MASTER

Technology and human resources in the Indonesian textile industry : the role of technological progress, education and HRD in economic performance

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Technology and Human Resources in the Indonesian Textile Industry - the role of technological progress, education and HRD in economic performance

Rick van der Kamp *1 August 1997*

Executive Summary

In this thesis, the role of technology and human resources in the Indonesian textile industry is invstigated. In order to do this, these concepts are defined as the quality parts of the factor inputs capital and labour, respectively. Their determinants are presented, and their developments in recent history are measured. The level of technology is measured by the maximum output per core-machine; the level of human resources is measured by changes in educational attainment and HRD activities. Indices for their developments are then contructed, and used as quality-adjustments in a growth accounting exercise for the Indonesian textile industry, and for the spinning and weaving industry seperately. The most important conclusions and recommendations will be given below.

The technology-index has increased from 100 in 1975 to 295 in 1994 (215 excluding the advance effect). In spinning, technological progress has been less rapid, with the advance effect causing an increase of some 91 percent in the period 1968-1994 and the shift effect only contributing 2.5 percent. In weaving, the shift effect caused an increase from 45 in 1940 to 332 in 1995, with the advance effect contributing another 85 percent during this period.

The human resources-index has developed from 100 in 1975 to 158 in 1995. The lion's share of this increase was caused by improvements in educational attainment of the employees over the years (56 percent), while only two percent was contributed by HRD activities.

The role of technological progress in economic performance has been a contribution of 30.4 percent to growth in value added in the period 1975-1994. Of this 30.4 percent, 16.9 percent has been due to the shift effect, and 13.4 percent was caused by the advance effect. Some 6.8 percent of growth in value added can be attributed to improvements in the level of human resources. Of this, 6.6 percent was caused by changes in educational attainment, and a mere 0.2 percent was due to HRD efforts.

Important recommendations for the Indonesian textile industry include a refocusing on the 'high-quality' segment of the textile market, since the 'standard-quality' segment faces increasing competition from a number of low-income countries. This refocusing should be accompanied by a continuing replacement of older technologies by newer ones, and a much more prominent place of HRD in personnel policies. Moreover, wages should be raised to increase domestic demand and attract better qualified employees. The government should play an important role in guiding these changes, and should make efforts to facilitate investments in new technology.

Acknowledgements

This research could not have been carried out without the help and support of a number of people. In Indonesia, I have had the privilege of being invited and working together with a group of wonderful people at the DTC, who have made my stay in Bandung unforgettable. I would particularly like to thank Pak Ben van Bronckhorst, who has initiated the cooperation between my department in Eindhoven and the Development Technology Centre (Institut Teknologi Bandung). Also, Pak Gede Raka has been responsible for my working-period in Bandung as head of the DTC, and provided inspired guidance. Pak Kusmayanto Kadiman, who succeeded Pak Raka, has been equally inspiring. Ibu Lanny Hardhy deserves special thanks as my daily guide and supervisor during my working period. Her helpful advice, as well as her knowledge of who to talk to, has been indispensable. Without the friendly help of the people at the Skill Development Project (Jawa Barat), I could never have carried out my field visits to the various textile firms. To all others - the staff of DTC, my friends at Sangkuriang, Khalid and Gail, and all other english teachers - I would just like to say: *Terima kasih terbanyak!*

In Eindhoven, many people have contributed in some way or another to the writing of this thesis. Leo Robben has assisted in setting up the cooperation between our department and DTC Bandung. Of course, my supervisors have been of great importance and help in the research process. I would like to thank Dr. Ad de Ron for his supervision as second supervisor. Prof. Eddy Szirmai deserves special thanks, being the initiator and the inspired overall supervisor of the process starting with acquiring the assignment until the final presentation of my thesis. Drs. Marcel Timmer, my third supervisor, has been both vital and essential in tackling a number of theoretical difficulties. Without his insights and on-line couselling in both Bandung and Eindhoven, I would have suffered greatly.

My family and friends deserve a special thanks as well, for all their immeasurable contributions. My brother Eddy, for his benevolent provision of his personal computer; my parents, for their considerable contribution to the costs of this research and of course their love and support; and Sophie Pauwels, for her understanding in difficult times. To the rest of my friends: nice one and thanks to you all!

Pada orang-orang di Indonesia: Masaku di Indonesia memang enak dan tak terlupakan. Mudah-mudahan saya bisa kembali ke Indonesia, supaya kita bisa berjumpa lagi. Untuk keramahan dan ke'ramah tamah'an yang saya terima begitu banyak: terima kasih lagi. Pada orang-orang di kantor DTC dan SDP: tidak ada ruang untuk menyebut setiap orang disini, jadi pada semua terima kasih untuk semua tawa..!

Preface

"...After I'd eaten breakfast I took a quick shower and crushed a cockroach that had dared into the communal bathroom of the cheap hotel I was staying in at the time. As I walked through the hall back to my room I took a moment to stand still and look at the ramshackle architecture across from the sewer-canal beneath me, outside the hall-window. In the rainy season, these cabines were never able to keep all the water out, I reckoned. Their inhabitants must be people from nearby kampungs, who didn't have family in the big city that could house them while they were working here to earn a living. The sewer-canal was in fact a small river and served simultaneously as a toilet, a laundrette and a bassin for drinking water. I watched these cabines and their inhabitants again as I walked from my hotel to the local bus-station, embarassed as one of them stared back at me and saw my disgusted face caused by the foul smell of the river. At the bus-station, many people were walking around without any apparent order or purpose. People were selling cigarettes and drinks, and others were there only to lure people into the 'angkots', the mini-vans that would take up to 14 people to anywhere on its route they wanted to for 300 Rp. The daily earnings of these people couldn't be more than 4,000 Rp..."

"...We hopped into Indra's brand new sedan and he drove us straigt to the Bandung Indah Plaza, while listening to his car's cd-system. In the beginning I had found it difficult to get used to the idea of living with students of a third-world country that had mobile phones and cars, but human beings can get used to a lot. Indra had parked his car and paid the parking attendant 200 Rp. We got out and walked into shopper's paradise, surrounded by the economic upper-class of Indonesia, that were more than willing to pay 200,000 Rp for some jeans as long as they were imported and genuinely American. We quickly made our way to the top floor, where we would catch a film in the luxury cinema situated there. To finish what had been a good day, we would grap some dinner at the McDonalds in the BIP. While the "warungs" outside were selling meals for 800 Rp, a meal at the Mac would probably set you back some 8,000 Rp. But then again, who's counting when you've got plenty anyway..."

There is a growing consensus among social scientists and policy-researchers that one of the big challenges for Indonesia in the near future is increasing the purchasing power of the vast majority of workers in agriculture and industry. If the momentum of economic progress is to be maintained, domestic demand will be playing an increasingly important role in industrial development. At the moment, Indonesia ranks amongst the countries with the highest social inequality in the world. I was in Indonesia during the riots of Tasikmalaya, Situbondo, West Kalimantan, Irian Jaya and a number of smaller riots in Jakarta and Bandung, amongst others. Beneath the surface of Indonesian friendliness and hospitality lies a growing dissatisfaction with the unimaginable economic inequality and the ever-present corruption that serves partly to maintain this status-quo. This anger culminates from time to time in outbursts of violence for seemingly incomprehensible reasons. The transformation of Indonesia from a low-income low-tech country into a middle-income high-tech country that is planned by the government will have to be accompanied by important improvements in labour-productivity, production-technologies and the level of 'human resources' for the many poor in Indonesia. These haven been some of the reasons for my research topics.

This thesis has come into being in cooperation with the *Centre for Research on Technology* (CRTech, also known as DTC), an institute of the *Institut Teknologi Bandung*. The field period of my research has been carried out at this centre.

Rick van der Kamp

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Introduction

This is a thesis about the Indonesian textile industry. It is the result of my Masters research that I have carried out in Eindhoven and Bandung to obtain my Master of Science title at the Eindhoven University of Technology, department of Technology and Development Studies (TDS). My motivation for choosing Indonesia as my area of research has been both personal and scientific. Both my grandparents were born in Indonesia, and via them I have always felt attracted to the archipelago. Within the context of development studies, Indonesia has experienced rapid growth rates as a 'second-tier' NIC (Newly Industrialised Country) for a good few years now. Developments in this country can be of great interest to other developing countries, as they themselves follow the path of industrialisation and economic development. In this setting, the textile industry is of particular interest because of its importance in the early stages of industrialisation, and because of its 'basic needs' character.

Problem definition and research questions

The Indonesian textile industry has been characterised by an impressive growth over the last 20 years. From an industry that catered mainly for the (protected) domestic market, it has transformed itself into a giant Indonesian manufacturing exporter. Its output increased over 15 times in this period, and the textile sector became one of the chief foreign exchange earners in the country. Labour-productivity increased dramatically, and wages in the textile sector followed this trend. In recent years, however, increased competition at the world market has seen Indonesian competitiveness fall slightly due to these increased labour costs. Compared to low-income countries like Viet Nam, China or Bangladesh wages in Indonesia are no longer in the lowest ranges of global textile production. A first response of the government to this declining competitiveness has been a sharp focus on technology and human resources as engines of economic growth in Indonesian manufacturing in their most recent five-year plan, *Repelita VI*. Although a broad consensus on these policy measures exists, the role of these factors in the economic development of Indonesian textiles, or in fact any other industry, is not yet completely known. Quality improvements in production (be it in the technologies used or the level of human resources) are mentioned frequently by managers and experts as important determinants of economic growth, but quantitative estimates are seldomly given. Past research has usually confined itself to the description of trends, rather than presenting economic analyses of the importance of these factors. The research question in this thesis is therefore:

> *What is the role of technology and human resources in the economic performance of the Indonesian textile industry?*

This question has been made operational by dividing it into a number of subquestions. These are:

1) *How can technology be defined and measured and how has it developed in recent history?*

2) *How can human resources be defined, how can its level be measured and how has this level developed in recent history?*

3) *What has been the role of these concepts in economic performance in the period 1975-1994?*

Approach

This thesis can be divided into two components. The first is a sector-study, in which the technological and economic developments of the textile sector in Indonesia are described, and related data are presented. The second is a growth accounting exercise in which I have tried to estimate the role of changes in the quality of the production factors in economic growth of the sector.
The sector study has been limited, and focuses primarily on a few aspects of Indonesian textile production that are relevant for the second part of this study. These aspects are the developments of economic output and value added, investment, labour-productivity, technologies used and the level of human resources, amongst others. It will also present conclusions reached by previous researchers in Indonesian textiles, as far as they are important for the other parts of this thesis.
The growth accounting part of this study has been limited as well. It will use the quantitative factor inputs labour and capital and quality-indices for both production factors - human resources and technology, respectively. A further decomposition of the residual (TFP) will not be attempted in this thesis.

Thesis outline

Chapter I serves as a general introduction to the Indonesian textile industry. First, a working definition for the Indonesian textile industry will be given. We will use, throughout this thesis, use the definition of ISIC category 321, and focus on medium- and large-scale firms (20 employees or more). The history of Indonesian textile production is presented, as well as governmental policies in the *Orde Baru* (New Order) period. Also, some of the economic data that will be used later on in the economic analysis or as background information for assumptions will be presented. Finally, some international dimensions such as labour costs and export barriers will be reviewed, and future prospects for the Indonesian textile industry will be discussed.

In *chapter II* a theoretical framework is sought to measure the contribution of technology and human resources in economic performance. We will see that the economic discipline of growth accounting provides an appropriate foundation for assessing the role of the factors of production in growth of output or value added. If the concepts technology and human resources are defined as the quality of the production, growth accounting can be used to estimate the (quantitative) role of technology and human resources in economic performance. A way of measuring the quantitative factor inputs also has to be found. For labour, we will see that total working hours, which is employment times average hours worked, is an apt measure. For capital, we will find that there are a number of important drawbacks attached to the use of the 'traditional' way of measuring real capital services (estimating the capital stock using the Perpetual Inventory Method). I have therefore decided to use another indicator for the capital stock, which is the number of core-machines in the textile sector. Core-machines are defined as the 'central' machines in the production process of the various subsectoral activities such as spinning and weaving. By using this indicator capital inputs can be divided into real capital stock, measured by the number of machines, and quality of the machines, or technology, measured by the maximum productivity (maximum output) of the core-machines.

