The wood procurement in Indian pulp and paper industry and its challenges

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Forest Technology and Logistics
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Intian paperiteollisuuden puuraaka-aineen hankinta ja sen pullonkaulat

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Paperiteollisuus on yksi suurimpia teollisuuden aloja Intiassa. Puunhankinnalla on merkittävä rooli paperiteollisuuden toiminnassa, mutta Intian kohdalla kyseistä aihetta on tutkittu erittäin vähän. Tämän tutkimuksen tavoitteena oli arvioida Intian paperiteollisuuden puunhankinnan nykytilaa ja lopuksi etsiä mahdollisia pullonkauloja. Tutkimusaineisto kerättiin haastatteluilla yhteensä 10 paperitehtaasta Intiassa.

PAPERITEOLLISUUS INTIASSA


HAASTATTELUISTA KÄY POIKKEUKSSETA ILMI, ETTÄ TEHTÄT OVAT TYYTYMÄTTÖMIÄ PUUNHANKINNAN NYKYTIILAN. SUURIN ONGELMA ON, ETTÄ PUUTA ON ERITTÄIN VÄHÄN TARJOILU, JOKA TEEKE PUURAAAKA-AINEEN HINNASTA ERITTÄIN KORKEAN JA PAKOTTAA TEOLLISUUDEN HANKKIMAAN PUUTA ULKOMAILTA JA PIDEMMILTÄ MATKOILTA, JOLLOIN KULJETUSKUUNNAN KSETTÖ Ovat MYÖS PIENIÄ JA VAIEKUTTAVAT OSALTAA PUUNHANKITAPROSSESEJA. NÄIDEN LISÄKSI PUUN VILJELY KOKONAISSUUDESSAAN EI KIINNOSTA PAIKALLISEN. INFRAstruktuuri on myös heikkoa ja junien käyttö puukuljetuksissa on hankala. Joidenkin tehtaiden mielestä myös politiikalla on liian suuri rooli raaka-aineen hinnan määräytymisessä. NÄiden lisäksi asiantuntemus toimitusketjun hallinnasta on heikkoa ja sopivia ohjelmistoja ei ole käytössä:

Avainsanat – Nyckelord – Keywords

INTIA, PAPERITEOLLISUUS, PULLONKAULAT, PUUNHANKINTA

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Ohjaaja professori Bo Dahlin. Tutkimuksen rahoitti Helsingin yliopisto, Teollisuuden metsänhoitajat sekä Metsämiesten säätiö.
The paper industry is one of the largest industrial sectors in India. In general, wood procurement processes play an important role in the operations of the paper industry, but there is very less research on India in this topic. The purpose of this study was to evaluate the present state of wood procurement in the Indian paper industry and finally to detect possible bottlenecks in the system. The data was collected by interviews from a total of 10 paper mills in India.

Paper industry in India is entirely based on a plantation forestry, where private farming plays a very large role. Wood procurement begins with planning. The field officers cooperate with the vendors in the field. The vendors are private operators who trade directly with up to thousands of farmers and are therefore necessary for the successful operations. Wood is almost always harvested manually by axes and rarely with chain saws. Long-distance transport is mainly carried out by trucks which can carry about 15 to 20 tons of wood at a time. At the reception, the quality of the raw material and the papers are checked, and the load size is weighed. After reception, the wood is transported either to the wood yard or alternatively directly to the chipper. The load is unloaded either by loaders, or sometimes, but rarely, by hand.

The results show clearly that the mills are dissatisfied with the present state of wood procurement. The biggest problem is that there the domestic supply is insufficient, which makes the wood raw material price very high and forces the industry to buy wood from abroad and longer distances which affect negatively to transport costs. In India, land ownerships of farmers are also small and it complicates efficient wood procurement processes. In addition, farming trees does not interest the local people. Infrastructure is also weak and the use of trains in wood transport is difficult. Some mills stated that the policy plays too big role in determining the price of the raw material. In addition, expertise in supply chain management is weak and no suitable software is available.

Avainsanat – Nyckelord - Keywords
Bottlenecks, India, paper industry, wood procurement

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Forewords

The objective of the study was to assess the current status of the wood procurement operations in Indian pulp and paper industry and to detect potential bottlenecks in the system. The study was run by University of Helsinki, The Department of Forest Sciences.
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List of abbreviations

AMC – Agricultural Marketing Committee
APO – Annual plan of operation
BILT - Ballarpur Industries Limited
CPPRI – Central Pulp and Paper Research Institute
CTL – Cut-to-length
EPT – Extended primary transport
FAO - Food and Agriculture Organization of the United Nations
FSI – Forest Survey of India
FT – Full-tree
GDP – Gross Domestic Product
GIS – Geographic information system
ICT – Information and Communications Technology
IIASA – International Institute of Applied Systems Analysis
MAI – Mean annual increment
NAEB - The National Afforestation and Eco-Development Board
NAP – National Afforestation Program
PT – Primary transport
SCM – Supply chain management
SIT – Secondary intermediate transport
ST – Secondary transport
STT – Secondary terminal transport
SWOT – Strengths, Weaknesses, Opportunities, Threats
TL – Tree-length
TNPL – Tamil Nadu Paper Limited
TOF – Trees outside forests
WCPM – West Coast Paper Mills
WHO – World Health Organisation
1 Introduction

1.1 Background of the study

Indian pulp and paper sector has made considerable progress during the last decades and characterised one of the key industries in India with a turnover of Rs. 50,000 crores (equal to 6.5 billion euros) (CPPRI 2015). It is calculated that the sector employs directly 500,000 people and indirectly even up to 1.5 million people. Therefore, its role in India’s employment, especially in rural areas, is significant. According to Kujur (2012), the industry’s share of the total output of all manufacturing industries is 1.19%. In a global perspective, India is ranked as 15th largest paper producer with a total of 813 pulp and paper mills. It accounts for 3.7% of the total world’s production with 14.99 million metric tonnes of paper and paperboard yearly. The industry is also expected to grow seven percent every year. This rapid increase is basically driven by the increase in domestic market. India is also considered the fastest growing paper market in the world.

The rise of information and communication technology (ITC) has affected negatively to the demand of paper products (Hilty et al. 2011). Nevertheless, the global consumption of paper products is increasing all the time, currently 1.6% annually. Especially the growth potential in Asia is enormous. (Finnish Forest Industries 2013). According to FAO statistics, the paper consumption in India was 10 kg per capita in 2013 which is relatively low comparing to the developed countries. The world average is 55 kg per capita, and for example in China, the consumption is 73 kg per capita. When comparing to Finland where the consumption is about 200 kg per capita, Asian countries are far behind (FAO 2015). According to Deloitte’s estimates (2012), the consumption in India will double by 2020 from 2010 levels mainly due to lifestyle changes and economic factors (Dixon J. et al. 2012). The rapidly growing demand for paper products, especially in the domestic markets, will put a high pressure on the industry in India but at the same time, it will open great opportunities to boost the industry to a new level. Since the paper industry in India is facing major changes in the near future, is important to know how the paper mills in India could improve their operations in order to rise to the coming challenges.
Wood procurement processes are one of the main actions in pulp and paper industry and its importance cannot therefore be neglected (Uusitalo 2005). On the contrary, it is becoming more and more crucial when harvesting and logistics costs continue to increase, and the customers are becoming more demanding. Also, rapidly changing conditions are making the nature of wood procurement planning not only more important but also more challenging. The wood procurement by the pulp and paper industry in India is struggling with several problems (CPPRI 2015). CPPRI has shown that the raw material costs of the total costs of the paper industry in India, is 57% in average while for example, the same number in Finland is 15% (Metla 2014). As there are not many up-to-date studies available on the topic of raw material procurement, logistics and value chain management in Indian pulp and paper industry, the roots of the bottlenecks are difficult to locate in the first place. Therefore, it is important to find out, how the wood procurement operations are carried out in practice. It helps further to detect the constraints in the system and that way, the paper mills in India could enhance their overall operations. To achieve these goals, every stage of the system, from the planning in the start to the wood yard operations in the end, should be investigated closely. This paper focus on to study the stages individually and to detect the potential bottlenecks in the wood procurement systems by the paper industry in India.

This study will serve as a groundwork for understanding the characteristics of Indian pulp and paper industry wood procurement today. Moreover, due to insufficient information about India, other tropical countries, such as Thailand and South Africa, will be used as examples in building the framework and creating a general understanding of procurement operations in the tropics.

1.2 Previous research

As it has been mentioned earlier, currently there is a lack of research on the topic of raw material procurement operations in India. Therefore, using other tropical countries data for the background was needed. In general, wood procurement operations in tropical countries are less studied. The studies have focused more on silvicultural practices, and not consider other stages of the wood supply chain.
The Central Pulp and Paper Research Institute has recently assessed the current status of the Indian pulp and paper industry. Compendium of Census Survey of Indian Paper Industry -book (2015) considers the trends and analysis of the industry nowadays. The book takes a stand on the current status of the industry, raw material scenario, paper manufacturing processes, energy scenario, technology, environment, newsprint sector and the role of standards in pulp, paper and paperboard. As the CPPRI is an institute with a focus area in technology, the book has only a little dealt with the wood procurement processes. However, they have an excellent overview of the present state of the industry in general.

Uusitalo (2005 & 2010) has some comprehensive studies of the wood supply chain operations worldwide. His focus in these studies has been, however, on Nordic Hemisphere and tropical countries have not much been mentioned.

Manavakun (2014) has researched harvesting operations in eucalyptus plantations in Thailand. The focus was on comparing different methods and on finding out possible solutions to improve the systems. South African Ground Based Harvesting Handbook (Ackermann et al. 2010) has several studies about timber harvesting and wood transportation in South Africa. The book takes a comprehensive outlook for South African wood supply chain operations today. As forestry in South Africa is based on plantation management, the book serves well as a background study for the research.
2 The aim of the study

The objective of the study is to assess the current status of the raw material procurement and to detect potential bottlenecks in the system. The research will depend heavily on field research in India, including face-to-face interviews with pulp and paper industry company operational teams. This paper focuses on only having an overview of wood procurement operations by the Indian pulp and paper industry, not going too deep into details.

Following research questions will be made during this research project:

- How is the wood as a raw material procured by the sample mills?
  - What stages does the wood supply chain include?
  - How the operations in the different stages have been carried out?
- What potential bottlenecks do the procurement system have?
3 Country profile of India

3.1 General information

India is a country in South Asia, neighbouring Pakistan in the west, Tibet, Nepal and Bhutan in north and Bangladesh and Myanmar in the east (Central Intelligence Agency 2017). Three water bodies surround India: The Arabian Sea to the west, the Indian Ocean to the south and Bay of Bengal to the east, the total coastline being 7,000 kilometres. 1.311 billion people are living in India which makes it the second largest country in the world by population after China. The population of India is increasing very rapidly, about 1.18% yearly. Moreover, India is very dense populated, 452 people living in one square kilometre.

![Map of India](www.mapsofindia.com)
India is the seventh largest country by area (Central Intelligence Agency 2017). The total area is 3.29 million square kilometres from which 2.97 km\(^2\) is characterised as a land, and the rest is water. 60.4% of the land area is agricultural land whereas the forest is covering 24% and the rest of land is for other land uses, such as urban land. The highest point, 8,598 meters above the sea level, can be found from the Himalayas in the north. A vast desert area, called Thar, is located in the southwest covering about 200,000 square km.

From the year 1858 till 1947, India was ruled by the government of Britain. Indian Independence Act 1947 divided India into two independent dominions, India and Pakistan (Indian Independence Act 1947). From those days, relations between these two countries have continued highly charged till the present. India and Pakistan have gone through four wars (worldatlas.com 2017). The first one took place just after the independence, the second one in the year 1965, the third in 1971 and the latest one in 1999. Nowadays, India is formed by 29 states and seven union territories. Being a republic, the chief of state is president, and the government is lead by a prime minister.

