways as a cause, changes are unlikely to occur. Despite the fact that ropeway technology came to Nepal in 1924, societal changes that would have created incentives for its growth did not occur and its use remained uninspiring and limited. The dominance of the centralised road transport sector was one reason ropeways did not take off. The road became the archetypal example of *koselee bikas*—something gifted from outside instead of fostered through local creativity catalysed by incentives for localised improvement in access. The use of ropeways as an end use of electricity also offers prospects for conserving the environment by creating avenues to minimise dependence on natural resources like forest products. This connection is evident in the case of the Bhattedanda Milkway. An arranged marriage between hydropower and suspension bridge industries funded through indigenous financing offers the opportunity to promote ownership, creativity and the invigoration of Nepali development efforts, which are currently stuck without a vision. Promoting ropeways that localise Nepal's development efforts may also help promote effective and meaningful democracy by correcting the imbalanced economic gradient in favour of marginalised rural hinterlands.

NOTES

1 These rates are based on Gyawali and Dixit (1996).

2 See interview with the Director General of the Department of Roads: 'Tarai will be less than two hours away,' *Nation Weekly* 25 July, 2004, Kathmandu.

3 Bitter battles are fought to ensure that a new road stops at one's village and goes no further, leaving all other villages beyond it as helpless trading hinterland. There are tremendous economic benefits for roadhead villages.

[4] Where the Bhattedanda Milkway was built was the region that saw the SinKaLama (for Sindhupalchok, Kavrepalanchok, Lalitpur and Makawanpur) Integrated Rural Development Project implemented in South Lalitpur, Barpak falls in the region where USAID implemented its Resources Conservation Utilisation Project (RCUP) in the early 1980s.

[5] One example in Nepal is how the value of land increases once a road passes through it. The cost of the road is borne by the government, but the profits from the high sales value of land and land speculation accrues to those who do not pay anything back to defray capital costs or even the cost of everyday maintenance. When the road to the Arun-3 Hydroelectric Project was planned, much land speculation occurred along the two proposed alignments. Land adjacent to the road had such high speculative value that it was sold by the *haat*, or hand length, even though no road was built in the end. See Gyawali (2003).

[6] See Kumar Venkat: Why 'Food-less-travelled' Is Better, *The Hindu Business Line*, Vol. 10, No. 342, 12 December, 2003.

[7] The term *desakota* is borrowed from Indonesian by scholars at the East-West Center, Hawaii, and means 'village-town'. In such regions, small farms need non-agricultural income to survive and sprout up mainly along the transport axes linking big cities with an intense mixture of agricultural and non-agricultural activities. See Norton Ginsburg *et al.* (1991) quoted in Gyawali *et al.* (1993).

[8] In assessing the technical and social indicators of inflexibility, we have used the criteria developed by Thompson (1994). The four technical indicators are 'large-scale', 'long lead time', 'capital intensive', and 'major infrastructure needs early on'. The corresponding four social indicators are: 'single mission outfits', 'closure to criticism', 'hype' (as in 'if we don't afforest Himalaya, Bangladesh will sink beneath the waves'); and 'hubris' (overconfident declaration that 'there is no alternative' or 'we have all the answers').

[9] Green roads are hill roads built without excessive cutting or dynamiting. The tracks are opened and widened slowly over a minimum period of three years to allow for the natural stabilisation of slopes. Allowing trees and other vegetative cover to grow over years is part of green technology. See Meyer *et al.* (1999)

[10] Construction and maintenance costs from personal communication with retired senior road engineer and consultant, Mr. Bam Dev Gyawali.

[11] The bare minimum routine maintenance of patching potholes, cleaning side drains, etc. is estimated by the DoR to cost about Rs 22,000/km.

[12] DoR collected roads tax from 1995/96 till 1999/2000. From 2000 onward, HMG/N's Roads Board Nepal has collected tax on roads with, it seems, a doubling the rate of collection.

[13] A good account of this drain from the periphery to the centre is provided in Blakie *et al.* (1980).