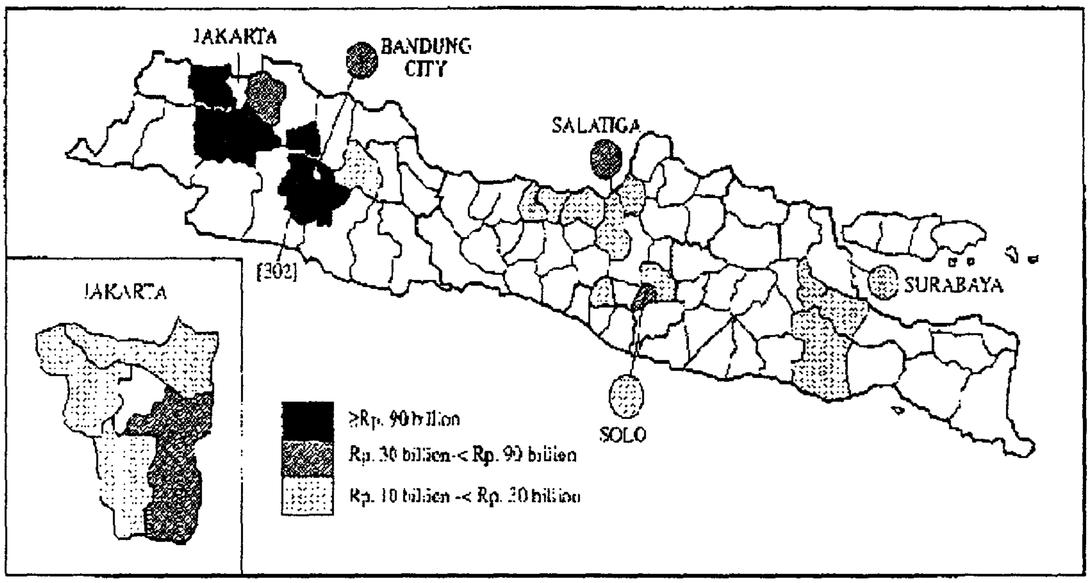
Chapter III will focus on technology. A narrow definition for technology will be used, referring only to the capital-embodied part of the broader concept of technology. A brief overview of the role of technology in economic theory will be given by using a few historical examples. Furthermore, the technologies used in the spinning and weaving subsectors in the Indonesian textile sector will be described at a technical level, and data will be presented on technical performance of the various types of core-technologies. We will also find that two effects can be distinguished in technological progress: the shift effect and the advance effect. With this information, an index for the 'level' of technology over the years will be derived using data on number of core-machines and productivity of the machines. Two indices will be presented: an index including only the shift effect, and an index including both the shift and the advance effect. The reason for this is the lack of precise and reliable data on the advance effect, which forces us to be prudent in estimating this effect and using it to derive conclusions. The technology-index at industry level (for spinning and weaving separately) will show us that the role of technological progress has been diverse. In spinning, the productivity of the core-machines has improved less than 3 percent in the period 1975-1994 if only the shift effect is taken into consideration. The advance effect, estimated at 3 percent annually, results in a development of the technology-index from 76 in 1968 to 170 in 1994 (1976=100). In weaving, the shift effect alone results in an increase in productivity of the weaving machine-park of over 7 times in the period 1940-1995. The advance effect (estimated at 1 percent annually) also contributes some 85 percentage points in the same period. For the entire textile industry, using weighted data on both subsectors, the shift effect has caused a productivity increase of some 128 percent in the period 1975-1994, while both the shift and the advance effect add up to 203 percent in the same time period.

Chapter IV deals with human resources. First, a definition of human resources is presented that is consistent with the traditional definitions of human capital and human resources; the productive potential of an individual or labour force. Secondly, some theories on the determinants of human resources, the role of human resources in economic growth and the relation between human resources and technology are given. Thirdly, the level of human resources in the Indonesian textile industry will be reviewed, focusing on education (schooling) and Human Resource Development (on-the-job training) in the sector. In the period 1975-1995, the average years of education received by the textile labour force has increased from 3.21 years in 1976 to 6.81 years in 1995. Information on the contents and some data of HRD activities in the textile sector is presented using the outcomes of field visits carried out in Indonesia. Fourthly, a human resources-index is constructed. Indices for the change in educational attainment and HRD activities are derived seperately, and afterwards combined. The index for educational attainment, using weights derived from income-educational attainment tables, has progressed from 100 in 1975 to 157 in 1995. The index for HRD is derived using a model suggested by Becker. Although the available data do not allow the construction of a statistically valid index, it has been derived with two objectives in mind: to challenge future researchers to further investigate into this important factor in economic production, and to suggest a methodology of investigating this aspect of industrial activity. The outcomes of this methodology are a contribution of 1.4 percent to the level of human resources in the period 1975-1995, assuming HRD activities have started in 1980. The final human resources-index has thus developed from 100 in 1975 to 159 in 1995.

Chapter V presents the equations and factor inputs used in the growth accounting exercise for the period 1975-1994, and, of course, the outcomes of this exercise. It is shown that over the period 1975-1993, annual growth of textile value added was some 16.9 percent. Of this growth (100 percent), 15.9 percent was contributed by growth in labour inputs, with 9.5 percent by growth in employment, -0.3 percent by average hours worked and 6.8 percent by increases in the level of human resources (6.6 percent for educational attainment and 0.2 percent for HRD activities). 37.9 percent of economic growth was accounted for by capital inputs, with 7.5 percent for the total number of (core-)machines and 30.4 percent for technological progress (16.9 percent for the shift effect and 13.4 percent for the advance effect). Economic growth that was unaccounted for, and can be found back in the TFP contribution, was 46.2 percent. If the advance effect and the HRD contribution are neglected (based on the insufficiency of relevant data for their calculation), TFP growth contributes some 59.8 percent of total growth in value added. At subsector level, spinning exhibits a high contribution of growth by capital inputs (68.6 percent), of which most is accounted for by increases in the number of machines (36.7 percent). In the weaving industry the shift effect is an important contributor with 25.7 percent. Labour and capital acccount for 13.9 and 34.4 percent, respectively, which results in a contribution of 51.7 percent by TFP growth.

Chapter VI presents the most important conclusions that can be drawn from this thesis, and will give recommendations for the near future. These recommendations will suggest that the Indonesian textile industry should refocus on the high-quality segment of the textile market. Accompanying, modern technologies should replace older machines and a stronger emphasis on and more investment in HRD is needed. Wages in the textile sector should be increased, to provide more purchasing power for the textile, which will benefit developments in the long-term. Finally, coordination and guidance should be given by textile organisations such as the API and the Indonesian government, who should also play a role in HRD efforts and capital provision.

I The Indonesian Textile Industry



In this first chapter, some general features of the Indonesian textile industry will be discussed. Its historical development and economic performance, as well as the government policies directed towards the textile sector are reviewed, after a working definition of the textile industry has been given. The economic performance of the textile sector in Indonesia in the period 1975-1994 will be treated in some detail. Important conclusions reached by authors that have investigated the Indonesian textile sector in the past will also be given some attention, as will happen with some international dimensions. Finally, some future prospects will be reviewed.

I-1 Definition

The textile industry can be defined as the industry that transforms some raw textile material (predominantly textile fibres) into yarn, fabrics and other textiles, except garments. In the ISIC list of industrial activities, textiles are defined with the 3-digit code 321.[1] This will be the foundation for the working definition used in this thesis. Furthermore, I will confine myself to medium- and large-scale industries (firms which employ 20 persons or more). There are two reasons for this. First, the available annual statistics from the BPS that are frequently used in this thesis all refer to medium- and large-scale industries. If small-scale industries had to be included as well, a detailed statistical analysis would not be possible. Secondly, the small-scale textile industry only constitutes a very small part of total textile output and employment. In 1986, employment in the small-scale textile industry (less than 20 persons employed) was 46,197, against 310,247 in the medium- and large-scale industries. Gross value added in the small textile firms was 32.4 billion Rp, while medium- and large-scale companies contributed 1,046.8 billion Rp. Employment was thus only 13 percent of total employment, while gross value added only constituted 3 percent of total value added in the textile sector.[2]

The textile sector can be further divided into subsectors. The Indonesian bureau of statistics, the *Biro Pusat Statistik* (BPS), uses a subdivision that is based on the ISIC categories. Firms that are involved in spinning, weaving, finishing, batics, bags, made up textiles, knitting, carpets and rugs, cordage and twine, capok and other textile activities are all categorised along these lines. Table I-1 presents this classification, together with their performance in value added and employment in 1994. The importance of the weaving sector in Indonesia is obvious, accounting for 45.3 percent of employment and 54.9 percent of value added. Spinning and knitting are second and third, respectively.

In 1992 a new classification was adopted by the BPS. Spinning activities were further divided into spinning mills (32111), threads (32112) and finished yarn (32113). The weaving subsector 'moved' code in this new classification, now represented by code 32114. Knitting remained unchanged as well, and some other minor changes were made.

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[1] United Nations, *ISIC classification*, 1968

[2] Data on small-scale textile industries from BPS, *Sensus Ekonomi 1986 - Statistik Industri Kecil 1986*, Jakarta, 1986

Table I-1 The textile industry subdivided, 1994

ISIC code	*description*	*employment*	*%*	*Gross Value Added*	*%*
32111	Spinning	136,827	22.4	2,288,337,074	29.5
32112	Weaving	276,831	45.3	4,259,488,264	54.9
32113	Bleaching, dyeing, finishing, printing	27,003	4.4	220,398,689	2.8
32114	Batics	15,987	2.6	47,339,431	0.6
32115	Gunny and plastic bags	9,670	1.6	37,437,893	0.5
32120	Made up textiles	25,955	4.2	140,910,080	1.8
32130	Knitting	91,883	15.0	509,085,457	6.6
32140	Carpets and rugs	2,230	0.4	49,943,295	0.6
32150	Cordage and twine	11,061	1.8	55,014,920	0.7
32160	Capok	4,411	0.7	9,776,683	0.1
32190	Other textiles	9,433	1.5	135,272,990	1.7
321	Textiles	611,291	100.0	7,753,004,776	100.0

Source: BPS, Statistik Industri, 1994

Various authors and institutions have included up- and downstream industries related to the Indonesian textile sector in their definition. Both Hill and the Indonesian Department of Industry, for instance, include synthetic fibre making in their analysis of the textile industry in various publications.[3] Since this industry is solely dependent upon the textile producers (in particular the spining mills) for its demand, this is not entirely illogical. However, the production of synthetic fibres is listed as a distinct category within the ISIC framework. Its place is among the chemical industries, and falls within the subdivision of synthetic resins and fibres. At 4-digit level, its ISIC-code is 3513.[4] The BPS (1990) classifies synthetic fibre production as a separate industrial activity at 5-digit level, with code 35133.[5] In the SITC classification, which is used in trade statistics, synthetic fibres are also separated from textiles.[6] Hill (1992) uses a definition in which spinning and fibre making both are included in ISIC 32111. In the SITC classification, Hill does acknowledge the special position of synthetic fibres. Given the classification used both by ISIC and by the BPS, it is not entirely certain whether problems can be avoided when using industrial statistics in the analysis.
Throughout this thesis, the working definition of the 'textile sector' or 'textile industry' will be as defined by the ISIC classification (ISIC 321), and adopted by the BPS, for medium- and large-scale industries (20 or more persons employed). At subsector level, the categories used by the BPS and listed in table I-1 will be used.

[3] See for instance Hill, H., *Indonesia's textile and garment industries - developments in an Asian perspective*, Australian National University, ASEAN Economic Research Unit, Institute of Southeast Asian Studies, Singapore, 1992

[4] United Nations, *ibid.*, 1968

[5] This has been a recent change in coding with the BPS. In 1987, synthetic fibres were still classified together with synthetic resins at 5-digit level (code 35130).

[6] According to the SITC, textiles are classified with code 651, while synthetic fibres are denoted with code 266.

I-2 Historical developments

The textile industry has been among the most important industries in Indonesia for a long time already, as it has been for a large number of developing countries in the 20^{th} century. Together with the food processing industries, it is usually one of the first manufacturing industries in the developing world. Its position as an industry providing for one of the most important basic needs for all inhabitants of a country largely explains its importance in the early stages of industrialisation. In an international context, developing countries usually have a considerable advantage in textile production, since the bulk of textile production is considered to be a 'low-tech' and labour-intensive industrial activity. Because of their low level of wages, developing countries are able to produce at lower costs than developed countries, and can become net exporters of textiles.

An extensive documentation on the developments of the Indonesian textile industry is available. I will attempt to give a survey of the most important issues, while the interested reader can refer to the bibliography for a more concise treatment of textile developments in Indonesia.

The rise of the Indonesian textile sector

The first industrial textile manufacturing efforts were made as early as the 1920s, when the introduction of an improved version of the handloom triggered industrial weaving activity.[7] The emergence of a factory weaving sector was mainly set in the area around Bandung, as a consequence of the presence of the *Institut Teknologi Tekstil* (Institute for textile technology, ITT) in this city. This institute was responsible for the development of the *ATBM (Alat Tenun Bukan Mesin)* the improved and partly mechanised handloom. Shortly after the ATBMs, the power looms were introduced in Indonesia. Both types of machinery were present in Indonesia at the start of the 1930s, a decade that was characterised by rapid growth of the weaving sector. The number of handlooms grew from a total of 257 in 1930 to some 44,000 ten years later, while power looms expanded from 44 to 8,000 by 1940.

Not much is known about the 1940s, which is partly due to the disruption of normal life because of the second World War and the struggle for independence that followed. It is clear, however, that little growth was achieved during this period. The 1950s saw the return to normal working conditions, which accounted for much of the increase in output during the first few years. Economic activity in general during the next ten years became increasingly chaotic, and the weaving sector proved no exception. Large foreign mills were nationalised, and the weaving producers were '*...at the mercy of unpredictable supplies of yarn import, much of them channelled through the Kooperasi to hand loom weavers*'.[8] By 1965, economic activity had as good as collapsed, and the country was at the eve of great political turmoil. The *Old Order* period (a name later given to the Sukarno era) came to an end, and the *New Order* government took power, lead by general Soeharto. Their first aim was to rehabilitate the economy and focus on economic growth and political stability.

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[7] See also next chapter.