3.2 Climate

India is located to South-Asia, and it is characterised as a hot tropical country (WeatherOnline Ltd. 2017). However, in the northern states, as Himachal Pradesh, Jammu Kashmir and Sikkim, the climate is cooler, classified as a continental climate. The summer in India starts in April and continues until October when the monsoon season starts. The summer months are scorching; the temperature can go up to 45°C or even more and the peak is usually reached in June. The monsoons can be very violent; percepitation can be up to 600 mm. They can cause a lot of floods and damages, especially nearby big rivers as Ganges. On the contrary, during the winter season, some places suffer from droughts when the rainfall is at its minimum. In the north, the winter can be cold when the temperature can decline so low as 5°C, but usually, it stays over 12°C. In the hilly areas in the north, the weather is only mildly warm during the summer months and snowfalls can occur.
3.3 Religion

Religion is playing an important role in people’s daily life. The most common religion is Hinduism which is representing 80.5% of Indian people (Office of the Registrar General & Census Commissioner, India 2001). The second largest is Muslim with 13.4% share and Christians are accounting for 2.3% of the people. Indian caste system, which is highly related to Hinduism, is one of the world’s oldest social classification system (BBC 2017). It divides Hindus into hierarchical groups based on their karma, which means work, and dharma, which means, in this context, duty. The caste system is based on Manusmriti which is the most important book on Hindu law. Traditionally the system divided Hindus into categories at which at the top were mainly teachers and intellectuals, the second layer was formed by warriors and rulers and the third one by traders. The caste system has been criticised for that it creates inequality and that the escaping from the fixed social orders is almost impossible. Although the caste system is banned by the government, it has its place in the people’s daily living. However, the urbanisation and modern lifestyle have declined the importance of the system, in particular among the young people.

3.4 Challenges

The poverty levels in India varies between states (The World Bank Group 2017). The average income in the poorest states, like Uttar Pradesh, can be as low as $436 while the average income in India is $1,410. The people in the most advanced states can earn four to five times more than in the poorest states. Although India has invested in education, the learning outcome is still keeping low. Less than 10 percent of working age people have achieved a secondary level graduation. From these graduated people, only a small amount has competence in global job markets. In addition to education, health care is struggling with several problems, yet the system has improved during the last decades. Maternal and child mortality are still high, and especially the nutrition of Indian’s children is a serious challenge. According to World Health Organisation (2015), the number of reported road traffic fatalities were almost 140 000 in the year 2013. WHO estimated, however, that the total fatalities were much more, about 210 000. Unfortunately, the trend of traffic deaths is increasing (WHO 2015). In addition to the traffic collision, the roads are overcrowded causing traffic jams, especially in the major cities. WHO has stated that
in India, the total number of registered vehicles is about 160 million from which 72% is representing 2- and 3-wheels vehicles. The total number of cars is nearly 40 million.

3.5 Major on-going projects

India has some projects with of great importance currently. One running project, ‘Make in India’, has been launched by Prime Minister Mr Modi in the year 2014 (Department of Industrial Policy & Promotion 2014). The purpose of the project is to improve economic situation by modernising old processes and policies. The project is based on decentralising governance by moving more authority from the government to businesses in India. Altogether 25 industry sectors are already been involved the project. The aim is to build confidence among different stakeholders as well as promoting skills development and innovations in India. In this way, the government aims to enhance the willingness of businesses to invest. The primary goal is stated to be to raise manufacturing’s GDP share to 25% by the year 2020. With ambitious targets, this project has got some critics as well (Ramana 2015). Some say that this export-led strategy does not work for India. Also, according to some arguments, the world is not ready for another large export-led country such as China and Japan. Addition to these, there are some concerns that foreign countries are only taking advantage of the cheap labour and less restricted environmental and social regulations in India.

Another major project, which is more related to pulp and paper industry, is national afforestation program (NAEB 2009). This program, known as NAP, is a flagship strategy of the National Afforestation and Eco-Development Board (NAEB) and aims to enhance people’s participation in forest management and policy making. This strategy does not only secure rural people’s daily needs, but its goal is also to maintain the biodiversity of nature.
3.6 Forests in India

3.6.1 Forest cover

According to Forest Survey of India (FSI) (2015), the current forest cover was 21.34% in 2015, from which very dense forests, with a canopy cover of 70% or more, are accounting for 2.61% of the total land area (see Figure 1). Moderately dense forests, where the canopy cover is between 40% and 70%, are representing 9.59%. Forests with more than 10% and less than 40% of canopy density are classified open forests and they are covering 9.14% of total land area. The largest forest cover can be found in Madhya Pradesh.

Figure 1. Different forest types shares in percentages of the total land area in India (FSI 2015).

According to Ravindranath et al. (2008), the Indian afforestation program is one of the largest in the world. The afforestation started in the beginning of 1980s, and it is carried out under several programs. The social forestry program took place the early 1980s and it was followed by Joint Forest Management program in 1990. In 1992, the afforestation was driven by National Afforestation and Eco-development Board (NAEB) programmes, and nowadays, private farmer and industry-initiated plantation forestry are mainly running the afforestation process. Figure 2 illustrates the forest cover in square kilometres from the year 1987 to the year 2015. These values are based on the FIS’s State of Forest Reports 1987-2015. As can be seen, the forest area has been increasing steadily from the
year 1999, when it was about 637,000 km$^2$ to the year 2015, when it was about 702,000 km$^2$. Before 1999, the forest cover is almost constant. The FSI has been estimating the forest cover in India since 1987 using remote sensing systems. CPPRI (2015) has estimated that in India, plantations for pulpwood production covers about 315,000 hectares of land, which represents 0.5% of the total forest area.

Figure 2. Forest cover in India has increased rapidly since 1999. The figure shows the forest area in km$^2$ (FSI 1987-2015).

Forest cover in India is increasing with 0.5% annually. Raghavan et al. (2014) discussed in a study about markets’ and policy’s role in the increment of the forest cover in India. They found out that the afforestation projects, mainly driven by policies and the need for commercial wood, are the main reasons for forest maintaining in India. Furthermore, the participation of the local people has a significant impact on successful afforestation practices achieving both forest and economic growth.
3.6.2 Forest policies

The first formal forest policy in India – the Forest Policy 1894 – was established to manage the state's forests for a public benefit (Joshi et al. 2010). While the policy aimed to maximise the public benefit, it limited the privileges of individual forest users. Moreover, the policy was not directly concerned forestry, but on the contrary, it raised agriculture above forest practices. It allowed agriculture as an option for land use without restrictions. The guiding factor of the policy was to fulfil the needs of the local people and taking the pressure away on the maximising the revenue of forest products.
In the year 1952, the Forest Policy 1952 was created (Joshi et al. 2010). In the very first time, the policy has the aim to increase the forest cover to at least 33% of the total land area. The policy created a system for a complementary land use as well. Furthermore, it aimed to ensure the supply of firewood, fodder and small size timber. Noteworthy is that forests were then classified into four different forest types: protection forests, national forests, village forests and tree lands.

The current forest policy – National Forest Policy 1988 – aims to maintain the environmental stability of nature and ensure biodiversity in India (Joshi et al. 2010). One of the main targets of the policy is not only to protect natural forests but also to increase the forest cover up to 33% of the total land area. The afforestation is carried out mainly through social forestry programs. However, there is no timeframe set in which time the target will be achieved and furthermore, it is problematic to achieve the target in the first place. As the population in India is increasing rapidly, more food and energy are needed. Therefore, more land has been converted to agriculture purposes, as well as supplies of fuelwood. The major limitations in afforestation are stated to be illegal cuttings and forest fires.

Joshi et al. (2010) criticise the unrealistic targets of the current policy. It would be better to focus more on improving the quality of growing stock rather than only having the attention in the forest cover increment. Also, they point out that more consultation is needed to set more reachable targets. It means more involvement and approval of all the stakeholders to get a general interest of the country.

Agricultural marketing committee (AMC) is a board run by Agricultural Marketing Department of Government of Andhra Pradesh (National Informatics Centre 2016). There are 191 AMCs in Andhra Pradesh, and they aim to enforce the guidelines at the local level. Among others, pulpwood trading is monitored by AMCs. For example, they have set that the paper mills have to use only identified weigh bridges for measuring the load at the mill. Also, they have set that the mills have to pay to farmers within five days after
the weighing has been carried out. The minimum price, which need to pay to farmer of raw material, is also set by AMCs. Nowadays, farmers prefer to sell pulpwood through AMCs as the committees defend the interest of farmers, but the other side of the industry, the paper mills, have criticised the actions of AMCs (Murali 2016). For example, the mills complain that now they are forced import more expensive wood from abroad or at the worst, forced to procure wood from the forests which affects negatively to the environment.

3.6.3 Plantation forestry

Plantations can be described in many ways (Evans & Turnbull 2004 p. 8). Mostly they are managed for wood production but also, they can have other aims, such as conservation, protection or other socioeconomic purposes. However, it is important to distinguish different types of planted forest for global assessment and communication. According to FAO (2000), forest plantations are defined as “those forest stands established by planting or/and seeding in the process of afforestation or reforestation”. Although this can be used in most cases, there are many types of plantations from short-rotation plantations for industrial usage through to “close-to-nature” plantations. Classifications depend on the intensity of management, in other words, whether the target is to maximise production of wood, environmental values or something between them (Evans & Turnbull 2004 p. 9).

Trees can also be grown outside the forest, being a part of agriculture landscapes or there can be other formations with a low crown cover (an example in Picture 3) (Schnell et al. 2015). According to Forest Survey of India (FSI), the trees outside forests (TOFs) in India are defined as all the trees which have over 10 cm diameter at the breast height and which are available on land which is not described as a forest. Since the urbanisation level worldwide is increasing (United Nations 2014, p. 1), TOFs are becoming a more important matter nowadays, providing firewood, fodder and income for the people. However, the definition of the term TOF varies between different stakeholders, such as agriculture farmers, forestry farmers and urban land users and therefore, it is difficult to calculate the real cover of TOFs (Schnell et al. 2015). It is estimated (FSI 2011) that TOFs
are covering 7815 km² of land area representing 0.2% of the total land area in India. The current growing stock is about 190 million cubic meters.

Globally, forest cover is decreasing in natural and semi-natural forests and mainly a result of conversion and agriculture practices. However, the plantation forest cover is increasing globally with 2% annually. According to Brockerhoff et al. study (2008), plantation forestry is aiming to curb forest loss and at the same time to produce timber and fuel wood. Some plantations are also established to reduce erosion, for carbon sinks and other economic, social and environmental purposes (Brockerhoff 2008).

Plantations that are managed sustainably can provide not only raw material for the forest sector but also some ecosystem services (Kanninen 2010). These services can include carbon sequestration, clean water production and biodiversity conservation. It is estimated that these things will have greater importance shortly. For the local people, plantations can provide both direct and indirect benefits. Direct benefits are goods, such as wood, fodder and medicine. Indirect benefits can be previously mentioned clean water production and carbon sequestration. These goods and services have a high importance of millions of people daily life and therefore, to maintain plantations is vital.
Ravindranath et al. (2001) discuss in their study that forest sector in India is aiming to meet the current demand for wood and biomass and, to protect the existing natural forests. Currently, the cover of dense forests (>40% crown cover) is only 12% of the total geographical area. Since the government bans the use of the natural forests, the only way to meet the current and future demand of wood in India is through afforestation programs with sustainable plantation forestry management practices. Currently, some estimates say that about 315,000 hectares of land is covered under pulpwood plantations (CPPRI 2015, p. 32).

According to International Institute for Applied Systems Analysis (IIASA), the forest sector in India is missing reliable data and information. At the state level, there is no information about the growing stock. Moreover, the system is lacking the data of different forest products as well as the biomass data. Since almost all timber and pulp wood is procured from tree-outside-forests, there is no inventory for those (Raj 2014).

4 Pulp and paper industry in India

Indian pulp and paper industry is producing currently about 14.99 million metric tons of paper and paperboard annually (CPPRI 2015, p. 11). From this, writing and printing paper production is 5.21 million tonnes, accounting 35% of total production whereas packaging paper production is much higher: 8.29 million tonnes per year. About 10% of the total production is newsprint. Currently, the total number of mills, which are operating, is 813.
4.1 Fibre sources in Indian pulp and paper industry

Indian pulp and paper industry is using three different types of raw material (CPPRI 2015, p. 13). The largest share is on recycled fibre, accounting to 64% of all required fibre source of the industry. Wood based material is considering to 26% of the total production while agro based material is 10%. Worth of noticing is that the shares have changed considerably over the last decades (see Figure 3 below). For example, in the 1970s the wood based industry was accounting to 84% of the total production whereas the agro-based and the waste paper-based contributed 7% and 9% respectively. All the newsprint production relies on recycled paper as a source of fibre, contributing nearly 99% of total
newsprint production and the rest is wood (see Figure 4). Most of the writing and printing paper production is based on wood, accounting to 51%, while recycled fibre is accounting to about 38% of total writing and printing paper production and about 10% is coming from agro residuals. In packaging paper, recycled fibre is again the most common source with nearly 77% share of total packaging paper production whereas wood and agro is contributing about 10% and 13% respectively.