[14] There is often a lag time, of almost ten years between the time a road is built and the time farmers finally change their cropping pattern from subsistence to cash crops. See Gyawali *et al*. (1993)

[15] Personal communications with Huta Ram Baidya, Nepal's senior most environmentalist and the country's first agricultural engineer.

[16] They are able to assert their views through the Chamber of Commerce and argue against political forces calling for transport strikes. The Chamber's argument is that one day of strike results in a loss of one billion rupees. See *Spacetime Daily*, Kathmandu, 25 April, 2004. The chairman of the Narayani Transporters' Union argued against Maoist transport strikes, mentioning that such *bandhs* cost them fifty million rupees in Hetauda in the month of Jestha alone. See *Nepal Samacharpatra*, 1 June, 2004.

[17] The biogas programme is one of the more successful alternative energy programmes in Nepal. The *Biogas Newsletter* has been published in Kathmandu for over two decades and captures the achievements and various problems faced by this sub-sector.

[18] For a discussion of the drudgery related to portering and the helicopter controversy between Lukla and Syangboche due to the initiation of helicopter service, see Dixit (1996)

[19] Translations of the respective phrases: '*uphill climb so steep your heart bursts*' and '*a path so steep it touches your nose*'.

[20] For a discussion about the spread of power tillers in Nepal, see Biggs *et al.* (2002)

[21] Personal communications with Marcus Moench, who has studied groundwater in India in great detail.

[22] These dynamics are described in Moench *et al.* (1999), Moench, Dixit *et al.* (2002) and Moench and Dixit (2004)

[23] This amount has been raised to fifty per cent, twelve per cent to the particular district and thirty eight per cent to the other districts in the region. The new arrangement is stated in a letter from the Ministry of Finance to the Ministry of Local Development on 20 January, 2004.

[24] A Nepali entrepreneur Kumar Nath Uprety submitted such a proposal to His Majesty King Gyanendra on 15 Kartik 2059 but the current outmoded rules of HMG/N regarding capital asset management and the disposal of defunct pieces of equipment is so unnecessarily complicated that few officials care to accept the challenge. This is also something that Christensen and Koukios (1997) highlight in their Seven Sins.

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Annexes

ANNEX A

COMPARISON OF COST EFFICIENCIES OF KHIMTI ROPEWAY WITH AN EQUIVALENT ROAD

While constructing the Khimti Hydroelectric Power Plant, it was decided to use a construction ropeway instead of an equivalent road to the site. This decision was made primarily because of the difficulty and delays that would be encountered in receiving the required official clearance to use government forestland. As the calculations below indicate, however, the ropeway was also financially more attractive than a road. In comparing both cases, capital services are calculated at an interest rate of 10 per cent. The amortisation periods of trucks and lorries correspond to the average service life, as determined on the basis of experience. In general, the service life of a ropeway is longer than the assumed amortisation period. The amounts used for the calculations are based on actual costs.

A. Basic parametres	Khimti ropeway	Equivalent road
1. Length (m)	2,100	8,000 (approximately)
2. Height difference (m)	622	Same as ropeway
3. System	Bi-cable (to and fro)	Gravel, 8 to 10% gradient
4. Travel speed (km/hr)	7.2	10
5. Net loading capacity (kg)	3,000	-
6. Transport capacity (t/yr)	22,000	22,000 or (10.6 t/hr)
7. Vehicle type	-	Skip lorry or truck
8. Number of round trips by one truck/day	-	8
9. Load capacity/truck (t)	-	4
10. Tyres per truck	-	6
11. Number of trucks per hour	-	3 (10.6 t/4 = 3)
12. Interval between trucks	-	60/3 = 20 min
13. Number of trucks required on the road 16 km x 60/20 x 10 km/l	-	5 at loading 1 at unloading 1 in workshop 1 standby (total 8)
B. Service life		
	Only during construction period. Dismantled after that and used elsewhere. Hence service life is longer than amortisation period for well-maintained ropeways.	The service life of a lorry/truck is approximately 350,000 km or 14,000 operating hours if repairs are not to increase the operating cost beyond measure. Each truck travels 10 km/hr x 10 hr = 100 km/day x 310 days/yr = 31,000 km/yr. A truck must be replaced after = 350,000/31,000 = 10 yrs. The service life of tyres is 30,000 km. Subsequentially, trucks with six tyres will require the following: (31,000 km/year x 5 trucks x 6 tyres/truck)/30,000 = 31 tyres/yr