[8] Hill, *ibid.*, 1992

The New Order and government policies

The development of the textile industry in the New Order period (1968-) is very much linked to government policy, which is why the two will be described simultaneously. One of the first actions of the new government was to introduce some capital-cheapening measures, to dismantle the yarn allocation system and to remove trade barriers. These policies resulted in a rapid transition of the weaving sector from one dominated by the ATBMs to a sector operating mainly with power looms. In ten years the ATBMs had as good as vanished, while the number of power looms (or shuttlelooms) had more than tripled. Despite the facilitating of capital imports, Hill (1992) claims that '*...a range of capital-cheapening distortions (...) may have hastened the the disappearance of the hand looms, but the fundamental determinant was an economic one.*' As we shall see in the next chapter, this observation is quite true.
Together with the acceleration of the weaving sector the spinning sector began a rapid development, after a long period of stagnation since the 1930s or so. Reasons for this 'take-off' were similar to those for the expansion of the weaving industry. Differences did exist as well, however, since most of the spinning mills had been nationalised and were thus government owned by the 1960s.
The government decided in favour of a protective policy package in the early days of the New Order. Import-substitution was practised, and firms were given the opportunity to grow within a protected domestic market. Rapid domestic growth and a guaranteed market sales provided a fertile basis for investment, while tax incentives further promoted investment in the textile industry. This resulted in a rapid growth of the entire textile sector, with spinning output growing 15-fold between 1969 and 1988.
Wibisono (1987) divides textile policies and developments into three periods: the period of stabilisation and rehabilitation (1966-1968), the period of import-substitution (1969-1981) and the period of export promotion (1982-).[9] The first period saw the introduction of a number of policy measures aimed at triggering growth in the textile sector. The second period provided a base for expansion while imports could be reduced and the domestic demand could be satisfied. The third period saw a shift in focus of the government, that wanted to ensure a more diverse composition of its foreign exchange earners (up to that period oil had been the dominant provider of foreign exchange), and wanted to develop and strengthen its industrial manufacturing brache.

For a more detailed look at government policies during these three periods, it is useful to take a closer look at policy measures taken during the successive *Repelita (Rencana Pembangunan Lima Tahun*, five-year development plans).
Repelita I (1969-1974) focused on rehabilitating the economy. State investments were made in new spinning mills, and the judicial framework for the textile industry was set up. The role of foreign capital and investment was regulated, and a range of tariff and non-tariff barriers was set up to protect infant industries. Tax reduction for investment was introduced, and tagets for textile production were set.
Repelita II (1974-1979) aimed at providing better primary necessities for the population. In the textile sector investments were made in development and rebuilding of factories and increasing production of raw materials, spare parts and capital goods. Also, saturated industries were given the opportunity to close. In this period, the first synthetic fibre plant was officially opened. Cooperation between small- and large-scale firms was actively supported,

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[9] Wibisono (1987), as quoted in Koesmawan, *Textile export marketing and technology acquisition efforts in the Indonesian textile industry: a case study*, University of Twente, Enschede, 1996

and a start was made with the development of industrial guidance and counselling. Fiscal policies for imported materials were enacted, to increase export competitiveness.
Repelita III (1979-1984) largely focused on ongoing developments, with specified objectives such as product quality and diversification. In this period, exports began to grow considerably.
Repelita IV (1984-1989) stressed the development of manufacturing industries other than oil and gas to enhance the industrial base and diversify the sources of foreign exchange, set off by the sharp decline in oil prices in the previous period. Monetary policies were aimed at building a 'managed float' exchange rate system with the US dollar, to keep the Indonesian Rupiah in pace with terms of trade and inflation developments. Efficiency improvements were aimed for by reforming customs, port administration and inter-island freight operation. During this repelita, the famous trade reform packages were introduced (1986 and 1987), removing constraints on foreign investment and export barriers. In 1986, a system was introduced that allowed export producers to purchase raw materials at the international market for world market prices (the duty draw-back system), which placed exporters on a free trade footing.
Repelita V (1989-1994) saw the continuation of the measures put in effect in the previous program. Special emphasis was now placed on 'deepening industrial structure'. Policies for trade were further improved to be conducive to exports.
On *Repelita VI (1994-1999)* relatively little can be found in existing sources. Its general focus is on modern technology and improving human resources. Various measures to promote the use of modern technology and the building of human resources have been introduced. A minimum wage (*Upah Minimum Regional*, a regional minimum wage) has been introduced, and continued expansion of the textile firms has been highlighted, while small, non-profitable firms are given the possibility of bankrupcy. Application for industrial quality standards (ISO) has been promoted to improve working and production conditions.

With respect to up- and downstream industries, the government has always aimed at an increase in self-reliance by actively promoting domestic production of both raw and intermediate materials and end-products. In 1979, the first synthetic fibre plant was opened, and the production of synthetic fibre has gained importance over the last ten years. Dyestuff production (an intermediate material used for dyeing) hase also been taken over from foreign firms, and protected as an infant industry. Garments have been, together with synthetic fibres, the most recent textile-related industries to develop. Its development speed has, again, been impressive.

The textile industry at present

The Indonesian textile industry has become Indonesia's largest non-oil foreign exchange earner, and the largest manufacturing producer together with the food-processing industry. Some of its key features have been collected in table I-2, which has been taken from Hill (1992). Interesting features of the textile sector are the historical difference between spinning and weaving factories (see previous paragraphs), and their location. Textile producers in Indonesia are overwhelmingly present in West-Java (and Jakarta), and to some extent in Central-Java. Policies of the Indonesian government to promote spatial distribution have been largely without succes. Reasons for this concentration include proximity to suppliers, trade ports (Jakarta) and the administrative centre (Jakarta).

Table I-2 Key features of the Indonesian textile industry

Feature	*Spinning*	*Weaving*
History	Mainly new	Many old firms
Factor proportions	Moderately capital-intensive	Labour-intensive
Scale economies	Significant	Moderate
Ownership	Significant foreign and government	Mainly domestic private
Vertical integration	Common (spinning-weaving)	Not widespread (except very large mills)
Size distribution	Very large firms dominate	Mainly large and medium firms
Sales orientation	Mainly domestic (for 'direct' sales)	Both export and domestic
Location	Mainly West-Java	Mainly West-Java; Central-Java sizeable

Source: Hill (1992)

In 1994, employment in the textile industry was recorded at 611,291 employees.[10] This placed the textile industry in the position of the largest manufacturing employer at 3-digit ISIC level. Gross output totalled 20,884 billion Rp, while gross value added was 8,055 billion Rp. Figure I-1 gives the shares in value added (at factor costs) of all manufacturing industries. Textiles alone take up as much value added as all food processing industries. The performance in manufacturing employment and value added again highlights the importance of the textile industry for Indonesia.

Exports had reached 5,332 billion Rp, or about 25 percent of total production in the textile sector. This share of exports in total production has been high (up to 40 percent) for the last four years.

Imports of finished products have not declined, as would normally be expected. In fact, imports of textile products have risen to some 2,480 billion Rp in 1994. This seemingly paradoxical development can be explained by a difference in the quality of domestic and foreign textile products.

Textile firms are now bigger than ever, and continue to grow. The average number of employees per establishment in the textile sector was some 303 in 1994, and has been growing steadily over the last 20 years.

A development that is not directly reflected by the most common economic statistics is the growing 'modernisation' of the Indonesian textile sector. Textile experts, managers and economic journalists all mention the integration of the sector in the world market, which is accompanied by increasing exposure to competition. Moreover, the textile industry is already focusing on the use of the most modern equipment, and is becoming increasingly aware of the influence of human resources in the production process. Starting firms at the moment only invest in the newest machinery, and international production quality standards (e.g. the ISO standards) are being applied for so that future sales can be secured (buyers in developed countries increasingly demand ISO or other qualifications from their global suppliers).

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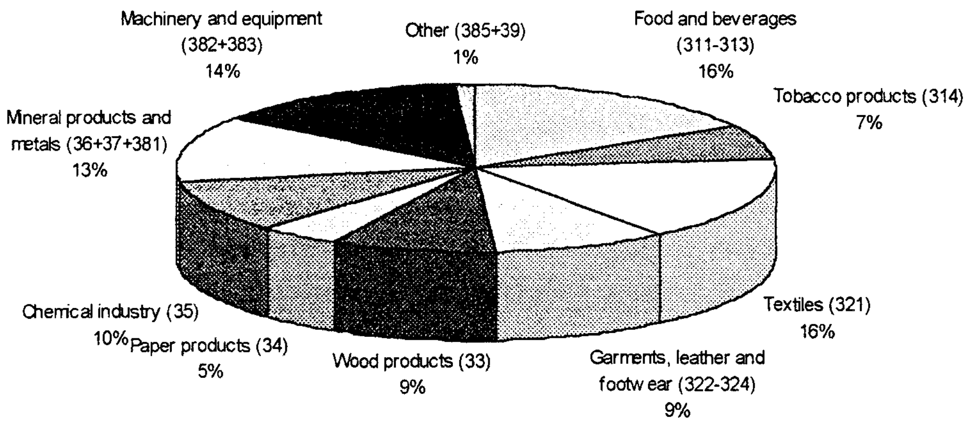
[10] All economic data from appendix

Figure I-1 Shares of Value Added in Indonesian manufacturing, 1994



Source: BPS, Statistik Industri, 1994

I-3 Economic performance between 1975 and 1994

Since the focus of this thesis will be on the period 1975-1994, economic performance in this period will play a very important role in the various analyses. We will therefore discuss a number of economic indicators and their development in the Indonesian textile industry.
In figure I-2 we see the development of gross output, gross value added and employment costs over the last 20 years. It should be noted that in the figure employment costs are included in value added, and that value added is included in gross output. The impressive growth of the textile sector in the last 20 years can be seen immediately; output in 1975 equalled 950 billion Rp (constant 1990 Rp), in 1994 this total had increased to 18.3 trillion Rp, or an increase of almost 20-fold. Gross value added has witnessed a similar increase, starting off at 238 billion Rp, and reaching 7.1 trillion Rp in 1994, almost 30 times its original total. Employment costs have gone from 103 billion to 1.2 trillion Rp in the same interval, which is a growth of more than a factor 10.
These differences in growth rates would lead to the suggestion that the composition of gross output has changed significantly over the years. To test this, we should look at the distribution of output. No table is given here, but the results will be discussed. The data for this analysis can be found in the appendix, knowing that the main other components of gross output are input costs and capital costs. The share of employment costs in total output has dropped slightly, from an average of about 10 percent in the first ten years of our concern to about 8 percent in the next 'decade' (1985-1994). The share of gross value added in gross output has varied from 25 to 35 percent. In 1994, the share of value added was unusually high at 39 percent. Conversely, the share of input costs in output has varied from 75 to 65 percent, with a low in 1994 of 61 percent. No unidirectional trend can be observed in these patterns, however.

It is interesting to see whether this growth in output and value added is also accompanied by a growth in labour productivity. Figure I-3 provides an indication of the developments of labour productivity in the period 1975-1994. The values have been transformed to an index, to allow a better comparison with the average level of wages in the textile industry. Szirmai has found similar patterns of labour-productivity developments in the period 1975-1990.[11] His data are derived from the same source (BPS), although a revision is mentioned. This probably explains the marginal differences that can be found. In the same paper, Szirmai finds that textile labour-productivity has 'caught up' to some extent with the world productivity leader (United States); relative labour-productivity has grown from 7.6 percent of US labour-productivity in 1975 to some 17.4 percent in 1990. As can be seen in figure I-3, Indonesian textile labour productivity has also grown considerably, by some 9-fold in the 20 years considered. No sharp rises can be observed, except for the last year (1994), in which labour productivity rose dramatically. Economic theory states that if the growth of the wages is not parallel to the growth of labour-productivity, the shares of labour and capital in value added will change.

Figure I-2 Gross output, value added and employment costs, 1975-1994

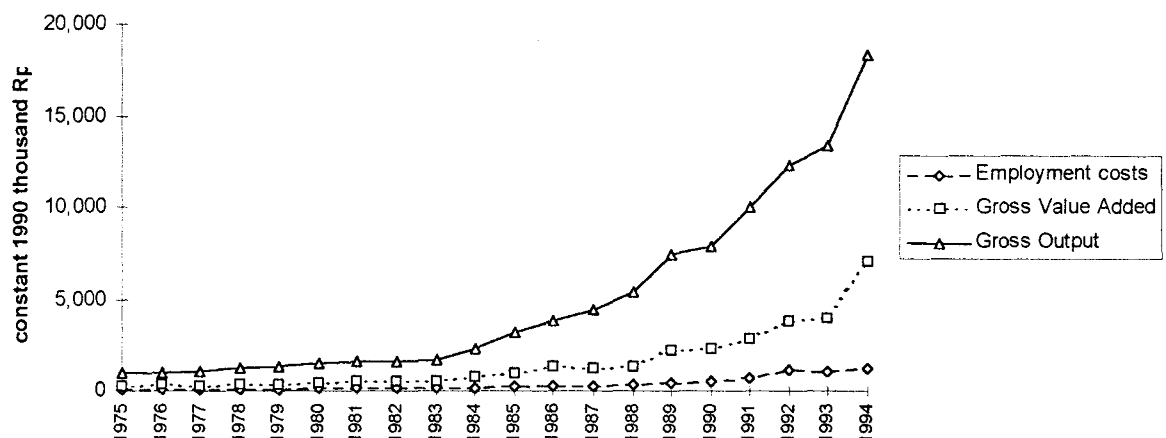
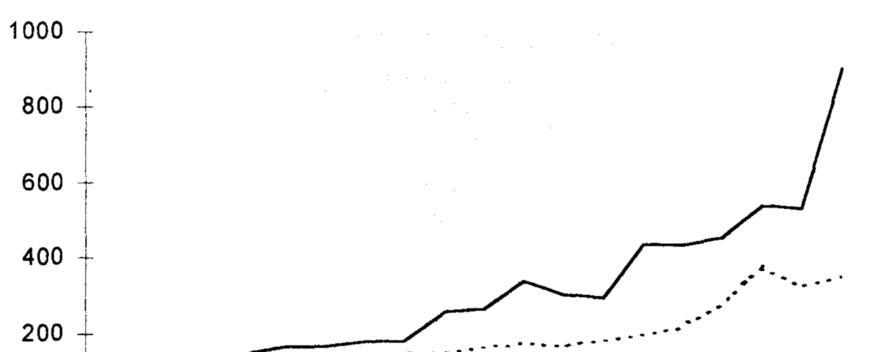


Figure I-3 Labour productivity and average wages, 1975-1994
(index)



Sources: BPS, Statistik Industri, appropriate years

[11] Szirmai, A.E., *Comparative performance in Indonesian manufacturing, 1975-1990*, Research Memorandum 538 (GD-3), 1993

We can see in figure I-2 that growth of labour-productivity has not been matched by equal increases in the level of wages, which results in a larger share of capital in value added (which can also be seen in figure I-1). From 1989 to 1992, the level of wages seems to be making up for its 'lost ground' in comparison with labour productivity, but in 1993 wages drop, to pick up again in 1994. By then however, the difference between the growth of labour productivity and the level of wages has reached a factor 2.5.
As we have seen in the previous sections, textile exports have become a very important foreign exchange earner in Indonesia. In 1994, textile exports took up more than 25 percent of total textile production. The development of textile exports, starting in 1984, is depicted in figure I-4. Textile exports are defined here according to the SITC classification (SITC 65), which is used in trade statistics. It quickly becomes obvious that the exports of textiles has grown impressively, from 278 million US$ (286 billion Rp) in 1984 to a maximum of 2,624 million US$ (5,327 billion Rp) in 1992.