Figure 3. The shares of raw materials in the year 2014 and 1970 (CPPRI 2015, p. 13).

Figure 4. Production of different paper products as per source of fibre (CPPRI 2015, p. 15).
4.2 The production of the Indian paper industry

India is consuming 16.73 million metric tonnes paper annually, accounting to 4.1% of the whole world demand (CPPRI 2015, p. 18-19). During the last few years, the paper industry in India has invested in increasing the production capacity. For example, the capacity has increased from 12.70 metric tonnes in the year 2010 up to 19.27 metric tonnes in the year 2014. However, the growth in the capacity is not met with actual production which was 14.99 million metric tonnes in the year 2014, mainly due to limited availability of domestic raw material. Most of the mills is operating at around 80% capacity. If the increase in the industry and paper consumption continues at the same pace, the production of paper is estimated to be 21.94 million tonnes and the consumption 23.51 million tonnes in the year 2025.

4.3 Exports and imports

Around 2.70 million tonnes of paper, paperboard and newsprint is imported in the year 2014, contributing to 16% of the total consumption in India while the same value was 1.34 million tonnes in the year 2007 (CPPRI 2015, p. 19-20). Therefore, the amount of imported paper products has almost doubled in seven years. The exports of paper products have been only one million metric tonnes per year, which is about 6.5% of the total production in India. However, there has been a slight increase also in exports comparing the current level to 2010 level.

India also imported about 370,000 metric tons wood in the year 2014, and the number is increasing year by year (Wood Resources International LCC 2015). According to Union Budget 2016-2017, the basic customs duty has been reduced from earlier 5% to current 0%, so there is no excise or countervailing duty for imported wood which is intended for manufacturing paper or pulp (Government of India 2016).
4.4 The major challenges in pulp and paper industry in India

The biggest challenge in Indian pulp and paper industry is stated to be the shortages in raw materials (CPPRI 2015, p. 22-23). The industry is heavily depended on the mixed sources of raw material, including previously mentioned wood, agro-residues and waste paper. When the domestic supply is not meeting the demand, India is forced to import more and more pulp as well as wood chips and waste paper. Since the natural forests are protected in India, only species such as bamboo and hardwood species are available for industry use. Moreover, government regulations and policies set restrictions to use degraded forest land for plantations. The agro-based industry is facing problems as well. Bagasse is a prevalent source of fibre in the paper industry, but it is an alternative fuel in sugar industry resulting in a high competition between industries. Also, the recovery is relatively low, only 75% in wheat straw. Thirdly, the transportation costs are higher, even up to 40% higher when transporting loose straw. Waste paper collection rate in India is low. Only 35% of the waste paper is collected while in developed nations it is about 60% and for example, in Finland, 83% (Tilastokeskus 2015). Moreover, the collection system is unorganised and inefficient, and the quality of the waste paper is weak (CPPRI 2015). The industry is highly depended on waste paper imports to meet the increasing demand of paper.

In addition to the raw material shortages, the industry is facing problems in costs of basic inputs (CPPRI 2015, p. 23-24). The raw material, chemical and coal prices are constantly increasing, causing difficulties in the competitiveness of the industry in the global markets. For example, the cost structure shows that the raw material price of the total costs is accounting 57% when in average Finnish mill the same value is 15% (see Figure 5 below). Figure 5 does not tell the whole truth of the situation as there are no absolute cost values added because of lack of the data from India. However, it illustrates well that the share of raw material costs of the total costs is much higher than in Finnish mills.
Indian paper industry is formed mainly of small and medium scale units which are based on recycled paper and agro residues (CPPRI 2015, p. 26). Regarding the production capacity, 426 mills in India have capacities varying from 5 to 50 tonnes per day while only 174 mills have the capacity of 100 tonnes per day. Although the larger mills have invested in new and more advanced technologies, the smaller ones are still operating with out-of-date technologies.

Pulp and paper industry is one of the most polluting industries in India (CPPRI 2015, p. 27). Therefore, the industry has had to confine to more stringent environmental regulations due to the concern of pollution and growing in public awareness. Therefore, the industry is forced to invest in modern technologies to make solid waste and black liquor management more efficient as well as to reduce water usage and air pollution.

As there is a shortage of raw material, there is a lack of skilled workforce as well. According to the CPPRI (Central Pulp and Paper Research Institute) estimations, the requirement of technical workforce will increase by 4% every year (The CPPRI 2015, p. 27). However, there are only seven institutions providing education in the field of pulp
and paper. The current amount will not meet the current demand, not to mention the demand in the future.

4.5 The scenario of wood-based paper industry

Indian paper industry is using 8.7 million tonnes of wood as a raw material annually (CPPRI 2015, p. 31-33). About 315,000 hectares of land is covered under pulp wood production from which about 75% is run by private farmers. Therefore, the importance of farm forestry in paper production is significant. According to some estimates, the demand for wood is increasing in the next ten years with 12 million tonnes which means about more 2.2 million hectares of the plantations need to be established. Also, it has to remember that the wood is used for other purposes, such as for energy so that the need can be much more. The average growing stock in Indian forests is also very low, only 62 m$^3$ per hectare while for example in China the same number is 104.62 m$^3$ (State Forestry Administration… 2016).

4.6 Social forestry in India

Social forestry in India is an approach to meet the growing demand for fuel wood, fodder and timber of the rural people (Kumar 2015). The primary objective is to provide goods and services for local people who are managing and planting trees by themselves. Social forestry has a significant role in India due to its positive effect on rural areas employment. Secondly, it increases the supply of fuel wood and fodder and at the same time, maintain the ecological biodiversity to some extent. Furthermore, it decreases the pressure of using natural forests. Social forestry has managed to increase the forest cover as well as the supply of industrial wood. Also, the employment situation in rural areas has improved significantly. Despite the achievements, social forestry has facing problem in people participation. There is a lack of appropriate technology as well as suitable policies and awareness among the local people. Moreover, the people’s attitude towards trees is negative. Land holdings in India are minimal and therefore, carrying out social forestry practices is not only challenging but also non-profitable.
One component of the social forestry is farm forestry. It means a practice where a farmer grows trees for commercial purposes on a privately-owned land (FAO 1988). The paper industry in India is using wood as a raw material procured from the farm forestry plantations. In India, forest plantations are the second major land use after agriculture crops (Joshi et al. 2011). National Agroforestry Policy 2014 by Ministry of Agriculture, is promoting tree planting among farmers.
5 Theoretical framework

5.1 Framework of the study

Figure 6 illustrates the steps in the wood supply chain in the context of this study. Also, it includes what different information was aimed to get from each step and from where the data was gathered. The aim was to investigate each stage (planning, harvesting, long distance transportation etc.) in the sample mills how they were carried out. That way, it was possible in some extend to create an overall picture of the whole procurement system in Indian paper industry. According to Uusitalo (2010), a normal wood supply chain includes planning, harvesting operations, long distance transportation, wood reception and finally, wood yard operations. This example of a chain was used as a framework of the study. Every stage in the chain was investigated as follows:

1. Harvesting planning
   1.1. How the planning is carried out?
   1.2. Who is/are in charge in the planning?
   1.3. What does the planning include?
2. Harvesting
   2.1. What are the methods, practices and equipment used in the harvesting operations?
3. Long distance transportation
   3.1. How the wood is transported to the mill from the harvesting site?
   3.2. What different transportation methods are in use?
4. Wood reception
   4.1. What actions does wood reception include?
5. Wood yard operations
   5.1. How the wood is handled at the wood yard?
6. Chipping
   6.1. How is the chipper fed?

Addition to above mentioned analysis, each stage is examined in a way that the potential restrictions in the system could be detected. This include operational teams’ opinions of the system as well as researcher’s observations gathered during the field work in India. The primary data was collected through interviews whereas the secondary was
gathered from previous studies on the topic. The data collection methods are explained more detailed in chapter 6.3.

Figure 6. Framework of the study.

It is important to understand how operations are carried out globally in general. This is made in the following sub-chapters. Previous studies on the topic has been used as a background material. It should be, however, noted that some of the studies use examples from the Nordic countries as there are less studies done regarding the wood procurement operations in the tropics. The stages, which are introduced in Figure 6, are explained more detailed later in this chapter. A term wood procurement is also further explained in the sub-chapter 5.2.

5.2 Wood procurement in general

Wood procurement is a process where the wood as a raw material used by the industry is delivered from the forest to the mill or another production plant. Procurement operations can be carried out by a mill, or it can be out-sourced (Stenzel et al. 1985). Traditionally
thinking, the process includes buying the wood, harvesting, transportation and reception at the mill (Uusitalo 2015) but in this context, wood yard operations can be thought to be an essential part of the chain as well. Uusitalo (2005) defines wood procurement systems as follows: “Wood procurement is a process that integrates a number of technical, commercial and logistical activities aiming to deliver wood raw material to wood processing mills; and simultaneously taking into account the most important characteristics of the conversion process and end-product.”

The term supply chain management (SCM) is often linked to the wood procurement actions (Uusitalo 2005). SCM is an approach in the business which aims to ensure the competitiveness of the company as well as to add value to all stakeholders in the chain (Ackermann et al. 2010). The competitiveness and value adding can be achieved by an efficient use of resources, such as labour and equipment, and with an effective information flow (Figure 7) between the organisations and companies (Pulkki 2001). The main idea is, thus, to fill the customer’s needs through the minimum costs but also high-quality products, not forgetting the role of a customer service. Wood procurement is, however, only one part of the whole supply chain. In forestry, the supply chain can include, in addition to wood procurement, tree improvement, silviculture practices, processing operations at the mill and transportation of the final product all the way to the customer. Although the nature of the wood supply chain differs from other supply chains, general supply chain tools and theories can be implemented in wood supply chain theories (Uusitalo 2005). However, one wood raw material can include several sub- or by-products which creates the fact that the suppliers can be involved in many supply chains (Heinimann 2000). Moreover, the whole supply chain can include both delivering the raw material to a production plant and delivering the final product to a client. In other words, one supply chain can include both downstreams and upstreams.
Wood as a raw material has, in addition, many quality characteristics which are needed to take into account. For instance, the density of wood, moisture content and fibre lengths affect to the final product quality and these characteristics have a significant influence in planning procedure as well (Ackermann et al. 2010).
The wood supply chain is a very customer orientated supply chain (Uusitalo 2005). Delivering right raw material with the right quantity and quality at the right time is vital. Figure 8 shows how customer service goals are linked to several strategies. In practice, these areas are typically planned separately, although the idea is to plan these as a unit. The core, customer service goals, include the price, dimensional and quality requirements and the ability to react to changes. Location strategy takes into account where the wood trade is taking place as well as the market shares in each wood procurement district. Transportation strategy considers methods of transportation, shipment sizes, routing and scheduling and transport decisions whereas inventory strategy deal with supplies, forecasting and purchasing scheduling decisions, including buffers for seasonal variations. Especially, seasonal variation and the ability to react to changes affects greatly to logistics costs in wood procurement.

Nowadays, wood procurement companies have managed to reduce raw material stock levels, mainly due to efficient inventory and transportation managing systems (Uusitalo 2005). The companies aim to keep the stock level as low as possible but on the other hand, a low stock level not only increases the transportation costs but it also increases the risk of profit loss. Moreover, storing can affect negatively to the raw material quality.
5.3 Wood procurement

5.3.1 Wood procurement planning

Wood supply chain planning includes three main planning sections (Figure 9). The procedure starts with a long-term or strategic planning, and it is followed by a mid-term planning which is also known as tactical planning. The most accurate planning is operational planning, also called short-term planning.

![Figure 9. Planning procedures in wood procurement.](image)

Strategic planning, as a starting point, effects the decision planning followed by it (Oberholzer 2010). Strategic planning can cover tens of years in the future, time frame being the rotation age, it will make the long term planning more challenging. Strategic planning is an essential part of the strategic management and mostly run at the corporate level. The strategic plan can include SWOT-analysis, resource allocation, market analysis and such things.
The time frame of tactical planning is usually three to five years (Oberholzer 2010). Tactical planning is a complicated procedure including many steps needed to be considered. Tactical planning is basically about setting the strategic plans for the company, including, e.g. terrain condition analysis as well as equipment availability and scheduling of the harvesting operations. The strategic planning aims to ensure that the equipment is fully utilised while labour needs are taken into account as well.