C. Investment cost (Rs)	Khimti ropeway	Equivalent road
15. Machinery and electrical equipment, including towers	18,359,200	–
16. Ropes	4,768,000	4,000,000 (8 trucks)
17. Construction work	10,000,000	80,000,000 (@ 10 mil/km)
18. Others	2,000,000	-
Total investment	35,127,200	84, 000,000
D. Operating and transport cost per year (Rs)		
19. 15 per cent interest on invested capital	5,269080	12,600,000
20. Amortisation of the road in five years (20 per cent of Rs 80,000,000)*	-	16,000,000
21. Depreciation of ropes and amortisation of the trucks @ 10 per cent of investment	476,800	400,000
22. Depreciation of plant and equipment @ five per cent	917,960	-
Sub total	6,864,000	29,000,000
E. Salaries wages and administrative costs per year (Rs)		
23. 1 foreman @ 5,000/month	60,000	-
24. 1 specialist @ 50,000/month	600,000	-
25. 6 trained workers @ 4,000/month (1 standby @ 8,000/month)	288,000 (96,000)	- -
26. Administration and management	104,400	54,000
27. 7 regular and two standby drivers @ Rs 5,000/month	-	540,000
Sub total	1,148,400	594,000
F. Energy costs (Rs)		
28. Motor power 77 kW, @ Rs 5 per unit (kWh), 8 hrs/day and 360 days/yr	1,100,000	-
29. Spares and consumable parts (excluding replacement cost of main rope) per year (lump sum)	1,000,000	-
30. Fuel (diesel oil @ Rs 15/l) 5 trucks x 10 hrs/day x 310 days/yr × 2l/h = 31,000 l	-	465,000
31. Tyres (Rs 8,000 each) 31 tyres/yr are worn out	-	248,000
32. Expenditure for various lubricants and lorry maintenance/yr	-	100,000
33. Road maintenance and repairs/year (lump sum)	-	100,000
Sub total	2,100,000	913,000
G. Operating and transport cost Rs per year (D+E+F)	10,112,400	30,507,000
H. Operating and transport cost Rs per tonne	459	1,387

* The service life of an earthern road can be taken as not more than five years in view of the high imposed loads. Regular repairs to damaged sections, particularly bends, are necessary.

ANNEX B

SYSTEM INFORMATION: HETAUDA CEMENT ROPEWAY

Distances between stations

Position	Distance (m)
Loading station (LS) to Pressure Frame Station No 1	939.73
Pressure Frame Station No 1 to Pressure Frame Station No 2	731.84
Pressure Frame Station No 2 to Track Rope Divide Station No 3	1,680.40
Track Rope Divide Station No 3 to Pressure Frame Station No 4	1061.63
Pressure Frame Station No 4 to Angle Station	1,122.16
Angle Station to Track Rope Divide Station No 5	1,784.78
Track Rope Divide Station No 5 to Track Rope Divide Station No 6	2,245.50
Track Rope Divide Station No 6 to Unloading Station	1,387.94

The length of the ropeway from the loading to the unloading station is 11,306 m and the difference in altitude between the loading and unloading stations is 275 m.