One of the first requirements for a growth of production is investment. The growth pattern of the Indonesian textile industry suggests that at least part of this growth should be accompanied, or caused, by large investments in this sector. Figure I-5 presents the investment data for the Indonesian textile industry in the period 1975-1994. As can be seen, large-scale investments have indeed been made. A peak in 1978 and 1979 preceeded the dramatic 'jump' in investment starting in 1988, when liberalisation and export-promotion policies triggered large-scale investment in the textile sector, as the sector became central in the countries focus on labour-intensive manfacturing exports. Data gathered by Hill (1992) reveal that a large 'investment-boom' also took place in the period 1970-1975, when import-substitution secured a steady growth of the sector. This period, however, falls outside the scope of this analysis.
The composition of the investment totals is another point of interest for this thesis. When we will take a closer look at the technological side of the textile sector, we will focus mainly on the machinery and equipment side of the stock of capital goods. Figure I-6 presents the composition of the total investments of 1990 and 1994. Machinery and equipment (represented by 'machines' in figure I-5) take up the largest part of investments. Its share varies from 70 to 80 percent. Vehicles, buildings, land and other investments are much less important. The growing share of machinery and equipment in total investment might be explained by the rapid modernisation of the textile industry in Indonesia; more and more, the latest equipment is bought by textile firms, which is naturally more expensive than second-hand or older-generation equipment.

On the nature of the textile firms operating in Indonesia, the following can be observed. The number of textile firms has been around 2,000 for the last 20 years. Figure I-7 shows the number of establishments in the period 1975-1994. No clear pattern can be discerned here. A definite conclusion can be drawn with respect to the size of the firms, however. Figure I-7 also presents this indicator, and clearly shows that the average number of workers per firm has been rising steadily over the last 20 years. Somewhat of an acceleration can be witnessed starting around 1989, which coincides with the dramatic increases in investment. A possible explanation for this development is the 'integration' of the Indonesian textile sector in the world market, as described in the previous section. Increased competition might have forced textile firms to grow bigger in terms of employment. This might also indicate the existence of 'economies of scale' within the textile industry. According to textile experts, bigger textile firms in Indonesia are also the more modern ones, and the ones better connected and more capital-intensive (which is practically the same as being 'more modern').

Figure I-4 Textile exports, 1984-1995

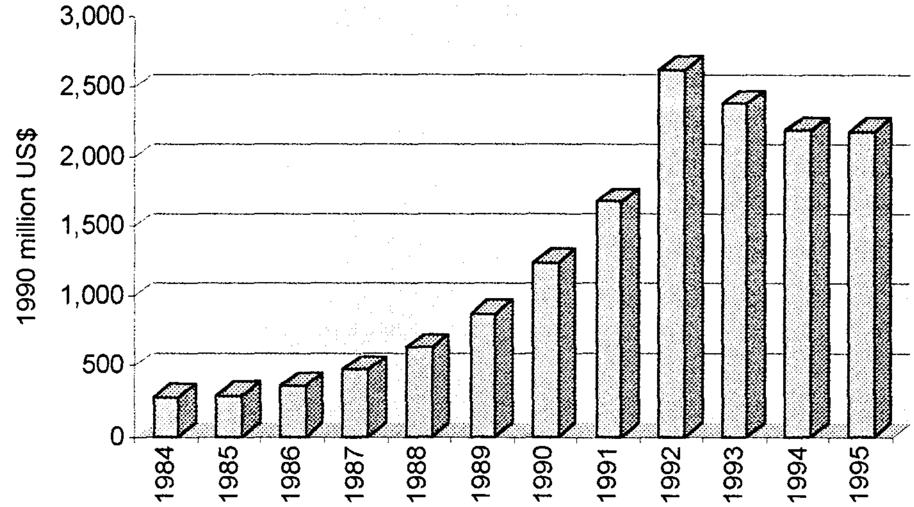


Figure I-5 Total gross investment, 1975-1994

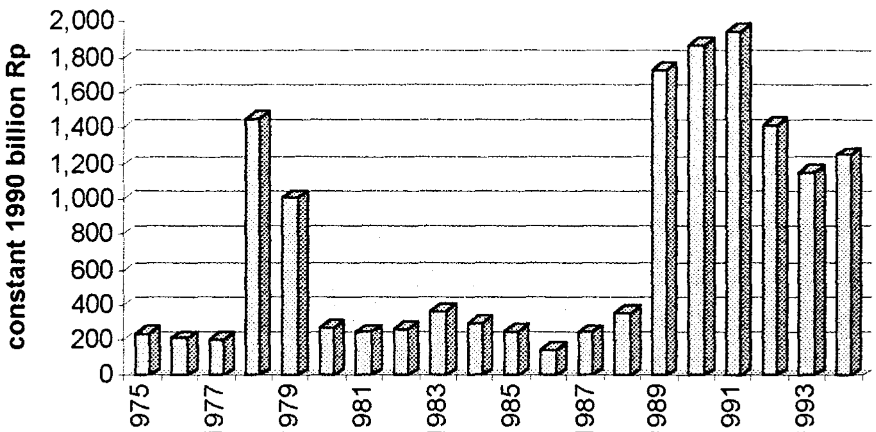
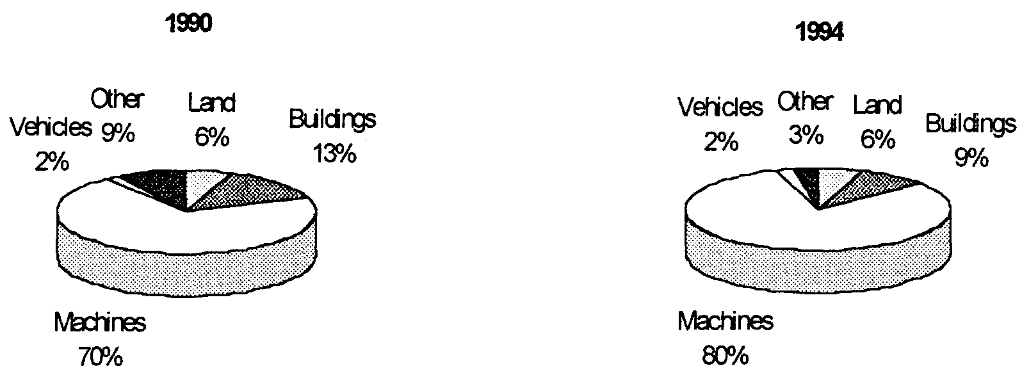
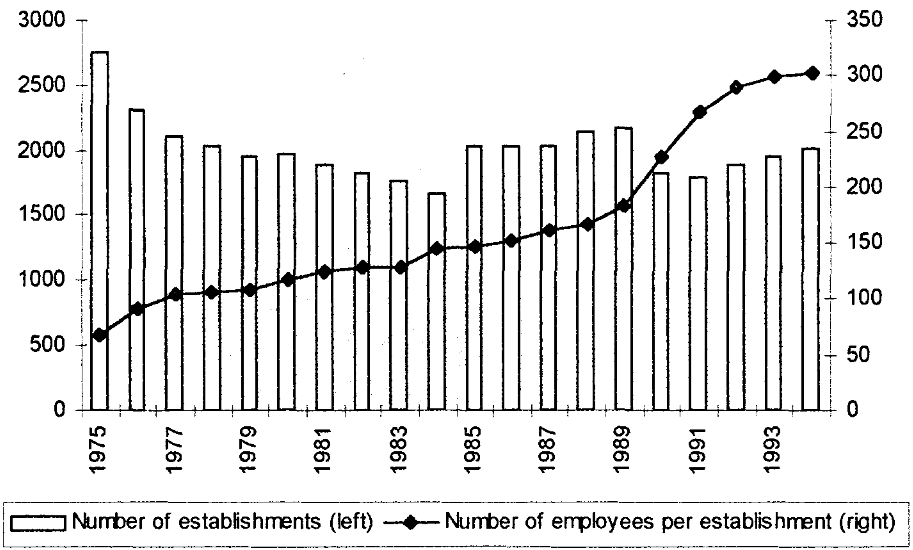


Figure I-6 Composition of textile investment, 1990 and 1994



Sources: BPS, Statistik Industri, appropriate years

Figure I-7 Number of establishments and number of employees per establishment, 1975-1994



Source: BPS, Statistik Industri, appropriate years

I-4 Some other aspects

In this section, I will discuss some aspects of the textile industry in Indonesia that have not yet been mentioned. Some international dimensions will be discussed, since the world textile market has become rapidly more important for Indonesia. Conclusions that have been drawn by researchers that have investigated the Indonesian textile sector in the past will also be given some attention. Finally, some remarks with respect to future prospects will be made.

International dimensions

The growing orientation towards exporting the products of the textile sector in Indonesia, starting in the early 1980s, forced the textile producers to adopt a more outward-looking attitude. Comparative advantages that Indonesia possessed over its foreign competitors had to be put to use to ensure continued expansion of the textile sector. At this time, Indonesia's main advantage was its cheap labour wages. Global textile production has a history of shifting its location to where the employment costs can be minimized, if, of course, continued production could be guaranteed. Indonesia provided a high level of political stability, and possessed a class of entrepreneurs that was willing to invest in and to manage textile production centres that could supply a large number of countries with their textile inputs. Table I-3 gives an overview of textile exporters in the world. For the two largest subsectors, spinning and weaving, this table lists the shares in exports for the years 1990 and 1993. The data used are derived from Indotextile, that has derived their information from GATT sources. The definition of spinning and weaving products are those applied by the SITC.

Table I-3 Shares in world exports of spinning and weaving products, 1990 and 1993
(million current US$)

	Spinning products				Weaving products				Total			
	1990		1993		1990		1993		1990		1993	
Italy	2,078	11.3	2,110	10.8	5,540	15.5	5,795	13.0	7,618	14.1	7,905	12.3
Germany	3,220	17.5	2,639	13.5	5,728	16.0	5,104	11.4	8,947	16.5	7,743	12.1
Korea	867	4.7	944	4.8	3,814	10.7	5,604	12.6	4,681	8.7	6,548	10.2
China			1,329	6.8			4,251	9.5			5,580	8.7
Japan	114	0.6	1,078	5.5	3,483	9.8	3,937	8.8	3,597	6.7	5,014	7.8
France	1,214	6.6	1,001	5.1	2,923	8.2	2,484	5.6	4,136	7.6	3,486	5.4
USA	1,242	6.8	1,024	5.3	1,306	3.7	1,676	3.8	2,547	4.7	2,700	4.2
Belgium-Lux	1,009	5.5	1,021	5.2	1,779	5.0	1,612	3.6	2,788	5.2	2,633	4.1
Pakistan	1,003	5.5	1,200	6.2	883	2.5	1,375	3.1	1,886	3.5	2,575	4.0
UK	1,258	6.8	991	5.1	1,422	4.0	1,290	2.9	2,680	5.0	2,281	3.6
Indonesia	109	0.6	390	2.0	755	2.1	1,553	3.5	864	1.6	1,942	3.0
India	360	2.0	655	3.4	727	2.0	1,106	2.5	1,087	2.0	1,760	2.7
Switzerland-Lcht	834	4.5	612	3.1	909	2.5	610	1.4	1,744	3.2	1,222	1.9
Spain	473	2.6	474	2.4	504	1.4	567	1.3	977	1.8	1,041	1.6
Hong Kong							1,032	2.3			1,032	1.6
Austria	453	2.5	370	1.9	802	2.2	618	1.4	1,255	2.3	988	1.5
Thailand	212	1.2	294	1.5	474	1.3	691	1.5	686	1.3	985	1.5
Singapore	154	0.8	223	1.1	471	1.3	627	1.4	625	1.2	850	1.3
Turkey	493	2.7	347	1.8	315	0.9	430	1.0	808	1.5	777	1.2
Brazil	317	1.7	227	1.2	135	0.4	209	0.5	452	0.8	436	0.7
Others	2,968	16.2	2,555	13.1	3,729	10.4	4,018	9.0	6,697	12.4	6,573	10.3
Total	18,378	100.0	19,485	100.0	35,699	100.0	44,588	100.0	54,077	100.0	64,073	100.0

Source: Indotextile, 1996

In 1993, when the big export-boom had already accelerated Indonesia's textile exports, Indonesia was the eleventh exporter of spinning and weaving products in the world. The prominent position of many European countries in textile exports is noteworthy, as well as the fact that most 'top-ten' countries are in fact industrialised or semi-industrialised countries. Only China and Pakistan preceed Indonesia in this listing as developing countries. The rapid growth of shares and absolute exports of Indonesian textiles is another item that deserves attention, and which is confirmed by national data on exports. In three years time, Indonesia has increased its share in global textile exports from 2.0 to 2.7 percent.