A well-done tactical harvesting planning includes timber volume calculations over the set time frame as well as roads infrastructure requirements (Oberholzer 2010). Tactical planning also considers which harvesting systems and methods are the most suitable for different sites. If some operations are outsourced, appropriate harvesting contractors are selected as well. Moreover, it is needed to consider the influences of the harvesting operations. Annual plan of operation (APO) is one part of tactical planning. APO focuses more on budgeting and phasing the compartments to be harvested. APO, as well as a tactical planning, is reviewed after every year.

The most accurate part of the harvesting planning is operational planning (Oberholzer 2010). As a tactical planning is divided into more detailed plans, for example concerning every compartment, this plan focus on harvesting operations and long-distance transportation, and in some cases, the contractors’ details.

5.3.2 Harvesting operations

Concerns about deforestation and reduction in biodiversity around the world have increased the importance of pre-harvest planning. With careful planning, natural biodiversity can be preserved while doing harvesting and logging operations. However, the primary objective of the harvesting planning is to minimise the total cost of the chain from planting to processing (Oberholzer 2010). The forest legislation also sets constraints on forest management activities. In addition, for instance, forest certifications can be said to be necessary for having access to the global markets. Owari et. al (2006) have studied
the importance of forest certifications. They have discovered that certifications are good indicators of companies’ sense of responsibility as well as they help to keep the companies’ market share in the competitive, global markets.

Harvesting operations can be carried out in many ways, depending on the availability of equipment, tools, people, animals and other resources (Uusitalo 2005). In most developing countries, the harvesting operations are carried out manually, using axes and chain saws. There are three main logging methods used worldwide. Nowadays, cut-to-length (CTL) method is becoming more and more common in wood harvesting activities, mainly due to customer requirements. CTL-method consists mostly of felling, deliming and bucking into wanted assortments (Längin et al. 2010). All these processes are made in the site. After extraction to the roadside, piling into different assortments is made before the long-distance transportation is taking place. Another method is tree-length (TL) method. In this approach, only felling and deliming are carried out in the harvesting site, and the whole stem is extracted from the forest to the roadside. The third commonly used method is a full tree method (FT) where a tree is transported to the roadside with branches and the top. In other words, deliming and topping are made at the roadside, or in some cases, even at the production plant. Occasionally harvesting processes can include also barking and chipping.

Manavakun (2014) has illustrated three examples of harvesting systems which are usually used in eucalyptus plantations. One method is manual harvesting, using chainsaws in felling and processing the trees. Afterwards, manual deliming, debarking, sorting and stacking are taking place. The processed logs are finally loaded onto trucks and then transported to the mill. In this method, loading the truck is also made by hand. The second method includes felling with a feller-buncher, and the forest transportation is made by a grapple, cable or clam-bunk skidder. Then a processor processes the logs and logs are sorted and stacked by a tractor. The tractor loads the logs onto the truck waiting for the long-distance transportation. The third method is also fully mechanised. Felling, debarking and processing are made by a harvester, and the extraction to the roadside is
carried out by a forwarder. At the roadside, truck loads the logs onto it with its own grapple and then transports to the production plant.

5.3.3 Long distance transportation

After harvesting operations, long-distance transportation is taking place. Concerning roundwood transportation, there are three main methods to carry it out: waterway, railway and by road (Uusitalo 2010, p 125-136). In a global perspective, the most common way is by trucks. Usually, waterway and rail transportation is made when the distance is longer. Also, the access is playing a significant role. Furthermore, a mixed method, which means a combination of these three methods, is necessary in most of the cases. Trucks are mostly needed to transport the wood to the port or to the train loading terminal where the raw material continues to the production plant. Long-distance transportation has an important in cost calculations. In the Northern Hemisphere, it can be 40-60% of all costs while in the tropics, the share can be much more.

According to Ackerman and Pulkki (2004), primary and secondary transportation can be divided into several phases, using a specific terminology. Primary transport (PT) is wood transportation from a felling area to the roadside. Extended primary transport (EPT) is a terrain transport from the roadside to a depot or directly to the processing site. Secondary transport (ST) covers transportation from the roadside directly to a processing site whereas secondary intermediate transport (SIT) consists an intermediate storage site and it does not include the transportation to the processing site. Secondary terminal transport (STT) is transportation from a depot to the processing site.

For example, in South-Africa, secondary pulpwood transportation is divided into two fields: long-haul and short-haul transportation (Ackermann et al. 2010). Short-haul transportation is carried out by tractor-trailer units whereas long-haul transportation is executed by trucks or trains.
5.3.4 Reception of wood and wood yard operations

Before the raw material is reaching the wood yard, it goes through a raw material receiving station (Uusitalo 2010 p. 136). The purpose of the station is not only to measure the amount of delivered raw material but also to check the documents and whether the quality and the size of the material fulfil the criteria set by the mill. If the delivered wood fulfils the criteria, the certification of acceptance is granted, and the wood can be delivered either to a wood yard or straight to a chipper or a fibre line.

Uusitalo has presented a few ways to measure wood at the station (Uusitalo 2010 p. 136). The most common methods are stacked measurement, weighing and electronic scaling which is also known as scanning. After weighting, the volume of delivered wood is calculated by using conversion factors. After the vehicle is unloaded, a tare weight is taken when the load weight is the difference between the full and empty load weights. At the wood yard, the trucks (or trains) are mainly unloaded by high-lift log loaders. In smaller plants, the truck driver can unload the truck by the truck’s loader.
6 Data and methods

6.1 Study area

Altogether ten mills were selected as statistical samples for this study. The mills are located in different geographical regions of India. The geographical comparison can be then implemented, including regional procurement policies. The data was collected in January-February 2017.

The mills involved in the study are the following:

1) Ballarpur Industries Ltd., Jagahdri
2) Ballarpur Industries Ltd., Balharshah
3) Trident Group, Barnala
4) Century Pulp and Paper, Lalkuan
5) JK Paper, CPM Unit, Songadh
6) West Coast Paper Mills, Dandeli
7) Tamilnadu Newsprint and Paper Ltd., Pugalur
8) International Paper APPM Ltd., Rajahmundry
9) ITC Ltd., Bhadrachalam
10) JK Paper Ltd., Rayagada
The project started by preparing a short research plan. It included the purpose of the study as well as suggestions how the research could be carried out. A national association, Indian Paper Manufacturers Association, IPMA, was contacted from where they suggested to contact Mr Dharmendra Daukia who is a professional in this particular area.
Mr Daukia is the head of raw materials at JK Paper Ltd, and he has years of experience in raw material procurement processes in India. He is also very aware of the current status of the pulp and paper industry in India in general.

After consulting the Indian contacts, a tentative timetable was made for the field work, including possible dates for the visits. Also, introduction letters were obtained of the research from both IPMA and the University of Helsinki. The contact information of operational managers was received through IPMA, and emails were sent to all mills with the introduction letters, the brief research plan and the tentative timetable. Luckily, all the contacted mills were able to arrange visits in the suggested dates.

6.2. Selection of the mills

The selection of the mills was made with the help of Mr Daukia. The main criteria for the selection of the mills was that mills have wood procurement operations. Beforehand it was thought that nine mills would be ideal to carry out the fieldwork in the set timeframe which was five weeks. However, 11 different mills were suggested to visit to have different points of views for the research. Some of the mills also have some development projects going on which could also be useful additions in the study. One mill was, however, not able to receive me due to unexpected difficulties in the mill operations. Thus, the final number of mills was 10.

6.2.1 Description of the mills

The mills involved in the study are presented below. JK Paper and Ballarpur Industries have two different units where have been visited. The information is gathered mainly from companies’ websites, but some of them have, however, a limited data volume.
**West Coast Paper Mills Ltd.**

West Coast Paper Mills Ltd (WCPM) was established in 1955, and it is located in Dandeli, in Uttara Kannada district in Karnataka, near the west coast. The most used fibre source is wood, representing 85% of the total raw material usage. The total wood usage is 980,000 metric tons annually. Eucalyptus contributes 64%, and the rest is Acacia. WCPM is using mainly domestic wood, accounting to 60% of total usage, but imported wood chips are playing a significant role in the production with 40% share of the total usage. The domestic wood is procured mainly from the states of Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra. WCPM is producing as final products paper/paperboard and multilayer board for both foreign and domestic markets. Total production of end products is 300,000 metric tons per annum with a turnover of Rs. 16.5 billion, equal to 234 million euros. The mill in Dandeli is employing 4600 people directly.

**Tamilnadu Newsprint and Papers Ltd.**

Tamilnadu Newsprint and Papers Ltd. (TNPL) was established in the year 1984 by the Government of Tamil Nadu, and the mill is located close to Pugalur, Tamil Nadu. The wood usage of the total raw material is 30%, the rest is bagasse and waste paper. The total wood requirement is around 400,000 – 500,000 metric tons yearly of which Eucalyptus is most common with a 90% share and the rest is Bamboo and Casuarina. TNPL is procuring almost all its wood from domestic sources; only small quantities are imported. The total amount of domestic wood is 450,000 metric tons whereas only 50,000 is imported. TNPL manufactures printing and writing papers as final products from where about 1/5 is exported to more than 50 countries and the rest is used domestically. The total production is 400,000 metric tons per annum with a turnover of Rs. 24 billion, equal to 342 million euros. The mill is employing 2000 people directly.

**Ballarpur Industries Ltd.**

Ballarpur Industries Ltd. (BILT) is largest manufacturer of printing and writing paper in India. BILT is part of Avantha Group which is a conglomerate running in India. BILT has six manufacturing units all over in India. The unit in Ballarpur produced about
180,000 metric tonnes of paper in the year 2015. The main species as wood raw materials are Leucaena, eucalyptus, acacia, casuarina and bamboo.

**Century Pulp and Paper**

Century Pulp and Paper, located to Lalkuan in the state of Uttarakhand, was established in 1984 and it manufactures almost 230,000 metric tons of paper products yearly. The unit produces writing and printing paper, tissue paper and paperboard from where writing and printing paper is dominant with about 86% share of the total production. Addition to these, the unit manufactures raw material for viscose filament yarn, staple fibre and paper grade pulp. Century Pulp & Paper is using mostly eucalyptus, bamboo and bagasse as raw materials but the waste paper is coming to a more common source of fibre nowadays.

**JK Paper Ltd.**

JK Paper Ltd. has two manufacturing units in India. One, JK Paper Mills, is located in Rayagada, Odisha and the other, Central Pulp Mills (CPM), is located Sondagh, Gujarat. The combined production per year is 455,000 metric tons. JK Paper units produce writing and printing paper, packaging boards, office papers and some speciality papers.

**International Paper APPM Ltd.**

International Paper APPM Ltd. is one of the largest paper and pulp manufacturers in India. They have units both in Rajahmundry and in Kadyam. The mill in Rajahmundry was established in 1921 by Carnatic Paper Mills Ltd. In the year 1928, The Andhra Pradesh Paper Mills Co. Ltd. bought the mill and again, in the year 1953, the mill was moved to the possession of the State of Andhra Pradesh. Nowadays, an American paper company, International Paper, owns a 75% share of IPAPPMM. Currently, the unit in Rajahmundry produces about 200,000 metric tons of paper products yearly.
**ITC Ltd.**

ITC Ltd. is one of the largest paper and pulp manufacturers in India. The unit in Bhadrachalam produces about 545,000 metric tons yearly and uses bamboo, waste paper and hardwood as raw materials. Harwood species in use are Eucalyptus (70-75%), Leucaena (25%) and some small quantities of Casuarina. ITC is also importing some wood from South Africa as well as from Malaysia and Vietnam.

**Trident Group**

Trident produces high quality paper for multi-colour high speed printing and publishing and high quality branded copier paper for both domestic and foreign markets. The first chemical plant was established in 1985 and the first paper unit in the year 1993. The units are located in Barnala, in the state of Punjab. The production is currently 200 tonnes per day and the total installed capacity is 175,000 tonnes per annum. Trident uses mostly eucalyptus as a wood raw material and the balance is covered by poplar.