Line equipment

The technical specification of the ropes is as follows:

Loaded track rope:	52 mm Ø, full locked coil 150 kgf/mm^2, MBL-229 mt
Empty track rope:	34 mm dia., half-locked coil. 150 kgf/mm^2 MBL-98.1 mt
Hauling rope:	Ungalvanised 6 x 7, F.S. 24 mm Ø., FMC quality, 150 kgf/mm^2, right-hand Lang's lay, MBL-37 mt

ANNEX C

SYSTEM INFORMATION: BHATTEDANDA MILKWAY

Detailed cost breakdown (rounded figures)

S.N.	Items	Cost (Rs X 10^3)
1.	Equipment, driving station, pulleys and other major parts (imported from Austria)	4,000
2.	Steel rope (imported from India)	540
3.	Generator (imported from India)	196
4.	Towers (assembled at BYS, Kathmandu)	800
5.	Foundation for towers	500
6.	Bolts for towers (imported from Austria)	200
7.	Shade for stations	300
8.	(Tables, chairs, balances, etc.) and on-the-job training	200
	Total	6,536

Technical information		
1	Total payload	450 kg (including carrier)
2	Line speed	0-3 m/s (maximum 11 km/hr)
3	Horizontal distance	3010 m
4	Elevation difference	506 m
5	Support tower	Lattice type
6	Driving motor	Electric gear motor, 9.2 kW, 3 phase, 16.4 A
7	Power source	15 KVA generator, 3 x 440 volt/60 Hz
8	Communication system	Telephone (battery-operated magnetic phone)
9	Square tube for mounting sheaves	2
10	Number of towers	6
11	Maximum height of tower	18 m
12	Longest span between towers	1400 m
13	Number of carriers	One (wooden) (2.15 m × 0.85 m × 0.40 m)
14	Pretension of cable	Skyline: 40.8 KN (drive station) 37.0 KN (revolving station), Revolving line: 9.5 KN (drive station), 8.0 KN (revolving station), Telephone cable: 5.0 KN.
15	Electric control system	Frequency regulator and brake resister (pre-assembled).
16	Braking devices	Electric gear motor with auto brake, safety brake on main drive pulley and hand brake

17	Carrier location indicator	Mechanical position indicator
18	Rope (standard galvanised, light petroleum lubricated)	Skyline: 3300 m, ordinary lay to right: WS (1+6) + 6 (1+6), Ø 14.5 mm, calculated breaking load 171 KN. Confirming specification GOST 3060 Revolving line: 6500 m, lang lay to right 6 (7 + 1) fibre core, Ø 9.5 mm, calculated braking load 58 KN, Confirming specification GOST 3069 Telephone cable: 3300 m, lang lay to right 6 x 7 + (1+6) +1 fibre core Ø 5 mm, calculated braking load 16.6 KN. Confirming specification GOST 3069
19	Operating hours	6 AM to 11 AM
20	Transportation	Rs 0.50/l of milk; Rs 1.00/kg of other goods
21	Milk hauled (first year)	400-750 l of milk per day
22	Number of staff (operation and maintenances)	5 (managed by RUC)
23	Speed	3 m/s (takes 22 min end-to-end; the same distance takes 2-3 hrs to walk with a load)

ANNEX D

SYSTEM INFORMATION: BARPAK ROPEWAY

Type	Bi-cable to-and-fro ropeway
Inclined length	2.5 km
Horizontal length	2.3 km
Elevation difference (Rangrung-Barpak)	978 m
Number of towers	10
Tower type	single mast, 1.5 m section steel pipe
Tower height	9-12 m
Track rope diameter	16 mm
Hauling rope diameter	9.5 mm
Drive original VW petrol engine drive replaced by Rotor Wound Induction motor	26 kW (capacitor feeder (KVR) installed to account for starting current
Make	ABB, Norway

ANNEX E

SYSTEM INFORMATION: MANAKAMANA CABLE CAR

Number of passenger carriers	31
Number of freight carriers	3
Capacity	600 passengers per hour
Passengers per carrier	6
Incline length	3.02 km
Horizontal length	2.8 km
Vertical rise	1034 m
Average gradient	37.26%
Speed on line	6 m/s
Trip time	8.40 min (at max speed of 6 m/s)
Number of towers	20
Top station altitude	1302 m
Bottom station altitude	258 m
System	Monocable
Power requirement	800 kVA