♦ *Labour costs*

An interesting indication of the advantage in labour costs is given in table I-5. In this table, wages in the textile sector in various countries have been estimated in current US$ per hour. Some large gaps between 1984 and 1990 can be explained by the different sources used for both years.

The difference between the industrialised countries and the developing countries becomes clear immediately. Between Indonesia and West-Germany, for instance, the difference in labour costs is 20-fold. The textile industry, with its generally labour-intensive nature, should thus be expected to follow international developments of labour costs. The increasing level of globalisation, defined by Erich Gundlach as the free flow of capital between different countries[12], will hasten such developments even further.

Table I-5 lists a large number of developing countries, with their textile labour costs per hour. The most recent developments in the international textile market indicate that Indonesia is slowly losing its competitive edge in labour costs. Various sources confirm that countries like Viet Nam, Bangladesh and China are rapidly developing an industrial base that will enable them to produce textiles and textile products as well, with labour costs that are even lower than those in Indonesia. It should be mentioned here that labour costs alone are not the sole determinant of competitiveness. If labour-productivity rises faster than the level of wages, as has happened in Indonesia, the 'index of competitiveness' (if there were such a measure) should actually grow, since the production costs per unit of output have dropped. However, there is no information on the level of labour-productivity in other textile producing countries. If these countries have witnessed similar developments with respect to labour-productivity and wages, Indonesian relative textile competitiveness may still have deteriorated.

Other countries with comparitively low labour costs are sometimes hampered by other unfavourable conditions that prevent large scale industrial (textile) investment, such as political or monetary instability (Nigeria and Russia). Singapore's position is also exceptional - its produces more per capita than many developed countries, but its labour costs are considerably lower than its western competitors.

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[12] Gundlach, Erich, *Falling behind or catching up?: Developing countries in the era of globalisation*, working paper prepared for the international seminar "Developing countries in the global economy: perspectives for Indonesia", Bandung, 2 Octobre 1996

Table I-5 Wages in the textile sector in various countries, 1985
(current US$ per hour)

	1984	*1990*	*1993*	*1994*	*1995*
Industrialised countries:					
Japan		13.96	23.65	25.62	31.27
West-Germany	4.67	16.46	20.50	20.77	24.23
Italy	4.25	16.13	16.20	15.65	15.91
Canada	4.70	12.83	13.44	13.60	14.18
USA	4.10	10.02	11.61	11.89	12.18
UK	3.49	10.20	10.27	10.74	11.60
Developing countries:					
Taiwan	1.60	4.56	5.76	5.98	6.47
Hong Kong	1.81	3.05	3.85	4.40	4.70
South Korea	1.57	3.22	3.66	4.00	4.44
Singapore		2.43	3.06	3.65	4.01
Malaysia		0.86	1.18	1.77	2.45
Mexico	1.82	2.21	2.93	3.22	2.27
Thailand	0.53	0.92	1.04	1.41	1.63
Phillipines		0.67	0.78	0.95	1.08
India	0.61	0.72	0.56	0.58	0.61
PR China	0.20	0.37	0.36	0.48	0.52
Russia		1.69	0.57	0.32	0.52
Indonesia	0.23	0.25	0.43	0.46	0.50
Kenya		0.63	0.31	0.41	0.46
Sri Lanka		0.24	0.39	0.42	0.45
Viet Nam			0.37	0.39	0.42
Nigeria		0.30	0.41	0.36	0.36
Bangladesh			0.23	0.26	0.28

Source:
1984: Departemen Perindustrian-Bank Indonesia, 1989
1990-1995: Suradja, 1996

♦ *Hidden costs*

Another issue of concern for Indonesian enterpreneurs are the so-called 'hidden costs'. Indonesia has, in the last few years, more than once been elected most corrupt country for business. This corruption can manifest itself in a variety of ways, and is of course as good as impossible to measure. In his latest publication on Indonesian economic performance, Hill writes:

> *"Corruption is a perennial topic of debate and discussion in Indonesia. Hardly a month passes without press reports of a new set of corruption allegations, or judicial proceedings at home or abroad which reveal illegal payments...Illegal payments and exactions are an everyday occurrence for all manner of government services: to expedite the installation of a telephone,to extend an expatriate's working permit, to reclassify a land zoning, for minor immigration services, in the process of 'tax bargaining' to secure government contracts large and small, and so on"*[13]

[13]Hill, Hal, *The Indonesian economy since 1966 - Southeast Asia's emerging giant*, Cambridge University Press, 1996

Nevertheless, some progress has been booked with respect to the reduction of corruption over the last 20 years. According to Hill (1996),

> *"...the blatant corrupt Customs Service was tackled decisively in April 1985. The export incentive scheme has been a model of efficiency. The banking reforms of 1983 and 1988 removed most credit subsidies and reduced the incidence of 'command loans' - both sources of significant corruption. Many NTBs* (non-tariff barriers) *have been removed , and with it the revenues accrueing to the licence-holder...State enterprises have begun to report in a more orderly and detailed manner...And with the growing internationalization of the Indonesian economy there have been stronger demands for commercial regularity...In sum, corruption in Indonesia is serious, widespread, and inherently non-quantifiable in its incidence and consequences. But at least there have been some notable achievements in the struggle to contain it."*

Wild guesses on the size of these hidden costs in the textile industry go around, but even the more precautious estimates frequently assume the hidden costs to be greater than the employment costs. Estimates of 10 to 40 percent of total costs are not unusual.[14] With the total labour costs constituting a mere 8 to 10 percent of total output, Indonesian firms lose a lot of their labour-related advantage if hidden costs are indeed at this level.

- *Export barriers*

The global trade in textiles and textile products is still heavily regulated. The most comprehensive trade agreement at this moment is the MFA (Multi-Fibre Arrangement). Hill (1992) cites Cline in his description of the MFA as *'...the most trade-restraining international agreement for manufactured products in existence'*. And, further on, *'..It is possible that the MFA provided an initial stimulus to countries in the very early stages of export orientation, but it very quickly becomes an important obstacle to growth'*. Indeed, in many Indonesian publications the MFA is mentioned as a restraining agreement, and as a problem for sustained growth in textile exports.[15] On the other hand, Gundlach denies the perceived obstruction to growth for developing countries by trade restrictions. Based on data on economic performance and trade policies by the industrialised countries, he finds no convincing evidence to support the restrictive function of trade preferences or restrictions.[16] For Indonesia, with its well-developed textile sector, it is most likely however that the MFA curbes export growth to a certain extent. The stagnation of textile exports in the period 1992-1994 (see previous sections) might be a direct consequence of the limiting nature of international trade agreements. Posibilities for growth are now seen in the light of 'maximalising existing quotas' as a consequence of trade agreements.

Growing globalisation and liberalisation might see the end of the restrictive MFA and other textile export-quotas, but it is unlikely that developed countries will open their markets unconditionally to cheap producers like China, Pakistan, Indonesia or Bangladesh. Since

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[14] sources wish to remain anonymous.

[15] see for instance Safioen, *ibid.*, 1990, or Suradja, *ibid.*, 1996

[16] see Gundlach, *ibid*, 1996. Erich Gundlach investigates the trade policies of European countries with respect to Asian and APC-countries, and concludes that growth has occurred for Asian countries despite trade restrictions, whereas growth has lagged for APC-countries even though they were granted unlimited export possibilities to the European market.

these matters are dependent upon economical as well as political factors, little can be said about the future of international trade agreements.

Past research

A large number of researchers have investigated thoroughly into the economic performance of the Indonesian archipelago before and after independence, in the Old Order and in the New Order period. It would of course be impossible to give a summary of all these efforts, and in most cases it would be beyond the scope of this thesis. On economic performance in general, well-known authors like Hal Hill and Anne Booth have performed a lot of excellent economic research. On the textile sector in Indonesia, the sizeable body of academic literature is supplemented by many 'industrial' domestic publications by texile organisations like *API (Asosiasi Pertekstilan Indonesia,* Indonesian textile association), and industrial research institutes like the *PT Data Consult* and the *Indotextile* institute of *PT Capricorn.* Moreover, the Indonesian department of industry has published regularly on the developments in the Indonesian textile sector.
I have chosen to present the conclusions of some relevant works, which in most cases deal with the textile industry directly. A variety of sources has been used, and my only criterium has been the relevance of the literature for the topics dealt with in this thesis. By no means, however, should this section be considered to be comprehensive.

In his 1979 dissertation, Hal Hill performs a choice of technique analysis of the Indonesian weaving industry.[17] Four weaving techniques are compared; one domestically manufactured handloom and three powerlooms of different speed and level of automation[18]. Hill finds that all four techniques considered are technically efficient, and that the range of labour and capital (investment costs) that can be used to produce a certain value added is very great. After introducing factor prices, Hill concludes that the two most labour-intensive techniques are not economically efficient, while the two most capital-intensive ones are. This contradicts with a frequently heard assumption that investors in developing countries often invest in equipment that is too capital-intensive, and therefore behave irrationally. Thus, the rapid replacement of handlooms by powerlooms that occurred in the 1970s is justified economically. Using shadow prices, the socially optimum technique turns out to be the technique that is the least capital-intensive of the two economically efficient ones.
In a rather mathematical analysis of the techniques used in the Indonesian weaving industry, Pitt and Lee focus on technical inefficiency and its sources.[19] They estimate production function models using time series of cross-section data, and investigate into the sources of technical inefficiency. Their main findings are that three firm attributes relate to firm efficiency; size, age and ownership. For maximum efficiency a firm should thus be large, young and foreign owned (as opposed to domestically owned). Capital intensity is not found to correlate with technical efficiency once these variables are controlled.
In a working paper prepared for a seminar on quality and competitiveness of Indonesian textile products, Safioen (working for API) gives a current state of affairs and highlights

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[17] Hill, Hal, *Choice of technique in the Indonesian weaving industry,* in: Economic development and cultural change, 1983

[18] for more technical details, see also next chapter

[19] Pitt, Mark and Lee, Lung-Fei, *The measurement and sources of technical inefficiency in the Indonesian weaving industry,* in: Journal of Development Economics 9, 1981

various problems.[20] In all textile subsectors, the productivity of the workers is still low. On utilisation rates, product specialisation, productivity of the machines, training and age the spinning sector, which is relatively new, scores best, while weaving, knitting and finishing reveal problems. Restructuring of the textile industry is recommended, with emphasis on the replacement of old machinery and the renovation of existing production units. The 'fear' of an outdated and old machine-park is also mentioned by other authors, but according to Hill (1992) '*..such concerns are not entirely warranted. These old power looms are increasingly playing a role in the industry akin to that of hand looms after 1966, filling niche markets not of interest to the large mills and providing useful supplementary earnings for owners and operatives alike.*' Safioen's main conclusions are that the demand for textile products is mainly dependent upon domestic demand and export performance. Domestic demand will grow with increasing purchasing power of the population, while export growth will be achieved if the competitiveness of Indonesian textile products can be maintained. In order to accomplish this productivity should be increased, old machinery should be replaced and the government should assist in credit supply and training programs to improve the level of human resources.

Thee Kian Wie, in a working paper on the Indonesian garments industry, stresses the importance of keeping up with developments in the world market, in order to retain competitiveness.[21] Closer knowledge of the strategies of Indonesia's competitors such as China, is important. The use of modern technology is supported, and together with this the improvement of human resources in the sector.

On economic performance in the period 1975-1990 Szirmai presents data on labour-productivity in various manufacturing industries relative to the United States.[22] Using the ICOP methodology (International Comparisons of Output and Productivity), he finds that labour-productivity in Indonesia has quadrupled in 15 years. Compared to the USA, the relative labour-productivity of the Indonesian textile industry has progressed from 7.6 percent in 1975 to 17.4 percent in 1990.

In 1996, the API organised another seminar on textile trade and industry, situated in Bandung. The working paper prepared by the general director of indutry, Firdaus Ali, presents the Indonesian textile situation in a context of growing globalisation.[23] Internal factors that are problematic are the level of production costs, tariff protection that is not yet harmonious, the level of human resources and the lack of ISO 9000 and 14000 qualifications. External factors that can cause problems are the curbing of textile trade by developed countries and increasing competition from China, Pakistan, India, Bangladesh and Viet Nam. Recommended areas of improvement are the efficiency of production, intensive fiscal and monetary aid, investment in restructuring and capacity-increase, reduction of import taxes and the optimalisation of existing quotas, mainly within the framework of the MFA agreements (Multi-Fibre Arrangements). Another paper, presented by Sudradjat at the same conference, presents roughly the same assessments of Indonesian textiles.[24]

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[20] Safioen, H. (Asosiasi Pertekstilan Indonesia (API)), *Prospek perkembangan industri tekstil dan kebutuhan tenaga kerja*, API, Himateksi, 17 November 1990

[21] Thee Kian Wie, *Technological Developments and its implications for Indonesia's garment industry, Economics of Trade and Development seminar*, 9 July 1991

[22] Szirmai, A. E., *Comparative Performance in Indonesian Manufacturing, 1975-1990*, Research Memorandum 538 GD-3, Groningen Growth and Development Centre, University of Groningen, 1993

[23] Direktur Jendral Industri Aneka, *Kebijaksanaan pengembangan industri tekstil dan produk tekstil nasional*, working paper, Departemen perindustrian dan perdagangan, Bandung, 26 March 1996

[24] Sudradjat, Ade, *Permasalahan pengembangan industri dan perdagangan teskstil dan produk tekstil*, working paper, API, Bandung, 26 March 1996

In a 1996 article by Aswicahyono, Bird and Hill, the effects of liberalisation policies are investigated. The authors have chosen Indonesia in the mid-80s as their study object, since this country possesses a number of reasonably well-defined policy-periods. Their findings suggest that liberalisation policy does not have major impacts on concentration, despite the claim by many opponents of liberalisation programmes. Ownership does change to an extent, but the principal change here is the decline in state-enterprise activities. Size distribution has also only suffered minor changes due to the liberalisation policies, as has the spatial distribution of the industrial enterprises. In addition to this we should add that the average size of the textile firms has grown steadily over the last 20 years, with an acceleration in the mid-80s, as we have seen in figure I-7. It is possible that the liberalisation policies have in fact contributed to this growth.