6.3 Data collection methods

6.3.1 Face-to-face interviews

The study is based on both primary and secondary data, of which primary data is dominant. Secondary data was collected from the internet as well as from libraries, using previous publications on the topic. The primary data was collected from the operational departments of the mills through interview sessions where operational managers and some of their team members were involved. According to Hox and Boeije (2005), primary data as a term means that the data will be collected at hand by the researcher. An interview survey is one primary data collection method where the target population is interviewed. It is the best strategy if the interviewer wants to collect data on observations, attitudes, feelings, experiences, or opinions of the target population. Since the study aim was to listen to operational teams of the sample mills and formulate an understanding of their perspectives, a survey would be the best option for the data collection. Moreover, since there is not much published on this topic before, and also, since the study is only a
preliminary study serving possible future researches, a qualitative approach is the best due to its exploratory characteristics (Myers 2013, p. 9). Addition to these, the lack of time is one of the main reasons for using only a qualitative approach instead of to collect statistical information in addition. Using primary data is important because the researcher can have a comprehensive view of the phenomena, rather than having data collected by someone else.

The respondents were asked to provide information about the wood procurement operations, including harvesting operations, long-distance transportation, wood reception and wood yard operations. Also, they were invited to tell their opinion of the system and which are the constraints in the wood procurement. The questions were prepared beforehand and carefully that the research questions will be covered but also, that the questions do not lead the interviewee. The questions were both open-ended and close-ended. Open-ended questions are helpful in order to gather some profound information but on the other hand, the answers may be difficult to generalise as the sample size in this study was rather small. The beforehand made questions are presented in Appendix 1. However, it transpired in the beginning of the field work that some of the predetermined questions were not relevant and were, therefore, not asked. Some extra questions were also added to the interviews in order to get desired results. The interviews were more like open discussions than structured sessions which was important to build confidence between the interviewer and the interviewee(s) and moreover, it helped to form a casual atmosphere to the discussions.

Semi-structured interviews formed this study. According to DiCicco-Bloom and Crabtree (2006), semi-structured interviews are formed by using predetermined open-end questions (please see Appendix. 1) as well as some additional questions which can emerge from the dialogue. Since there was a lack of studies on wood procurement operations in India, it was difficult to formulate relevant questions in advance and thus, some unexpected results were found. A semi-structural approach will allow more freedom to an interviewer to modify the structure during the in-depth interviews. However, the frame of all the interviews were needed to be uniform to combine or/and compare the results afterwards. In addition to interviews, the field work included visits in plantations as well
as to see the supply chain operations in practice. Unfortunately, due to lack of time which was only 5 weeks, and without an interpreter during the field work, vendors and farmers were not interviewed.

6.3.2 Data analysis methods

Burnard (1991) presented method of analysing interview transcripts. He is presenting several different stages that will take place during the analysation process. However, he points out that no one method can be used for analysing a different kind of interview data. His example is a semi-structured and open-ended interview which will be recorded. This example has, thus, similar features as this study. Therefore, this analyse was adopted in this study to some extent. It has to be remembered that Burnard’s example is more for social researches so that in this study used some modification of it. The modification is explained below.

Since the study of Burnard study has 14 different stages to analyse but this study will have only a few of them. Burnard has described the stages step by step, starting from making notes through to a stage where the link between the literature and the results will be formed. The stages between them are results’ categorising, meaning that the similar results will be grouped to different subcategories. The research will be carried out mainly using hand-made notes, including interviewees sayings as well as possible ideas emerged from the dialogue. In some cases, using a recorder is suitable, for instance, when the interview is taking place in an office environment. After the interviews, a results’ categorising will be carried out. Since the study will have different sub-topics, including e.g. harvesting and long-distance transportation, categorising is very crucial. When all relevant results are under each sub-topic, it accelerated the analysis. The analysis ended to form a linkage between the literature and the results.
7 Results

The following results are based on the interviews and visits during the field work in India. Below in Table 1 and Table 2 the results of the study are compiled together to compare the operations between the sample mills. Later in the following sub-chapters, each wood supply chain stage is explained more detailed. All the mills are named by using alphabets (e.g. Mill A, Mill B and so on) in order to avoid linkages between the specific mill and the results.

Table 1 below illustrates how the planning and the harvesting operations are carried out by the sample mills. As it can be seen, almost all the mills are using vendors in the planning, expect Mill H that is directly contacting farmers. Regarding the harvesting operations, all the mills use CTL-method (cut-to-length) as a harvesting method. The harvesting is carried out mainly by axes: only Mill E has implemented motor-manual working method to its harvesting operations. Worth of noticing is that Mill E, as well as Mill H in some extend, use debarking machines while other are using bill hooks to debark the logs. All the sample mills load the truck at the site by hand.

Table 1. Planning and harvesting operations by the sample mills.

<table>
<thead>
<tr>
<th>Planning</th>
<th>Harvesting operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mill A</strong></td>
<td>Manager sets the yearly plan</td>
</tr>
<tr>
<td>- field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes</td>
</tr>
<tr>
<td>-</td>
<td>- manual loading</td>
</tr>
<tr>
<td>-</td>
<td>- manual debarking</td>
</tr>
<tr>
<td><strong>Mill B</strong></td>
<td>Manager sets the yearly plan</td>
</tr>
<tr>
<td>- field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes</td>
</tr>
<tr>
<td>-</td>
<td>- manual loading</td>
</tr>
<tr>
<td>-</td>
<td>- manual debarking</td>
</tr>
<tr>
<td><strong>Mill C</strong></td>
<td>Manager sets the yearly plan</td>
</tr>
<tr>
<td>- field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes</td>
</tr>
<tr>
<td>-</td>
<td>- manual loading</td>
</tr>
<tr>
<td>-</td>
<td>- manual debarking</td>
</tr>
<tr>
<td><strong>Mill D</strong></td>
<td>Manager sets the yearly plan</td>
</tr>
<tr>
<td>- field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes</td>
</tr>
<tr>
<td>-</td>
<td>- manual loading</td>
</tr>
<tr>
<td>-</td>
<td>- manual debarking</td>
</tr>
<tr>
<td><strong>Mill E</strong></td>
<td>Manager sets the yearly plan</td>
</tr>
<tr>
<td>- field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes and chain saws</td>
</tr>
<tr>
<td>-</td>
<td>- manual loading</td>
</tr>
<tr>
<td>-</td>
<td>- mechanised debarking</td>
</tr>
<tr>
<td><strong>Mill F</strong></td>
<td>Manager sets the yearly plan</td>
</tr>
<tr>
<td>- field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes</td>
</tr>
<tr>
<td>-</td>
<td>- manual loading</td>
</tr>
<tr>
<td>-</td>
<td>- manual debarking</td>
</tr>
</tbody>
</table>
Table 2 below shows what are the practices in the sample mills, regarding the long distance transportation, wood reception and wood yard operations. Truck transportation is clearly the dominant method by the mills: only two mills (Mill D and F) use train and the share of is only 10%. In all the mills, documents and the quality of wood is checked at the gate. Also, the load is measured using weigh scaling. Wood reception, therefore, works alike in all the mills. There are also similarities among the sample mills, concerning the wood yard operations: most of the mills are using grapples to unload the loads. Only Mill B unloads mostly by hand, although grapples are in used in some extend. Internal transportation (transportation at the mill site) is made by tractor-trailer combination in all the mills.

Table 2. Long distance transportation, wood reception and wood yard operations by the sample mills.

<table>
<thead>
<tr>
<th>Mill</th>
<th>Planning</th>
<th>Harvesting operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Manager sets the yearly plan - field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes - manual loading - manual debarking</td>
</tr>
<tr>
<td>H</td>
<td>Manager sets the yearly plan - only field officers gather the wood supply information</td>
<td>- CTL-method, manually by axes - manual loading - manual/mechanised debarking</td>
</tr>
<tr>
<td>I</td>
<td>Manager sets the yearly plan - field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes - manual loading - manual debarking</td>
</tr>
<tr>
<td>J</td>
<td>Manager sets the yearly plan - field officers gather the wood supply information together with the vendors</td>
<td>- CTL-method, manually by axes - manual loading - manual debarking</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Long distance transportation</th>
<th>Wood reception</th>
<th>Wood yard operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill A</td>
<td>- by trucks</td>
<td>- unloading by grapples - internal transportation by tractors</td>
</tr>
<tr>
<td></td>
<td>- documents and quality of wood are checked - scaling of load based on weighing</td>
<td></td>
</tr>
<tr>
<td>Mill B</td>
<td>- by trucks</td>
<td>- unloading by hand/grapples - internal transportation by tractors</td>
</tr>
<tr>
<td></td>
<td>- documents and quality of wood are checked - scaling of load based on weighing</td>
<td></td>
</tr>
<tr>
<td>Mill C</td>
<td>- by trucks</td>
<td>- unloading by grapples - internal transportation by tractors</td>
</tr>
<tr>
<td></td>
<td>- documents and quality of wood are checked - scaling of load based on weighing</td>
<td></td>
</tr>
</tbody>
</table>
The wood procurement process in the interviewed mills can be presented as a flowchart (see Figure 10). The process starts with the planning followed by the purchasing processes. After that, harvesting operations can take place. The wood is then stored temporarily at the site waiting for long-distance transportation. There can be one or more depots where the wood can be stored before reaching the mill gate. Then the wood will be received and transported either straight to the chipper/fibre line or the wood yard. Some
mills are importing wood from abroad, and it is usually transported straight to the mill from the port.

7.1.1 The sources of wood

The mills involved in the study, are heavily depending on farm forestry practices. The source of raw material is 100% plantations which are mostly managed by farmers. Only small quantities are procured from government owned plantations. The government owns larger areas of plantations, and some interviewed mills pointed out that the wood procurement is easier and cheaper to carry out from there. The sample mills stated that normally private owned land holdings are small, about 2-3 hectares but there are also larger ones (4-10 hectares). Based on the results of this study, it can be concluded that the landholding in India is very fragmented. On the other hand, it is difficult to say, is this the case regarding the other land uses as well, such as crops and agro-forestry, since only wood plantations were visited and investigated.
The sample mills are using mainly three different genera for as a wood raw material: *Eucalyptus* sp., *Leucaena* sp. and *Casuarina* sp. Of them, *Eucalyptus* is the most common one. *Casuarina* is mostly farmed in the coastal areas whereas *Leucaena* is used all around India. Some mills are using *Populus* sp. due to its better qualities for paper making. Also *Acacia* sp. is commonly used. Some of the sample mills are using bamboo as well, but due to its longer rotations and permission requirements by the government, its usage is decreasing by them. *Eucalyptus* is the most popular genus for paper making in the tropics globally (Rockwood et al., 2008) and based on the results of this study, the case is not different in India. Also, it can be noted that the selection of genera depends in some extend on where the mill is located.

According to the sample mills, the wood raw material is transported to the mill either as logs or chips. The chips are common in north of India as well as in the coastal area. North of India is known for plywood industry, and therefore, veneer waste and chips are well available as raw material for paper industry. Indian pulp and paper industry is also importing a lot of chips from abroad, mainly from South-Africa, Myanmar and Thailand. Some mills in coastal areas are using imported chips as a fibre source because of the close location of ports. Although imported wood is more expensive than domestic, some sample mills stated that it is more homogeneous and with better quality. There are, therefore, differences inside the country depending on where the mill is located. It has to be noted, however, that only three mills of the target population are using veneer waste as raw
material and hence, it is difficult to draw a conclusion how common practice it is in the paper industry in India. Noteworthy is that these mills were located to the north of India and thus, based on the results of the study, it could be concluded that veneer waste may be a common source of wood raw material in the north.

The rotations cycles vary between species. Eucalyptus and Leucaena have the shortest rotations with about 3-4 years whereas Casuarina, as well as Acacia, could take more than five years. The length of the rotation cycle depends on not only the growth conditions but also on farmers’ willingness to sell as well as on the industry demand. Also, worth of noticing is that the rotation cycles are rather short in India when comparing to the other tropical countries. For example, in Thailand the rotation cycle of Eucalyptus is 5 years and in South-Africa even 8-10 years (Manavakun 2014). According to the results, eucalyptus has also the shortest rotation lengths and may be the reason for its prevalence as wood raw material among the sample mills.

Most of the mills involved in this study are running nursery operations. They produce seedlings and plants and the operations include also researching and developing more advanced clones. The main reason behind nurseries is to motivate the farmers, by providing plants and seedlings. In return, they can sell the wood back to the mill. Worth of notice is, however, that the farmers are free to sell to anyone. According to the results of this study, running nurseries may be a very common practice among the paper industry in India. On the other hand, the study did not discuss how often the farmer sells the wood back to the mill that provided free plants and seedlings. It was not, however, a problem among the sample mills and therefore, it may be concluded that it happens very rare.
7.1.2 Purchasing and planning

The wood supply chain in the sample mills starts from the planning procedures. The procedures include 1) strategic planning, predicting the demand for the coming year, 2) tactical planning allocating resources and 3) more detailed operational planning. The procedure is illustrated as a flow chart below (Figure 11), starting point being the strategic planning followed by the tactical planning and ending to the operational planning.