ANNEX F

INITIAL FINANCIAL PROJECTION: MANAKAMANA CABLE CAR

Details	Cost (Rs X 10^3)
Total investment	389,214
Sources of finance	
Long-term loan	268,941
Short-term loan	3,324
Total equity of owners	116,949
Operating costs (100% capacity utilisation)	
Fixed costs	80,109
Variable costs	23,919
Revenue (100% capacity utilisation)	
Cable car service	183,845
Income from cafeteria	1,096
Financial and economic indicators	
Break-even point	50%
Return on investment (3rd year of operation)	22%
Return on equity (3rd year of operation)	47%
Payback period	4.75 years
IRR	27%
NPV (18% discount rate)	115,752,000
Proposed tariff (Rs)	200-300 per trip
Weighted average cost of capital	17%

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PHOTO CREDITS AND SOURCES

Cover photo	Toni Hagen/Bir Bahadur Ghale
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b. Bhattedanda	Gerold Muller
c. Nepal Ropeway	Kirtan Ram Bhandari
d. Manakamana Cable Car	Manakamana Darshan Pvt. Ltd.

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15. *Tar bato*	Eco-System Pvt. Ltd.
16. *Tar pul*	NWCF
17. NFF boat	RONAST

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About the Publishers

NEPAL WATER CONSERVATION FOUNDATION (NWCF)

NWCF is a non-governmental, non-profit and non-political organisation that conducts interdisciplinary research on interrelated issues that affect the use and management of water and energy. NWCF aims to promote the sustainable development, management and conservation of natural resources through generating and disseminating scientific knowledge to be used in informed decision making. It promulgates research findings through education and advocacy. Its specific focus is on capacity building, both of the upcoming generation as well as of disadvantaged groups, so that resources can be used without compromising the rights of either the future generation or non-human life. By building the capability of younger generations of professionals to analyse issues related to sustainable development, NWCF maintains a pool of interdisciplinary analytical expertise. NWCF publishes the interdisciplinary journal *Water Nepal*.

KATHMANDU ELECTRIC VEHICLE ALLIANCE (KEVA)

KEVA is a clean environment initiative by government, citizen-based and private sector partners in Nepal and abroad. Supported by USAID's Clean Air Initiative, the Alliance at present consists of PADCO Inc., Winrock International, the City and County of San Francisco/San Francisco Clean Cities Coalition, and Electric Drive Transportation Association (EDTA). KEVA started with the objective of reducing vehicular air pollution in Kathmandu Valley and has been successful in promoting zero-emission electric vehicles. The Alliance engages in policy dialogues with government officials and conducts public awareness programs with transport and energy consumers at the grassroot level. KEVA has focused on eliminating constraints to the expansion of electric-based mass transit systems and feels that ropeways can prove to be a feasible environmentally-clean transport alternative in Nepal's fragile hills.

Nepal's Other Transport Future

For the last half a century, Nepal has neglected a valuable transport technology, the ropeway. It has many virtues suited to a mountainous terrain: it is almost three times cheaper to build than an equivalent motorable road, eight times quicker to install and twice as energy efficient. Despite the successful example shown by another mountainous country, Switzerland and their obvious benefits, ropeways have remained outside the purview of transport planners and failed to be promoted by main political ideologies.

Ropeways in Nepal consists of policy and planning reviews, case studies of successes and failures, and analyses of what an alternative transport future for Nepal might look like. Even the simplest of motorable roads will not reach many Himalayan hamlets because they are difficult to build and expensive to maintain. The authors in this volume argue that ropeways would provide impetus to rural development by reducing drudgery, making markets accessible and diversifying livelihood opportunities for marginalised farmers.

By asking what the starting point in promoting such a clean technology would be, this book lays bare the fundamental questions before conventional approaches to transport policies and development. It will be of interest to a wide range of readers concerned with the challenges of technology in mountain development.

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ROPEWAYS in Nepal

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