Koesmawan has thoroughly investigated the textile export marketing and technology acquisition efforts in the Indonesian textile industry.[25] His 1996 dissertation discusses a number of important issues with respect to export-orientedness (defined as the share in production destined to be exported) and technological advancedness (share of production with latest technology). After deriving data on export-orientedness, no significant relations between export-orientedness and firm indicators such as labour-productivity, firm size or technological advancedness were found. On the other hand, relations existed between technological advancedness and size or labour-productivity. Koesmawan suspected a lot of measurement-'noise' in his data, and constructed a revised export-orientedness indicator. This was defined as the share of production destined for export to developed countries (Japan, USA, Europe). Now, export-orientedness was found to correlate strongly with technological advancedness. This observation, together with the persistence of a textile and garments industry in developed countries like Japan, Germany, Italy and NICs like South Korea and Taiwan suggests an interesting hypothesis. It seems that the global textile market can be subdivided into two markets with specific features: first, a *'standard-quality'* low cost market exists, that can be found mainly in developing countries and in the 'lower' layers of developed countries. These consumers do not posses a great purchasing-power, and place prime importance on price of the textile products. Secondly, a *'high-quality'* market exists, in which consumers are willing to pay more for textile quality, design and delivery-speed, amongst others. These consumers are found mainly in the more affluent countries. To produce for this market requires a more capital-intensive mode of production, and a high level of human resources (able to quickly respond to textile technology and fashion developments). Therefore, countries with higher levels of labour wages, but also a higher level of 'technological advancedness' can still maintain competitiveness, since they still hold, in their market segment, technology- and human resources-related advantage (i.e countries with lower wages and a lower level of technological advancedness are not yet able to produce the required goods). The presence of two distinguishable textile markets is confirmed by experts and managers, and is a topic of growing concern and political debate. This observation can also serve as an explanation for the continuingly rising imports of textiles in Indonesia, although production has grown exponentially. Imported textiles may very well be high-quality goods, that are not yet produced in sufficient quantities in Indonesia, and that are consumed by the country's growing economic middle- and upper-class.

This chronological anthology of research on the Indonesian textile industry yields a number of interesting and general observations. However, some questions remain to be answered.

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[25] Koesmawan, *ibid.*, 1996

Technological advancedness and innovation are given as important conditions for retaining competitiveness, although developing countries are, in classic economic thinking, usually encouraged to exploit their advantage in low labour wages. Indonesian sources particularly seem to stress the importance of replacing 'outdated' technologies, without the role of this technological progress in production being entirely clear. Considerable improvements in labour-productivity have been reported by various authors, without definite ideas on its causes - there has not been substantial quantitative research into the sources of growth in the Indonesian textile industry. The level of human resources is increasingly becoming an important topic in textile publications and policies, but its role in economic performance and technological progress remains unclear.

Future for the Indonesian textile industry

If time series of textile performance are used as a basis for extrapolation, a few forecasts can be made for the near future (the year 1999). Gross value added will, according to these forecasts, continue to grow exponentially, reaching some 20,000 billion Rp (1990 constant Rp). Textile exports are more difficult to predict, since the last few years have seen a stagnation of exports. Using linear extrapolation, exports may reach some 8,400 Rp, but exports have reached a 'deadlock' in the period 1992-1994. The steady growth of employment over the last 20 years makes this indicator less difficult to predict; some 900,000 employees may be working in the sector in 1999. For the spatial distribution of the textile firms, little change can be expected in the next few years. They will remain overwhelmingly present in West-Java and Jakarta, with Central-Java playing a minor role as well.

The direction of Indonesian textile developments is another matter of concern. We have seen that Indonesian labour costs are no longer in the lowest segment of the world, and other factors (like hidden costs) may worsen Indonesia's labour-related advantage in textile production. Also, it becomes apparent in Koesmawan's work (1996), that market developments are somewhat two-fold, and that two separate textile markets can in fact be distinguished. Besides this, we have seen that the Indonesian textile sector has integrated with the global textile market, and that technological 'catch-up' has been and is being performed by many firms. The latest technology is increasingly used, and efficiency and quality control have become more important. Experts place a lot of emphasis on modernisation and replacement of old machinery, as well as the declining competitiveness of Indonesian textile exports.[26] Developments, according to them, should be focused on restructuring, increasing efficiency and shifting to products with higher value added (usually higher quality products). All this would lead to a recommendation to increase economies of scale, product diversification, technological advancedness and the level of human resources. It seems that competitiveness for the textile sector is fading in the 'standard-quality' market, but comparative advantage still exists in the 'high-quality' segment, where Indonesian firms compete with their Taiwanese, Korean, Japanese and European colleagues. As we have seen in table I-3, there is still enough market share to be gained in these segments of the global textile market.

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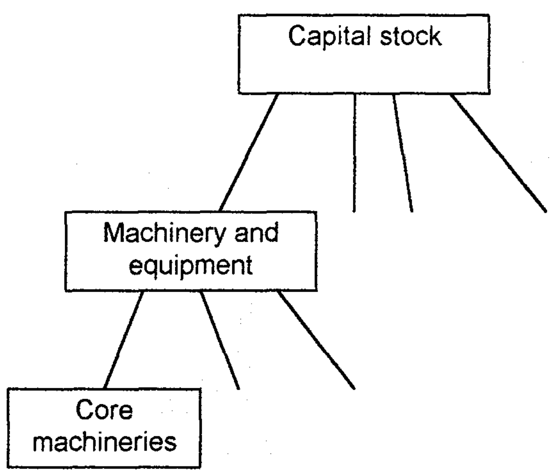
[26] see amongst others article, *Textile exports lose competitiveness*, in: Jakarta Post, 26/12/96 and article, *Textile industry must improve to survive, warn analysts*, in: Jakarta Post, 13/11/96

II Intermezzo - Theoretical framework



In the previous chapter, a general introduction to the Indonesian textile industry has been given. If we now want to proceed with our investigation and tackle the research question posed in the title of this thesis, we first need to present our theoretical framework.
In this chapter, I will attempt to present a model that can link economic performance to the developments of textile technology and the level of human resources in this industry. First, we will find a model that relates economic development with developments of the production factors labour and capital. Secondly, we will investigate the application of the model in linking technology and human resources to economic output. Theoretical problems will be discussed, and if necessary the model will be adapted to fit the needs of our research objectives.

II-1 Finding a model

The research questions posed in this thesis oblige us to 'dissect' economic development into growth that can be attributed to the various factors of production. Using capital and labour as factors of production (and thus omitting land from the analysis), we need to link their development with economic growth. The tool to achieve this is the so-called production function, which may be written (in *translog* form) as

$$O_t = e^{\left(\alpha_t \ln K_t + \beta_t \ln L_t + \ln TFP_t\right)} \tag{2.1}$$

where O_t is output at time t, K_t is an index of capital inputs at time t, L_t is an index of labour inputs (at time t), α_t is the partial elasticity of output with respect to capital (with labour being constant), β_t is the partial elasticity of output with respect to labour (holding capital constant), and TFP_t a rest factor, referred to as Total Factor Productivity.
To facilitate working with this equation, a few assumptions are usually made. First of all, many authors assume *constant returns to scale*, which means that a doubling of both the production factors will lead to a doubling of output. Mathematically, this boils down to $\beta=1-\alpha$. This assumption has the advantage of reducing the number of coefficients, and thus reducing the amount of data needed in the equation.
Another assumption frequently made is a market situation of *perfect competition* and *profit maximalisation*. If such a market situation is assumed, production factors are paid their marginal product.[1] In this situation, the elasticity of output with respect to the production factors equals the share of this production factor in total output. Or, to put it differently, if labour is paid its marginal product (which is required in a perfect competition and profit maximalisation market), the partial elasticity of output with respect to labour inputs equals the share of total labour costs in output.[2] This assumption greatly simplifies the calculation of the partial elasticities, since they can now be calculated by simply taking the share of the production factors in value added.

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[1] If marginal product were lower than the payment of a production factor, producers would continue to add this production factor until no further profit could be made. Marginal products could never exceed the payment of a production factor, since no producer would add a production factor that costs more than it yields.
[2] The partial elasticity of output with respect to labour inputs is defined as $\beta = (dO/O)/(dL/L)$. If dO/dL (marginal productivity) equals the ratio of labour wages and output prices (w/p_o), β can be written as (wL/p_oO), which equals the share of labour costs in output. The same goes for capital inputs.

Growth accounting

A frequently performed analysis using a production function is *growth accounting*. The objective of growth accounting is to attribute economic growth over a defined time period to its production factors, in our case labour and capital. To achieve this, the production function can be modified slightly, since the main purpose is explaining growth of output and not necessarily the exact levels of production and factor inputs. By differentiating the translog production function mentioned earlier, we arrive at[3]

$$\frac{d\ln O_t}{dt} = \alpha_t \frac{d\ln K_t}{dt} + \beta_t \frac{d\ln L_t}{dt} + \frac{d\ln TFP_t}{dt} \qquad (2.2)$$

This equation is continuous in time (providing all terms are positive). Its discrete approximation (using Tornqvist) is

$$r_O = \left(\frac{\alpha_t + \alpha_{t-1}}{2}\right) r_K + \left(\frac{\beta_t + \beta_{t-1}}{2}\right) r_L + r_{TFP} \qquad (2.3)$$

where the r stands for annual growth rate of the variables in subscript.[4] We thus arrive at a formula that states that the growth rate of output equals the growth rate of capital inputs weighted by the partial elasticity of output with respect to capital, the growth rate of labour inputs weighted by the partial elasticity of output with respect to labour, and the growth rate of TFP.

♦ *Measuring the variables*

For economic performance two variables are commonly used. *Gross output* is used in analyses that includes intermediate inputs, since the economic variable gross output comprises both capital and labour costs as well as intermediate inputs (also known as raw or intermediate materials). The inclusion of intermediate inputs in the calculation brings about a restriction: this method can only be used at sector level. If a whole economy is considered, the (physical) output of one sector can be used by another sector as raw or intermediate material. Taking gross output as a measure for economic performance would lead to "double-counting" (including the same good more than once in the summation of output over the various sectors). To avoid this, economists often use *gross value added* as a measure of economic performance. Gross value added is defined as the gross output minus intermediate inputs (input costs), or as the payment of the production factors labour and capital.[5] In value added-based calculations, intermediate inputs can thus be omitted.
The measurement of the inputs of the production factors labour and capital is based on their quantities. For labour, *total working hours* are used as a base for labour inputs. For capital, *annual capital services*, usually based on the gross capital stock and the average lifetime of the capital goods, are taken. If information on the number of employees and their average

[3] It should be noted here that the α and β are not truly time-dependent, but are determined by changes in K, L and O. Therefore, there is no time-differential of these variables in this function.
[4] For a more elaborate derivation of this formula, see Jorgenson, D. W., *Productivity - International comparisons of economic growth*, The MIT Press, Cambridge Ma., 1995
[5] By definition, Gross output equals Labour costs plus Capital costs plus Input costs

working hours is available, total working hours can be calculated without too many theoretical pitfalls. Even when data on average working hours are lacking, the change in total number of employees can serve as a justifiable proxy for the change in total working hours. With capital inputs, it is unfortunately not as straightforward, since most measurement of capital goods is not done in real terms, but is usually a summation of investment (in financial terms). Because of these difficulties, I will treat the measurement of capital inputs in a separate section.

Capital inputs

Ideally, capital inputs would be separated into a series representing the "number of units of capital goods used", including their utilisation throughout the year, and an annual quality series representing the "average productivity per unit of capital goods". This, at least, would be in analogy with the methodology used for labour inputs, and this would allow an unambiguous distinction between the quantitative and the qualitative components. However, with more than one type of capital goods included it becomes as good as impossible to derive a quality series for the productivity of these capital goods involved in the production process, mainly because of their variety.[6] Besides this, totals for units of capital goods are not often readily available, since most investment data are expressed in monetary terms. Therefore, economists usually build an estimate of the total capital stock based on investment data, that are deflated with a price index of capital goods. If a capital stock series can be derived, information on the average lifetime of capital goods allows the construction of a series of annual capital services.

The methodology of building a time series for the capital stock using investment data and deflating indices is known as the *Perpetual Inventory Method* (PIM).[7] An important drawback of the PIM is the large amount of data needed; for a comprehensive series, investment data should go back beyond the average lifetime of the capital stock, so that no estimate on the capital stock in a base year is needed.[8] Besides this, the PIM requires detailed information on inflatory developments of specific capital goods and on lifetimes of the capital goods in question. If no precise data are available, the accuracy of the estimate will be reduced.