Figure 11. Crucial steps of wood procurement planning in the sample mills.

The manager of raw material sets the need of the raw material and divide it into each procurement region where the field officers of the company are operating. The demand is based on the estimations of coming year production. Each district has its field officer. Some mills only have a few officers whereas larger mills can operate with tens of officers. The allocation is based on the gathered information from the field, including the current supply as well as the information when and how much the farmers are willing to sell. The field data is collected by the field officers with the help of local vendors or, sometimes, village heads. The vendors, also known as contractors, are middle-men who are contacting the farmers, buying the wood from them and delivering the raw material to the market or straight to the mill. Mostly, the field officers cooperate in the field with vendors.
Nine interviewed mills of ten are using vendors in the wood procurement processes. Based on the results of the study, one might well conclude that this is very common practice in whole India. Also, the structure of the procurement organisation of the interviewed mills is almost the same which could mean that the most of the mills in India are using the same organisational structure as the sample mills. Noteworthy is that a functional cooperation between the vendors, the farmers and the mills are essential part to efficient wood supply chain.

Only one mill in this study was directly in contact with the farmers and carrying out the harvesting operations and long-distance transportation by itself. The mill has employed local people which are contacting the farmers, negotiating the prices, purchasing the wood and organising the harvesting operations and transportation to the mill. The people are directly working for the mill. The mill highlighted that in this way the wood plantation farming could be more profitable for the farmers. However, this represents an opinion of only one mill so it is difficult to reason, is this practice more profitable for the farmers, than using vendors instead.

The field officers of the sample mills gather the data, including the information of supplies, farmer’s willingness to sell and such things. Usually, the interviewed mills are using vendors due to the limited resources of their own. One mill can use thousands of farmers as suppliers, and therefore in most cases the vendors are necessary.

In northern India, the sample mills are dependent on the veneer industry using the veneer waste as a source of raw material. They are, therefore, co-operating with veneer industries. Also in the north, vendors are running so-called wood collection points where a mill can purchase wood. These collection points gather the wood from areas nearby. Mostly the wood comes to the points from about 50 km radius, and it is transported mainly by the farmers. As all the sample mills, which were located in Northern part of India (three units), were using veneer waste as one source of raw material. The results of the study indicate that the paper industry in the northern part of India may be in some extend dependent on the veneer industry. It was unclear, however, where the veneer industries
were located and therefore, it is hard to conclude which mills in the north cooperate with the veneer industries.

“Purchase-at-the-gate” is nowadays a rising trend in Indian pulp and paper industry. In this method, farmers can execute harvesting operations as well as transportation to the mill by themselves. Therefore, they can maximise their profit without having any middlemen involved in the chain. Some mills are even supporting this method, especially nearby the mills, with the intention to raise the welfare of the farmers and at the same time, ensure the availability of raw material. “Purchase-at-the-gate” -method is mostly taking place in core areas, about 20-30 kilometres from the mill when a tractor-trailer combination is a possible transportation method. Unfortunately, the farmers were not interviewed and above mentioned things represent only mills opinions of this practice. Thus, it is problematic to conclude, is this profitable to the farmers or not. However, it can be said that shorter the distance of transportation, the more profitable it would be for both the farmers and the mills.

7.1.3 Harvesting

Harvesting operations are taking place mostly in the winter time which begins in October and lasts until March. Then the temperature is decent, and the rainfall is at a minimum. During the summertime, from April to June, the temperature can rise to 50 degrees causing the impossible working conditions for the labours. Moreover, the harvesting during the summer time is banned by the government. The monsoon season is also low harvesting season due to the heavy rainfalls making the terrain as well as road conditions difficult to operate. Monsoon season is taking place from July to October. The harvesting operations are carried out mainly by the vendors and their labour, or by the mills. Also, in some cases, farmers are doing it by themselves. About ten people are working at the same time in the site. The number of people depends on the site’s size but also, on the availability of work force.

Since the government has banned the harvesting operations during the summer time, it can be concluded that all the harvesting operations in the Indian paper industry are carried
out during the winter time. Also, extreme weather conditions are setting timeframes when to harvest. There are also differences among the sample mills, who are carrying out the operations. Therefore, it is hard to estimate, which one of the practices is the most common in India. Based on these results, it could be drawn a conclusion that the harvesting operations run by the vendors and the mills are the most prevalent.

The different harvesting processes are illustrated in Figure 12 below. All the mills in the study are procuring wood from the plantations where the harvesting operations are carried out manually, mostly using axes and sometimes, but rare, by chainsaws. The CTL method is commonly used. In this approach tops and branches are cut and left to the harvesting site. The cutting is based on the criteria set by a mill (see Picture 11 below in page 51). In most of the cases, the minimum diameter for the logs are 6 cm, and the length varies from one meter to 1.5 meters. After felling the trees and cutting them into assortments, the logs are piled in the site waiting for the truck loading (see Picture 7). The terrain conditions in the site are almost without exception suitable for a truck to operate and thus, making the extraction to the roadside unnecessary.

Manual working was still an only method to carry out the harvesting processes in all the visited harvesting sites during the field work. Motor-manual method, meaning that using chainsaws or brush saws in cutting, is very rare: only one site had a chain saw but noteworthy is that the operator did not carry any safety equipment (safety trousers, boots, helmet and such things). Thus, the methods in the visited plantations differ from the practices in Thailand: motor-manual method is currently predominant method in Eucalyptus plantations (Manavakun 2014). CTL-method being the most common harvesting method globally (Uusitalo 2010) seems to be however, the most common one in India as well, according to the results of the study. Also Manavakun (2014) has shown that CTL is also prevailing method in eucalyptus plantations in Thailand.
Casuarina also produces saw logs and poles in addition to pulpwood. This timber is sold to the pole markets. A farmer gets a higher price from the timber comparing to the pulpwood. Therefore, the harvesting carried out in a way that the share of timber is maximum. The timber is piled to different piles, separately from the pulpwood. Although the farmer could increase the incomes by farming Casuarina, the study did not reveal why it is not that common as it is currently.

![Harvesting processes in Indian wood plantations.](image)
Usually debarking is carried out at the site or at some temporary terminal. Some mills are doing also debarking at the mill. Debarking at the harvesting site and terminals is made mostly manually, using billhooks or axes. Some are using debarking machines at the site as well, but it is not very common (Picture 8).

Based on the field work of the study, manual loading of a truck at the site seems to be most common practice in India: grabbers and such things was not in use. This is also mostly the situation in Thailand as well (Manavakun 2014). Worthy of notice is also that debarking machines are not that common among the sample mills. Debarking machines were discovered only at the government owned plantations and at one private owned harvesting site.

![](image_url)

Picture 8. Debarking machine at the harvesting site.

7.1.4 Long-distance transportation

According to the sample mills, almost all the long-distance transportation is made by trucks. Only a couple of sample mills have a possibility to train connections, and its share was only about ten percents per each mill. The transportation distance varies a lot. By trucks, it can be from 20 km up to 500 km while railway transportation is used for much longer distances, up to 1500 km. Transportation can also be made by a tractor-trailer combination when the distance is only 20-50 kilometres. That method is mainly operated by farmers who own land nearby the mill.
Based on the results of this study, the raw material is delivered straight to the mill, or in some cases, there can be a depot where the wood can be stored for some days. Also, a manual debarking can be done there (Picture 9). Usually storing is kept to a minimum there and mills are using them only when needed.

![Picture 9. Manual debarking by axes.]

Trucks are mainly used amongst the sample mills because it is a flexible method. In this context, it means that trucks can operate from the plantation straight to the mill without having any extra unloading and loading processes. Train transportation requires delivering by truck to the train terminal where the wood is loaded to the train. Moreover, sometimes a truck transportation is needed from the destination, for example from a train terminal to the mill. Some interviewed managers stated that it would raise expenses too much. Trains have to be loaded and unloaded by hand, and it requires a lot of time as well as workforce. Both the loading and the unloading could need up to 200 men. Also, the loading takes about 5 hours when unloading is slower, taking about 8 hours.

Long distance transportation of wood by trucks is the most common method globally (Uusitalo 2010), and it seems that Indian paper industry is by no means an exception. Although rail network is one of the densest in the world, it has been utilised only a little for wood transportation. For example, Anttila et. al (2010) discuss that the rail
transportation can be a competitive method for wood transportation from remote locations. This is the case in India since the transportation distances are getting longer and longer. However, as it has appeared from the interviews, both the loading and unloading of a train require many resources, both workforce and time, and therefore limits the utilisation of trains.

Usually, a truck can carry 15-20 tons of wood at once, and the bigger trucks with four axels can carry about 25-30 tons (see an example from Picture 10). The maximum weights are set by the Ministry of Road Transport and Highways, Government of India (1996). The transportation costs vary between 20%-30% of the total at-the-gate cost, depending on the transportation distance.

As it can be noted, the legislation in India set the limits to the road transportation. Most of trucks are rather small, but on the other hand, mainly due to a poor infrastructure in India which were mentioned as one of the major constraints in the industry, the roads are very hard to be operated by bigger trucks.

![Picture 10. Three-axel timber truck in the loading.](image)

Truck loading is made manually, and it is very time-consuming process. The truck usually drives to the plantation, and the loading is performed at the site. In most cases, a truck is operated by two men.
7.1.5 Wood reception and wood yard operations

In most of the sample mills, the wood reception is running around the clock. As mentioned before, an average truck can carry 15-20 tons, which means 50-100 truckloads per day through the gate in average. At the gate, officers are checking the documents. The documents include details on the farmer, the plantation, the vendor and the transportation company. This information is vital to proceed through the gate. Quality checking is also carried out at the gate. The officers are checking moisture content, logs’ size and the quality (see Picture 11). If the documents are accepted and the quality requirements fulfilled, the vehicle proceeds to a weight bridge. All the mills in the study are using measuring based on the weight of the load. Afterwards, tare weight is taken, and the balance between the full and empty load is calculated.

As there are 50-100 trucks coming through the gate per day, long queues can be developed, as it has been discovered during the field work. At few visited mills, the drivers can wait for 24 hours before the truck is unloaded. Unfortunately, this study did not reveal, what is the root cause for the long queues. Furthermore, some of the interviewed managers did not see the situation as a problem because they do not have to pay anything to drivers for the waiting.

All the sample mills use weighing to calculate the quantity of wood in a truck. This is also the most common method in the Nordic countries, according to Uusitalo (2010). Based on the results, it could be concluded that the most of the paper mills in India may use the same method to scale the load.
After the weighing procedure, the vehicle can continue either to the wood yard or straight to the chipper/fibre line. At the wood yard, the wood is unloaded manually or by machines. Most of the mills are using loaders for unloading logs, but chips are unloaded mostly by hand. Some mills have excavators for chip unloading (see Picture 13). Logs are piled into stacks and chips are stored at a chip yard. Logs can be stored up to 3 months whereas chips only a few weeks. According to the interviewees, the quality issues during the storing are minor, mostly due to a fast usage of raw material. Thus, the mills are trying to keep the raw material stock to the minimum, although the supply at the mill needs to be sufficient in the summer to ensure raw material availability during the low harvesting season. Some moisture loss is still happening lessening the quality of the raw material.

During the field work, it was stated by some of the sample mills that they do not have any quality issues. Some of the mills stated, however, that during the storing some moisture loss is happening. Several studies, e.g Metsäteho Oy (2004), have shown that the storing affects negatively to the biomass quality, causing fungi, colouring and moisture loss. Especially, it becomes emphasized in the tropical countries due to extreme weather conditions. Moreover, most of the storing facilities in the sample mills were uncovered and thus, exposed to both rain and the sun light. Some statements by the interviewees were, therefore, in contradiction with the previous studies made on the topic. On the other hand, when the wood is utilised fast, like in the most of the sample mills, the degradation
of the quality is at minimum. Also, some of the interviewed mills see the quality lessening as a minor problem as the raw material quality has a little or no effect to a price of a final product.

Picture 12. Feeding the chipper at the mill.

From the wood yard of the sample mills, the raw material is transported to the chipper. The internal transportation vehicle is mostly a tractor-trailer combination (Picture 15), and it is carried out by the mill, or it is outsourced. The mills are using the principle of first-in-first-out. It means that the wood which comes first will be utilised first. Debarking at the sample mills is executed by debarking machines.
Picture 16. Untying station at a mill.
7.2 Bottlenecks in wood procurement

Table 3 below illustrates the constrains in the wood procurement system of the sample mills of the study, according both the interviewees and the researcher’s own observations during the field work. The constraints can be divided into four different categories: technological, natural, social and political constraints. The technological constraints have issues related to working methods as well as tools in use whereas environmental constraints include problems affected by the environment and the climate. Social constraints include things related to the people, such as ownerships. Political issues include problems which are more and less influenced by the political decisions. It has to be noted, however, that the division is not necessarily as straightforward as the table shows because some of the constraints could be under several categories. Figure 13 shows that the categories illustrated in Table 3 are interlinked to each other as one category can affect to another and vice versa. The bottlenecks in the system are explained more detailed later in this chapter.

Table 3. Bottlenecks in the wood procurement systems amongst the sample mills of the study.

<table>
<thead>
<tr>
<th>Technological</th>
<th>Environmental</th>
<th>Social</th>
<th>Political</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lack of knowledge in logistics</td>
<td>- some quality issues during storing seasonal variations</td>
<td>- too small land holdings</td>
<td>- raw material availability</td>
</tr>
<tr>
<td>- lack of proper optimization tools/software</td>
<td>- seasonal variations</td>
<td>- farmers are not motivated to farm wood</td>
<td>- high at-the-gate prices of raw material</td>
</tr>
<tr>
<td>- manual working still dominant</td>
<td></td>
<td>- using vendors (+/-)</td>
<td>- poor infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- AMCs</td>
</tr>
</tbody>
</table>

Figure 13. The relationship between different constraint-categories.
All the mills in the study are facing problems with raw material availability. They stated that it is a major issue in Indian pulp and paper industry. While the supply is not meeting the demand, it causes a steady increase in raw material price. Some managers told that the raw material price in Indian pulp and paper industry is currently the highest in the world. According to one wood procurement manager, in the year 2010 the price of pulpwood was about 2000-3000 rupees per metric ton (26-40 €, rate on 14th November, 2017), but nowadays, the new standard is stated to be about 5000 rupees per metric ton (65 €). Also, when the availability is poor, the transportation distance is increasing all the time. In some states, the competition of raw material is so high that some mills are forced to procure wood from other states. Companies have to use bamboo as a raw material, too. Bamboo is criticised to be of poor quality, and it takes much longer time to grow it until the industry can use it.

The price of pulpwood is in euros about 50-60 and thus, does not deviate from the prices what they are e.g. in Finland (Indufor 2012). Nevertheless, it needs to be taken into account that the costs in India in general are much smaller than in Finland which is commonly known fact. Also, as it can be seen from Figure 5, the raw material itself forms the major part of the total costs of the industry. That indicates clearly that the wood is too expensive comparatively to the other costs of the industry.

The land holdings are minimal in India, according to the most of the sample mills. Most of the farmers have holdings only 2-3 hectares and under 10% of farmers hold land over 10 hectares. Continuous incomes among the farmers are very hard then to achieve and causes a situation that the rotation lengths are very short, only 2-3 years because farmers want to have incomes faster. It affects the wood quality negatively. Also, it is difficult to predict when the farmers are willing to sell the wood in the first place. Also, the size of logs is too small. Moreover, when the holdings are small, mechanisation level is difficult to grow. Mills are facing serious problems in motivating the farmers. Since the farmers are getting better incomes from crops, an establishment of forest plantation is not attractive. Low mechanisation increases the need for labour. Although the labour is relatively well available, it is said that the turnover of workers is very high.
All the interviewed managers stated that infrastructure is weak in India. It supports well the information which were provided from some official publications (e.g. Kumar 2005). Although national highways are in good condition, in rural areas roads are very weak and too narrow. Moreover, according to the results, the roads are hazardous, people are not so often concerning about the speed limits and other traffic regulations, and traffic accidents are quite frequent in India. Roads are, therefore, very difficult to operate for heavy trucks. According to the sample mills, some cities have banned heavy vehicles from operating at specific times in the city centre, mostly during the day time, to lessen the jams.

Although the rail network in India is very dense, using trains for wood transportation is rare amongst the sample mills. It is accounting about 10% of the total wood transportation. The main problem that the sample mills mentioned is that it is expensive and in most cases, a mixed method is required. It means that the wood is transported from the forest to the train by trucks or another vehicle and again, from the train to the mill by road. It raises the expenses and requires more time. Also, the freight cars in trains are covered. This regulation is set by the government. Thus, both loading and unloading have to be made manually with up to 200 workers, and the processes can take 5-8 hours.

One interviewed manager stated that there is a lack of proper software and technology in supply chain management. The same software is used also in food and steel industry. Also, trucks have to carry wood with moisture, so the real supply for paper making is much smaller. Moreover, according to this manager, the expertise in logistics is weak in India. As only manager has mentioned these as problems, it is difficult to say, are the other sample mills seeing these as constraints.

One problem which emerged from two of the interviews is that there is a lot of uncertainty in the markets. No one knows what the status of the sector is and it is hard to predict the future. Also, when the quality of the wood is poor, some of the mills are using imported wood with better and more homogeneous quality while some mills are using domestic wood. The quality of raw material is stated to have only a small affect to the price of the final product. Noteworthy is that these issues were mentioned only by two mills and therefore, generalisation to whole Indian paper industry cannot be done.
It has been mentioned before in this paper that as India being a tropical country, some extreme weather circumstances occur. It forces the industry plan their operations carefully in order to fulfil the raw material demand during the low harvesting seasons, especially in the summer time when the logging is banned by the government. The monsoons also make the harvesting operations difficult, if impossible, to carry out. Challenging circumstances create uncertainty in the wood supply chain. Moreover, since the manual working is still dominant in Indian paper industry, it makes the processes not only slow but also very dangerous.

In the state of Andhra Pradesh, Agriculture Marketing Committee (AMC) has a significant role in the pulpwood markets, according to two sample mills. The main function of AMC is to lobby for the farmers. Although this committee has achieved a lot of positive things, the mills are seeing it as a constraint. The main problem is stated by the mills to be that the committee is increasing the raw material prices, setting a minimum price which farmers should get. Moreover, the mills are complaining that this committee is only acting in Andhra Pradesh, so that will distort the competition all around India. These mills said that it is all about politics and the minimum price rule is set for only hunting for votes from the farmers. As AMC is running in Andhra Pradesh, other sample mills that were located in different states, did not mention this as a problem as it does not affect to their operations. Nevertheless, this stated to be one of the major bottlenecks by the sample mills that are acting in the state of Andhra Pradesh.

All the mills in the study have stated that quality issues of wood are minor as the raw material is used so fast and the storing time is short. However, few of the sample mills are still facing some quality problems although they do not see that as a big problem. Firstly, there are no covered storing facilities in the sample mills, and therefore, the sun and rains are affecting the moisture content of wood. High humidity is also enabling to fungi to grow, causing discolouring in wood substance. Secondly, as harvesting operations are carried out manually by all the interviewed mills, biomass loss is happening. Especially, manual debarking has a significant impact on the weight loss.
Although the use of vendors is an efficient, and in most cases, necessary way of doing business from the sample mills’ points of view, some interviewed operational managers stated that they are eating too much profit from the farmers. However, as there are many farmers under one mill, using vendors can be the only way to supply the wood due to the limited labour resources of the sample mills. Some sample mills pointed out that doing procurement with the vendors are the most stable.

Some of the sample mills are seeing the competition in the pulp and paper industry unhealthy. While some mills are using poor quality domestic wood, some are using imported which has been stated to be more homogeneous and better quality. The sample mills think, however, that the quality of raw material has only a small effect on the price of the final product. Interesting would be, how much raw material is rejected after chipping but this has been excluded from a closer examination.

As is can be noticed, there are several problems emerged from the interview sessions. First, all the sample mills mentioned the low availability of wood as the biggest constraint. Secondly, all the interviewed managers said that the land holdings in India are too small which hampers efficient wood procurement operations. The other issues that were mentioned were more or less opinions of only few sample mills, and therefore difficult to generalise to whole India. Noteworthy is that using vendors divide opinions along the sample mills: some of the sample mills mentioned that the vendors are eating too much profit from the farmers whereas some of them said that it is not a problem. Nine of the ten mills agreed, however, the vendors are essential part of their wood procurement operations.
8 Discussion

8.1 Wood procurement and its bottlenecks in Indian pulp and paper industry

The results show clearly how the wood supply chain includes the same stages as anywhere in the world (e.g. Uusitalo 2010): wood procurement starts from the planning, followed by the harvesting operations, whereupon long distance transportation takes place. The chain continues via receiving station where the wood is measured, finally to the production plant where the wood is either stored or fed to the chipper. Although the similarities to wood procurement operations globally can be found, closer examination reveals lots of differences between India and for example, the Nordic countries. For instance, according to the observations of the researcher during the field work, the working culture in India is very well different when comparing the situation e.g. to Finland: safety in India, for instance, could mean very different things than it is Finland. This already makes the comparison very difficult.

As a summary of the results of this study, the wood procurement in Indian pulp and paper industry is insufficient. Based on the interviews, the industry is not satisfied with the current situation. Especially, shortages in the raw material have led to a situation where long-distance transportation of wood is too long. It affects greatly the at-the-gate cost of raw material and further, increases the total operating expenses of the industry. Also, if the supply of domestic wood is not meeting with the demand, it will raise the prices too high and force the industry to import more and more wood from abroad. However, the claim that the price is the highest in the world might be exaggeration from some of the interviewed managers. For example, at-the-gate-prices in China are almost 80 euros. Still, the raw material costs’ share of the total costs are too high (see Figure 5).

Noteworthy is that the most of the operational work is carried out manually in the visited sites and mills. For example, harvesting operations and debarking are executed without expectation with axes, chain saws are used very rare. Also, in some of the sample mills, the unloading is made by hand, although loaders are common nowadays. Manual working is not only slow but also, very dangerous. Without proper equipment, both tools and
safety, the risk of injury is very high. In this study, however, safety issues were only mentioned.

There may be several reasons for generality of axes and manual working in general. Firstly, the labour is cheap in India and it is easily available. Secondly, the diameter of the wood is small and makes the axes rather quick method to cut. Thirdly, the people may not have the know-how to use chain saws and other motor equipped tools. Finally, the manual working employs also a significant amount of people and moving to more mechanised systems could be shunned by the industry. Also, manual working has long traditions in India and therefore, it is difficult to move to more modern practices.

CTL-method is common in harvesting processes in India, according to the plantation visits during the field work of the study. The method has its advantages. First, the wood can be transported to the mill easily as the truck capacity can be fully utilised. Secondly, the raw material does not need any extra handling at the mill site as it can be straight fed to the chipper.

Fragmentation of the landholdings India could be one reason for the high costs of the procurement processes. For instance, Zhang et al. (2005) have shown that the smaller are the landholdings, the higher are the production costs per unit. One of the sample mills, that were procuring wood the government owned plantations, stated that the procurement from there is easy and cost-efficient. Easiness and cost-efficiency may be a consequence of a possibility to procure high amount of wood from one, specific area.

Based on the interview results of the study, worth of mentioning is that using vendors is a general practice in wood procurement processes. It is an essential part of successful operations of the sample mills. When the number of farmers is very high, even up to thousands, the mill own resources are not sufficient to carry out the wood procurement. Moreover, over the years developed confidence between the farmers and the vendors are often very important in keeping the raw material flow stable. The vendors are making, however, too much profit from some sample mills’ point of view. Some of the mills are
thus, promoting the core area procurement in which the farmers can sell the wood at the mill gate without having any middlemen involved. Core area procurement may be too hard to use on a wider scale as a raw material is hard to collect from longer distances by the transport means of the farmers. Interesting would have been, how the farmers and the vendors see the procurement system themselves but unfortunately, this study does not discuss this.

The mill reception of the sample mills is too slow as the queues at the mill gate can be even 24 hours long. There might be several reasons for the current situation. Firstly, the unloading could be too slow as the unloading equipment at the mill site is over-resourced and outdated. Secondly, the processes at the mill gate can take time when the papers as well as the quality of raw material need to be checked properly.