♦ *Quality adjustments for factor inputs*

The measurement of factor inputs using their quantities implies that another source of economic growth, quality improvements in inputs, is not accounted for by capital or labour inputs, and is thus attributed to the rest factor Total Factor Productivity (TFP). This variable in fact represents all changes in output not accounted for by a change of factor inputs, and can be described as 'output per unit of input' in the production function. These quality improvements can be diverse, from an improvement in efficiency of machinery to an increase in production due to favourable weather conditions. Among the first growth accounting exercises were those performed by Solow and Abramovitz.[9] Their findings indicated that

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[6] Capital goods comprise buildings, transport equipment, and a variety of machines, amongst others.

[7] See Ward, M., *The measurement of capital - The methodology of capital stock estimates in OECD countries*, OECD, Paris, 1976, which is still probably the most comprehensive treatment of capital measurement.

[8] Only if investment data go back further than the average lifetime of the first units of capital, there will be no capital good from the initial year present in the first year for which the capital stock is estimated. If the capital stock has to be estimated without information on the average lifetimes of the different vintages included in the capital stock, it is impossible to scrap the capital goods when their lifetime has expired.

[9] Solow (1957) and Abramovitz (1956), as mentioned in Thirlwall, *ibid.*, 1994

between 80 and 90 percent of growth in output could not be accounted for by increases in capital per head. This greatly disturbed economists, who had up untill then assigned an important role to capital accumulation in the production process, and it stressed the role of quality improvements in the production process. Ever since these findings were published, much effort has been put in reducing the role of the rest factor TFP in growth accounting. Many economists have introduced some form of quality-adjustment for the production factors, which can be described by

$$L_t^* = I_{L,t} L_t \qquad (2.4a)$$

and

$$K_t^* = I_{K,t} K_t \qquad (2.4b)$$

With L^*_t and K^*_t being defined as the quality-adjusted labour and capital inputs, respectively. The I refers to the quality index for the variable in subscript.

Labour inputs

The fact that not all labour inputs can be considered to be equally productive, and should therefore not be given equal weights in the treatment of labour inputs, has inspired economists to introduce forms of quality adjustments. The indicator most commonly used for this weighting is the total years of education employees have followed. The foundation of this method is the division of labour inputs into segments with equal years of education received.[10] Since not every additional year of education contributes equally to the productivity of labourers, weights have to given to the educational segments. This is usually done by taking income as an indicator for labour-productivity, and calculating the average income of the different educational segments in a base year. This average income can then be used as a weight for the segments over the years. In this way a time series is derived, that can be used as an index for the productivity of labourers. Some authors have gone even further than this, dividing labour inputs in segments based on educational attainment[11], sex and employment status.[12]

Capital inputs

Measurement of the quality of capital inputs is usually confined to the inclusion of the *advance effect* in estimates of annual capital services - the assumption that capital goods of more recent vintage can produce with higher productivity because of technological developments. Jorgenson has devoted a lot of effort to the measurement of capital and the inclusion of advance effects in his estimates of capital stock and capital services.[13] In his 1995 publication, Jorgenson divides the capital stock of the United States per sector into 156 components (or segments), based on sort of institution, producers' or consumers' durable equipment, residential and non-residential structure and land. The weighting factors used are the shares of these groups of capital goods in total capital stock (using monetary terms).

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[10] see Denison, E. F., *Why growth rates differ - Postwar experience in nine western countries*, The Brookings institution, Washington D.C., 1967

[11] Educational attainment in fact refers to the 'highest diploma an individual has received' in the educational system. Often, it is measured using total years of education as a proxy.

[12] See Jorgenson, ibid., 1995

[13] see for example Jorgenson, D. W. and Landau, R., *Technology and Capital Formation*, The MIT Press, Cambridge Ma., 1989

II-2 Adapting the model

We have seen that a production function used in growth accounting can be used to examine growth rates in a certain time-interval, and can attribute this growth to changes in the factor inputs. However, we have not gone into details yet considering the measurement of technology and human resources, and their place in the economic growth accounting model described above. In order to come to a valid assessment, we need an unambiguous definition of the key variables, and a well-defined place in the economic analysis. This section will examine whether the growth accounting model can be applied to assess the role of technology and human resources, and will adapt the model if necessary. To do this, a definition of the key variables has to be given first. Secondly, it will be examined whether the variables fit in the model presented earlier. Finally, the model will be adapted and presented in its adapted form.

Defining the key variables

The elaborate definition of technology and human resources is given in the chapters that are devoted to these phenomena. At the moment, the conclusions of the sections on the definition of the variables that can be found later in the thesis will only be presented.
Economic performance will be defined in this thesis as the growth of gross value added of the textile industry (20 or more employees, see chapter I)), as defined in the ISIC classification and the BPS statistics (ISIC 321).
Technology will be defined as the maximum productivity, or maximum output, per unit of capital, reprenting the technology embodied in a given piece of machinery. We will thus only investigate capital-embodied technological progress. Disembodied technological progress will thus be assigned to the growth of output per unit of input (TFP). As an operational definition, we will use the maximum output of the core-technologies in an industrial sector (in our case, of course, the textile sector).
Human Resources will be defined as the productive potential of an individual.

Looking at the definitions of technology and human resources, they seem to represent the quality part of the factor inputs. The quality of the production factors labour and capital can be represented by their maximum productivity or productive capacity. Human resources are the productive capacities of labourers, while technology refers to the maximum productivity of the capital stock.

Fitting technology and human resources into growth accounting

The previous section suggested an elegant way of fitting the concepts of technology and human resources into the economic methodology of growth accounting. Both concepts can be seen as the qualitative parts of capital and labour inputs, respectively. Before we accept the the methodology of growth accounting as our tool in assessing the role of these quality indicators, however, a more detailed investigation in the data measurement and processing is obligatory. For both capital and labour inputs, a detailed analysis will be given below.

♦ Labour inputs

For the inputs of the production factor labour, the methodology that should be followed seems straightforward. Data on total working hours are needed, which can be calculated by using data on employment and average working hours, using

$$L_t = TWH_t = Employ_t \cdot AWH_t \qquad (2.5)$$

with L_t being (quantitative) labour inputs at time t, TWH_t being total working hours, $Employ_t$ being employment (number of workers) and AWH_t being average working hours per labourer at time t. An index of the quality of labour inputs, or human resources, can then be used to weight annual labour inputs with their productivity (or quality) level. The way in which the index for human resources is derived is the topic of chapter III. The final equation for labour inputs thus becomes

$$L_t^* = I_{HR,t} \cdot L_t \qquad (2.6)$$

with L_t^* being the quality-adjusted labour inputs, and $I_{HR,t}$ being the human resources-index at time t. The distinction between a quantity and a quality index can be fully maintained in this way, and no theoretical difficulties need to be solved.

♦ Capital inputs

The final index for capital inputs, unlike its labour counterpart, requires some thorough investigation into the details of measurement and concepts. In the previous section, we have seen that the most frequently used method for estimating annual capital services is the derivation of capital services by using estimates of the (gross) capital stock and the average lifetime of the capital goods. We have also defined technology as the quality, or productive capacity, of the capital stock. However, it is not possible to derive a technology-index and use this as an I_K, a quality index that can be multiplied by the (quantitative) annual capital services derived from the gross capital stock. The reason for this is the following.
In the construction of the gross capital stock, capital goods are added with their deflated prices as weights, because investment figures are used that are expressed in monetary terms. This implies that when an old type of machinery is replaced by a new type, which is more expensive, this leads to an increase in the gross capital stock, because this new type of machinery is not deflated 'back to' the price of the old type of machinery. In other words, the shift effect (changing shares of various production-technologies in the capital stock) is already incorporated in the gross capital stock, *in as far as their increased productivity is reflected in acquisition prices of new types of capital goods.* On the other hand, the advance effect (increasing maximum productivity of newer capital goods) is normally not included in the gross capital stock, since prices of capital goods that have risen over the years (and can suggest increases in productivity) are deflated back to the prices of the same type of capital goods in the base year. Only when price indices are used that exclude price changes due to quality improvements (hedonic price indices), the advance effect can be included. All this means that a multiplication of annual capital services derived from the gross capital stock with a technology-index would lead to double-counting of the shift effect.

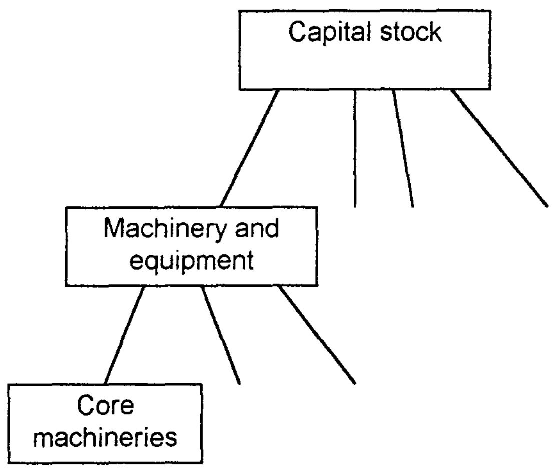
There are two ways to circumvent this problem. Another way of measuring annual capital services can be found, or the quality-adjusted capital stock can be adapted to exclude the shift effect. I have chosen to opt for the first. There are a few reasons that have lead to this choice. First of all, the analogy between the treatment of labour and capital inputs would be lost if the quality index of capital inputs would be 'reduced' and part of the quality changes would be included in the quantitative index of capital (which would then of course no longer be a true quantity index). Besides this, we would lose the valuable theoretical distinction between productivity and number of machines, which enables us to measure 'technological progress'. Secondly, the Perpetual Inventory Method itself is not void of some theoretical problems. Let us assume, for instance, that in a random year after the base year technological developments have led to a reduction in the costs of the production of a machine with 10 percent, while the productive capacity of that machine has increased by ten percent. In the same year, prices of other capital goods (buildings, transport equipment, other machines) have risen by 10 percent. Let us also assume that in that year, investments have only been used to replace outdated equipment (in other words, no expansion of the sector in terms of number of machines has taken place). It will now be very likely that the deflator used for capital goods in this sector will have risen, since the prices of most capital goods have risen. This means that investments in this particular machine, that were already less than usual because of technological developments in another sector, will be deflated even further because of increases in the prices of other capital goods. The productive capacity will have risen, but the estimated capital services and the gross capital stock will have shrunk because of lower investment and the deflation of this investment. The problems related to the measurement of capital services in this example can be reduced to the applying of deflators, that are most often not very detailed. In fact, very 'general' deflators like the price index of machinery and equipment in an economy are sometimes used, which makes it rather difficult to obtain precise estimates of the capital stock of a particular sector. Avoiding these problems requires a disaggregated approach, but sufficient data are not always available. Also, using the PIM implies the inclusion of the shift effect, but only as far as it is reflected by the prices of the different machines. If price-productivity ratio varies between machines, this can lead to measurement errors.

Because of these reasons, I have chosen to construct a new estimate of the annual capital services. This estimate will be based on the total number of 'core'-machineries (machines that are at the heart of the production process).
If one decides to use numbers of machines as the foundation for an estimate of the capital stock and the capital services, the number of different types of machineries included in the summation can usually only be one. Basically, this is a consequence of the fact that the only weights that are appropriate to use for machines that are used for different parts of the production process are the share of different machines in value added, which are very hard to obtain. Therefore, if an estimate of the gross capital stock, or annual capital services, is demanded, only one type of machinery can be used to 'represent' the production process. Problems would immediately arise if we were to include two machines that were used for different parts in the production 'line' (e.g. ring spinning frames and roving machines) in one estimate. Therefore, a methodology using totals on machines must confine itself to the use of one type of machinery if detailed information on shares in value added is not available (as is the case in this research). The 'core' type of machinery that can be pointed out in a lot of production processes seems an obvious choice, since it is often the most expensive piece of machinery, and about it most information is usually available. Measuring capital inputs by using the number of core-machines has been used before in economic analysis. In their book

on technology choice in cotton textile industries in Japan and India, Otsuka and his colleagues use the number of spindles and looms as an indicator for the physical quantity of the capital inputs.[14] The derived series are used in a growth accounting analysis, to determine the growth rate of TFP.

After having decided on the type of machinery, totals on their presence should be collected. It needs to be remembered, though, that this way of estimating annual capital services assumes that developments in one type of machinery is representative for developments in all capital goods. Figure 1 represents this assumption schematically. It presents the structure of the capital stock, and clarifies the position of the core machineries as one of the segments of the subgroup machinery and equipment, which is on its turn only a segment in the total capital stock. In chapter I we have seen that the share of the machineries and equipment in total investment was 70 to 80 percent, by far the largest group in total investment.