It could be beneficial to all parties that the rotation lengths could be increased. The farmers could maximise the yield and the industry could use better quality wood as raw material. For instance, Delgado-Matas and Pukkala (2011) have shown that the optimal rotation length is 22 years for the eucalyptus species which were investigated in their study, expect one genus that was calculated to be 12-15 years. Although, that study took place in Angola and there were only six different genera represented, it may be concluded that extending the rotations lengths in India is more than possible. However, it is hard to motivate farmers in the first place as it could mean lower incomes for them. It is obvious that the farmers want to maximise the incomes whereas the industry tries to get raw material to the mill gate as cheap as possible with a certain quality. One solution could be that the industry would begin to price the wood as per quality.

8.2 Limitations of the study

There are several limitations which may affect the results. First, some unexpected results were detected. Thus, it may have some negative effect to form a uniform completeness because the interview questions, which have been prepared beforehand, slightly changed as the research progressed. Moreover, the interviewees may have a too optimistic picture of the situation or, on the contrary, too pessimistic. Also, as an outside organisation made
the study, the interviewees may have hidden some information. Also, using a foreign language (English) for both interviewer and interviewees could be liable to lead to errors. Worth of mentioning is that notes were written by hand because using a recorder was either forbidden or mostly unpractical due to outside office circumstances. Manual recording can cause some errors in the results as well as some information may have been left unnoticed.

One major limitation of the study is that there were only ten mills involved the study as there are over 800 pulp and paper mills in India. Thus, it is difficult to know how representative this study is in the first place, concerning the whole paper industry in India. Also, since the farmers and vendors were not interviewed, there is no other side of the wood procurement represented. It could, therefore, lead to too optimistic picture of the system.

In addition to these, the researcher was inexperienced interviewer and therefore, some mistaken could have been made. For instance, the researcher noticed few times that the interviewee led too much the session and some questions were not asked or the answers were too short because the time allocated to the sessions sometimes expired. Moreover, the researcher has focused in his university studies more on the wood procurement operations in the Nordic countries and thus, it could lead to errors as the lack of expertise in this specific topic. Due to this, during the very first interview, it came out that some of the predetermined questions were not relevant and were, therefore, not asked.

8.3 Future research

This topic needs clearly more studying. During this research, it has been noted that there are very few studies done on this subject. In general, procurement processes in the tropics have a lack of proper scientific research. This study suggests, therefore, that every step of the wood supply chain in India need closer examination to enhance the chain as a whole. Also, vendors and farmers are needed to be represented in the future research as now they have been left outside. This study may serve as a framework for future research. Some potential future research topic has been presented further in this chapter.
8.3.1 Possible future research topics to enhance wood procurement operations

The availability of domestic wood needs to be increased. Shortages in raw materials, especially in wood, are stated to be the biggest problem. The problem requires consideration and actions, not only from the industry but also from the government and paper associations. First, more plantations need to be establish. In India, about 47 million hectares, which represents about 15% of the total land area, is classified as wastelands (Focali 2015). Of that, almost a half is suitable for eucalyptus plantations. Turning these lands into plantations would also serve the government to achieve the plan to increase the forest cover and also, secure the raw material supply for the industry. One may study how to change these waste lands suitable for the industry use.

One mill has established corporations in which the mill and the farmers set up a company together. The company sells the wood and act like a typical company, but the ownership and managing stay still with the farmers. As a company, farmers can get loans easier when there is a mill involved. Thus, the farmers can invest more in their operations and increase the size of their farming area. It will increase the size of the plantations when there are many farmers involved, and at the same time, enhance the processes in the wood procurement by the industry when the raw material is located to one, specific area. It would be interesting to see how this could work in whole India. Thus, this could be one area of a closer examination.

Weak infrastructure prevents fully functional supply chain processes. One possible study area would be how to improve the infrastructure in order to enhance the wood supply chain logistics in India. Although the national highways are in a relatively good condition, smaller roads in rural areas need renovation. It is in the interests of all the stakeholders that the operating conditions are good. For instance, the government needs to allocate more money for the maintenance of roads because otherwise, the maintenance backlog will increase year by year and further, the budget is only enough for bigger highways and rural area roads will get less attention. When the roads are in a better shape, e.g. the capacities of trucks could be increased. Also, the restrictions related to railway
transportation could be loosened. For example, if uncovered freight cars would be allowed in wood transportation, it could accelerate both loading and unloading processes and furthermore, make possible to transport wood from longer distances. Interesting would be how the improvement of the infrastructure could work in practice and how to get all the stakeholders (the industry, the farmers and the government) participated to the development processes.

![Diagram](image)

Figure 14. Possible future study themes on the wood procurement operations in India.

The mills could provide more field courses to the farmers. The lack of proper technology and knowledge in harvesting operations make the work very dangerous and inefficient. For example, proper and safe use of chain saws could be taught to farmers and field workers and also, to the vendors. Knowledge and proper equipment will probably motivate farmers to continue wood plantation farming. Manavakun (2014) discussed in her study that the training should start from learning the basics in theory and then, moving to the practice, including the right techniques, working methods, equipment and work safety. She suggests that an official training institute or several institutes could be established in Thailand. These institutes would also be helpful in India, and they could be operated by the mills. This needs, however, more studying. Future research could discuss
how willing the mills are to organise trainings, how these can be implemented efficient way to India, and what would be the results of the trainings. Through the training, mechanisation level would be increased and safety issues improved. The sites are also easy to operate for tractors and they could forward the wood to the road side if the transportation distance is too long for carrying by the people. It has to be taken into account in possible future studies, however, that the forest sector employs a significant number of people. Therefore, increasing the mechanisation level could affect negatively to the employment and further, decreases the incomes of the people.

Brush saws are commonly used in Thailand (Manavakun 2014). When the diameter of trees is small (5-10 cm) as in India, brush saws could enhance the productivity of harvesting work. Also, brush saws are much safer to use than chain saws (see an example from Picture 17). One may study, how to implement safely and effectively motor-manual logging to the paper industry in India. This could take place, for instance, through the training courses by the mills.

Picture 17. Harvesting with a brush saw (Husqvarna 2017).
Since loading a truck at the site takes several hours, it can be described as one of the most time-consuming process in the chain. Also, it needs many people to do it. The mill could invest on a grabber mounted for example to a tractor. It does not have to be large since the raw material is with rather small diameter and length. There should be at least one grabber-tractor combination on each procurement district. It can move to another harvesting site as the logs at the previous site are loaded to a truck. Then it would be fully utilised. When it is equipped with good lights, the loading process could take place even at the night time. The tractor can be operated by the mill’s personnel, or it can be outsourced. It would be interesting to see how this could work in practice as the mechanisation level in India is stated to be low. Thus, one future study area could be this.

Information technology could be utilised more. GIS based software and maps could advance procurement planning, and the supply could be updated in real time. Moreover, GIS is very helpful for optimising both forest and long distance transportation. Nowadays, when smartphones are more common, mills could develop own applications from where they can follow the status of procurement even in the field. Applications could include a wide range of information, e.g. details of farmers and the current supply. Also, as it seems that the information flow is insufficient in the current system, these applications can work also to keep the fluent information flow alive between the stakeholders in the chain. In addition to these, the mills’ gates gather truck queues rather fast and easily, and there is no appropriate system to handle the situation. Since the drivers can wait up to 24 hours before the truck is unloaded, it means loss of income. The applications could provide information of the line status at the gate. The drivers could check and book a specific time for unloading as well. Implementation of these applications and software could be one interesting area of future studies. All the stakeholders of the chain should be involved in the development.

As it has been mentioned, the uncertainty in the markets is complicating the operations of the mills. The uncertainty could be avoided by providing real time information of the markets, average market prices of raw materials, harvesting and transportation costs, domestic and foreign supply and such things. Some interviewed managers stated, however, that the information exchange in the sector is carefully monitored by the
government in order to avoid unfair competition in the markets. On that account is important to consider which data should be published and which not. Thus, this need more studying how to avoid the unfair competition while to provide real time information of the markets.
9 Conclusions

The study describes the status of wood procurement operations in the Indian pulp and paper industry. It needs to take into account that some of the results are not enough saturated and therefore, difficult to generalise to whole India. The basics seem to be, however, the same in all the sample mills: vendors and manual working hold still good today, transportation is carried out by trucks and the procurement organisations are built using the same formula.

Although the industry has developed considerably during the last few decades, there are lot of to be done and the task is very challenging. The need of paper products is decreasing globally, but in India, the development is the opposite. Therefore, to ensure the availability of raw material in the first place is crucial and it requires a lot of effort and work both from the government and the forest industry sector. Moreover, each stage in the wood procurement is needed to examine closer and all the extra processes should be taken away in order to improve overall efficiency of the system. This needs better communication and first of all, trust amongst the stakeholders.

Worth to consider is that pulp and paper industry globally is moving more to the southern hemisphere due to low costs. It could open new possibilities to India. Therefore, India needs to liberalise its economy and be more open to foreign investments. However, the burden of colonialism has been such that India is still looking its place amongst other growing economies.

Although the system needs a lot of developing, it was good to see how the industry is putting effort to improve the current situation. World-class nurseries and development centres, corporations where farmers can be involved, and mills own software to enhance the planning procedures are good examples which are needed to be recognised. The industry is also investing more and more in the cooperation with farmers where face-to-face meetings and plantations visits are essential parts. These facts proof that the industry is heading to the right direction, and most of all, is motivated to do whatever it takes.
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Appendices

Annex. 1

Predetermined interview questions

1. **How is the raw material procurement organised in your company in terms of organisation structure?**
   a. Are there any area representatives?

2. **What raw materials the mill(s) is/are using?**
   a. What are the genera in use?
   b. How much raw material is needed to produce one ton of pulp/paper?
      i. Are there any side products? If yes, where you are using it?

3. **Where does the raw material come from?**
   a. If there are more than one, please specify the shares of them.
   b. Are there any supplies outside of India?
   c. Of what elements the raw material price is formed?
      i. How the wood price is divided into different elements?
      ii. How much does the wood cost at the gate?

4. **How are wood plantations managed?**
   a. What is the average annual yield (tn/ha)?
   b. What is the average rotation of a stand in years?
   c. How the harvesting operations are carried out and what is the productivity in harvesting operations?
      i. What are the possible bottlenecks existing?

5. **How is the raw material transported to the mill?**
   a. If there are several methods in usage, please specify the shares of each in percentages?
      i. What are the factors affecting to the decision to use this/these specific method?
   b. Is the transportation operations outsourced or is it your own?
   c. What is the average transportation distance of each method?
      i. Is it increasing or decreasing? Please specify, why.
   d. What kind of trucks are in use?
   e. What you see as bottlenecks in raw material transportation?

6. **How is the raw material stored, both at the mill and the terminal?**
   a. Are you using any temporary terminals?
      i. If yes, where they are located?
   b. How long the wood is stored before using?
   c. How the storing affects to the quality and what those issues are?
   d. What you see as bottlenecks in raw material storing?

7. **How are the operations at the mill carried out?**
   a. How unloading is carried out?
   b. How many truck or/and train loads are coming to the mill per day?
   c. How the wood is measured?
d. Is there any quality checking at the gate?
   i. Or not, where it is done then or isn’t it done at all?

8. **What are procurement planning procedures?**
   a. How long in advance the planning is done and how often is it updated?
      i. What plans are done annually, monthly, and in an operative level?
   b. How does the information flow between different actors in a chain?
      i. Are you using any specific software?
      ii. Are you using any maps for planning?
      iii. Could the information flow be more efficient between companies, contractors and suppliers? If yes, how it could be developed?
      iv. How you get information from the suppliers? And how they get information from you?
   c. Do you do planning in an operational level, including purchase and financial planning?
   d. How well you can react on the changes in delivery and how easy is it to predict future demand?
   e. Are there any seasonal factors which need to be considered in planning (e.g. monsoon season etc.)?

9. **Open-ended questions**
   a. How you would describe your raw material procurement strategy and how efficient it is currently?
   b. In your point of view, what do you see as bottlenecks in the procurement system?
   c. In your point of view, how the system can be improved in general?
      i. Where to focus on?
      ii. What are the major problems?
      iii. What are limiting factors?
   d. In your opinion, how at-the-gate cost of wood could be reduced?
   e. How the government is succeeded to improve forestry and your operations in India?
   f. In what direction the pulp and paper sector in India will develop in next ten years, especially in terms of the raw material and its availability?
   g. What are the good things in the system?