Figure 1 - Structure of the capital stock



The assumption that changes in the number of core-machines represent changes in the total volume of capital goods is rather bold, but not entirely without justification. In a production process that is continuous, all changes and all speeds must be harmonised with each other. It would do little good to purchase a new ring spinning frame without having the 'auxiliary' machinery to enable spinning production. Continuing this line of thought, it would be of little use to invest in new machinery if there were nowhere to house these machines. And, in order to house the machines, land has to be acquired to build factory halls. The most hazardous part of the assumption is probably not the idea that changes in different capital goods relate, but that they relate proportionally. The only empirical evidence for this is the relatively stable shares between machinery and equipment, buildings, transport equipment, land and other investments.[15]

Summarising, I have opted to follow a procedure to arrive at capital inputs which avoids using monetary terms for capital stock. Since capital inputs should be given in the form of a real index, this method has a clear advantage over the 'roundabout' method of deriving capital services from a capital stock expressed in monetary terms. On the other hand, it is not possible, mostly because of the enormous amount of data needed and measurement problems, to include all capital goods in the analysis. We are thus faced with a trade-off; the

[14] Otsuka, K., Ranis, G., and Saxonhouse, G., *Comparative technology choice in development - The Indian and Japanese cotton textile industries*, The MacMillan Press, London, 1988

[15] See tables on textile investment in appendix A.

methodology used to arrive at capital inputs is a more direct and accurate one, but the range of capital goods has necessarily been confined. If an index of real annual capital services is now weighted with a technology-index, we arrive at

$$K_t^* = K_t \cdot I_{Tech,\,t} \qquad (2.7)$$

With K_t^* being quality-adjusted capital inputs, K_t being quantitative capital inputs and $I_{Tech,t}$ being the technology-index (including both shift and advance effect), all at time t.
Because of the manner in which capital services are derived in this analysis (at subsector level, focussing on core-machineries), one more problem has to be addressed. Any industrial sector comprises a number of subsectors, all with their specific products and production processes. If we want to combine these various subsectors into one series for capital services, we will have to use weights to add the various subsector technology-indices. With two subsectors we can write

$$I_{Tech,\,Sector,\,t} = v_{1,\,t} I_{Tech,1,\,t} + v_{2,\,t} I_{Tech,2,\,t} \qquad (2.8)$$

With I_{Tech} being the textile technology-index at time, and the vs being the weights for subsector 1 and 2 at time t. Deriving these weights will be the discussed in chapter III.

II-3 The final model

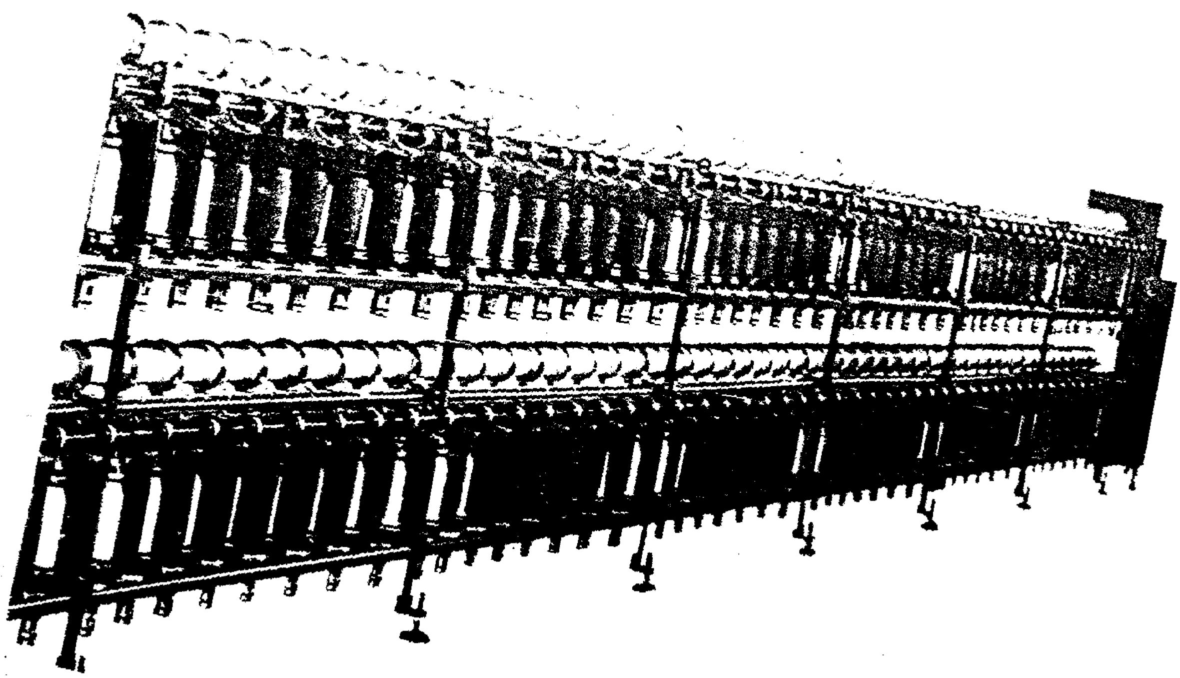
We have now presented an economic method that can assist us in analysing economic growth (growth accounting), and we have discussed theoretical difficulties in measuring the role of technology and human resources within this framework. Also, we have adapted the conventional way of measuring capital to fit our needs of a technology-index and a quantitative index for capital services. For the measurement of human resources, the existing methodology of deriving quality indices proved to be suitable. We have thus arrived at a final model to be used in atrributing economic growth to its production factors and their developments. As a summary, table 1 presents the discussed topics in a structured way.

Table II-1 Factor inputs

Production factor	***Quantity***	***Quality***
Capital	Number of core machines	The level of *Technology* (productivity of the stock of core-machines, due to shift and advance effect)
Labour	Total working hours	The level of *Human Resources* (productivity of the labourers)

In the next two chapters, the topics of technology and human resources will be dealt with in more detail. Following this, an economic analysis will be carried out for the Indonesian textile industry.

III Technology



In this chapter, I will present the technologies used in the Indonesian textile industry, and will try to derive an index representing the technological progress in this sector. Since this exercise is by no means a standard one, the underlying theories will be elaborated as much as possible, to allow the reader to follow the process along with the important steps taken.
The structure of this chapter is as follows: first, I will present the definitions of the core concept of this chapter, technology, and chose the conceptual definition I will use in this thesis. Secondly, I will present a brief summary of theories on technology and economic growth. Thirdly, the technologies used in the Indonesian textile industry will be listed, along with some technical and economical information. Finally, I will derive an index of technological progress in the textile sector, and I will discuss its use in economic and technical analysis.

III-1 Definitions

From a sociological point of view, technology can be defined within its context in society:

> *'Technology can be defined as a systemised, formalised, standardised, accepted in broad circles of society, coherently applied whole of insight and knowledge with reference to the ways and means to reach human objectives in its broadest sense.'*[1]

In their search for the role of technology in the industrial process, authors exhibit a tendency to extend the definition of technology to not only the 'hardware' part (machines and equipment), but also include such items organisational routines, human resource management and information processing. Van Egmond (1993), for instance, presents a conceptual definition that stresses the human resource part of technology:

> *'Technology may be defined as the application of the existing body of skills and knowledge to the production of goods and services required by a society in which and by which it is being used'*

The definition of technology presented by Boon also 'swings' up and down from the technical to the human side. He does in fact define technology as a concept related to both capital and labour, and proposes to treat technology as a more or less equal factor of production:

> *'Technology is concrete know how, disembodied or embodied in physical terms of production, concerning the production transformation process. Technology should not any more be treated as datums to economic science but rather as a distinct, but capital related, factor of production which, in cooperation with the well-known production factors, enables an output and is therefore also entitled to as a share of an income'*[2]

[1] Egmond-de Wilde de Ligny, Emilila van, *International Technology Transfer to developing countries - collection of lecture notes 0N070*, Centre for International Cooperation Activities, faculty of Philosophy and Social Sciences, Eindhoven University of Technology, 1993

[2] Boon (1983), as quoted in Koesmawan, *Textile export marketing and technology acquisition efforts in the Indonesian textile industry: a case study*, (proefschrift UT), University of Twente, Technology and Development

In Thee Kian Wie's work we find a slighlty more 'physical' definition, but still one that emphasises associated procedures and organisational matters:

> *'A collection of physical processes that transform input into output, the specification of the inputs and outputs, and the procedural and organizational arrangements for carrying out the transformations'*[3]

More recently Koesmawan, an author who has done extensive research work in the role of technology transfer in the textile industry in Indonesia, proposes the following four 'ingredients' for the definition of technology, that might even be see as a 'summary' of technology definitions:

> *Technology is conventionally considered to comprise at least four components:*
> - *'technique' - the specific configuration of machines and equipment to produce a good or service (often thought of as the 'hardware' component of physical capital);*
> - *'knowledge' - comprising knowledge of science and technology, skills, experience, know-how, attitudes, (often popularly thought of as the 'software');*
> - *'organization' - the institutional arrangements by which the technique and knowledge are combined, and the means by which they are managed (again seen as part of the software);*
> - *'product' - the good or service resulting from the above processes (OECD 1983, p. 4).*[4]

Another definition, putting an emphasis on 'measurability', is the one given by the United Nations in recent years. Their methodology of *technometric* analysis incorporates a concept of technology that comprises hardware, humanware (human resources), orgaware (organisational processes and routines) and infoware (the control of information flows).[5]

It becomes clear that almost all authors, when defining technology, opt for a 'broad' definition of the concept, including not only the hardware part of it, but also organisational, information and human resource parts. In the definition of the UN human resources are more or less considered to be part of the larger concept of technology, implying that hardware and humanware operate on the same level, but technology refers to an allcomprising concept. However, not all authors subscribe to this hierarchy of terms. Koesmawan (1996), for instance, writes literally *'Its application...makes technology one of the most strategic human resources'*, effectively reversing the order of the hierarchy of terms.
Since I have in my thesis chosen to separate the concepts of human resources and technology, a 'broad' definition of technology would unavoidably lead to a somewhat overlapping framework of conceptual definitions. If we were to employ the narrower 'every-day-use' definition of technology, referring to hardware or, to put it differently, capital-embodied technology, this problem would be avoided. We can refer to this definition as the 'narrow' definition of technology, a definition that approximates the somewhat obsolete term

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Group, 1996

[3] Thee Kian Wie, *Technological developments and its implications for Indonesia's garment industry*, economics of trade and development seminar, 9 July 1991, Economics Division, Research SChool of Pacific Studies, The Australian National University, 1991

[4] Koesmawan, *ibid.*, 1996

[5] United Nations, *An overview of the framework for technology-based development*, Bangalore, 1989

'technique'. It is interesting to note that 'technology' is commonly (in every-day-use) used to describe only one part (hardware) of a bigger idea (the broad definition of technology).

Since I have no intention whatsoever of disclaiming the work of so many authors that have spent much of their valuable time in coping with this problem, I do not intend to redefine the concept of technology. However, because the 'broad' definition of technology can lead to oblique operational definitions, I will use the concept of human resources (or human capital) next to the concept of technology, thus defining technology in the narrow way, referring to the hardware part or capital-embodied technology. There is one more important advantage of applying this narrow definition; the parallel between capital and labour can be maintained. If we let technology refers to the quality of capital goods, and human resources refers to the quality of the labour force, both concepts fit perfectly in the economic framework that is used in other parts of this thesis (see previous chapter and chapter V). It is interesting to note that there are more institutions that opt for such a 'parallelisation' - the Indonesian government has placed full focus on 'technology' and 'human resources' in their latest five year plan.[6] This focus distinguishes between the two concepts on equal level as well.
Without further mentioning, the definition of technology used in this thesis will thus refer to the 'classical' capital-embodied technology. In this way, I hope to leave the existing body of terminology in tact while at the same time not creating vagueness with regard to the definitions used.

III-2 Technology and economic growth

I will not attempt to give a comprehensive and full account of all views on technology and its role in economic growth in this paragraph. Rather, I will attempt to give some historical examples, that serve only to give a first insight into this topic.

The beginning of the 20th century saw the introduction of the production function, a mathematical function that related output to its factor inputs via a production function, which has been treated in detail in the previous chapter. Ever since the production function has been used for growth accounting, and the first results indicated an overwhelming importance of the TFP growth, economists have tried to minimize the contribution of TFP, which is always calculated as a rest factor. With the 'disappointing' results of the first growth explanations came the realisation that factor inputs also have a qualitative component. Quality of labour and capital inputs were therefore variables that have ever since been used to reduce the importance of TFP growth. The fact that both the quality of capital goods (technology[7]) and the quality of labour (human resources) are nowadays often included in the definition of technology (see previous paragraph) has been reason for some authors to substitute the term '*TFP*' with '*T*'(=technology) in the production function.[8] This theoretical argument can however never be completely maintained, since determinants such as 'efficiency' and, at country-level, 'allocation of means of production' can not be included in the term technology, but do play a role in production growth.

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6 Repelita VI, 1994-1999
7 according to our definition
8 see for instance Thirlwall, A.P., *Growth and development - with special reference to developing economies*, MacMillan Press, London, 1994

Theoretically, there have been a large number of attempts to 'internalise' technology into economic models in the second half of the 20th century. One of the first proposals was by Solow, and later Nelson.[9] They suggested that the capital stock, which was then calculated using quantitative data only, should be corrected for quality changes, using average age and a rate of productivity improvement. The capital stock derived in this way incorporates quality improvements; because of this the term 'embodied technological progress' is used. The altered contribution of TFP growth is now productivity growth excluding the growth in productivity caused by technological progress 'embodied' in capital goods.
Other economic theories have incorporated the concept of technology as well, and have often given it an important role in explaining economic growth. The 'new growth theories', for instance, are a collection of economic theories focussing on the role of technology and R&D in an open economy. The existence of differences between countries in the level of technology or the expenditures on R&D is expected to have 'spillover' effects for the country less technologically developed. An interesting example of such a theory is the one by Bart Verspagen.[10] His economic model building results in a 'catching-up' or 'falling behind' model for the less developed country, dependent upon the initial level of the technology 'gap' and the level of technological capabilities.
Nowadays, the variable technology plays a key role in almost every economic model developed. This tranformation, from exogenous determinant to endogenous key variable, is illustrative for the change in thinking about the role of technology in economic growth. The large body of research that has been performed on the role of such things like innovation, R&D and technological capabilities is another strong indicator for the central place technology plays in academic thinking on economic growth.
In the long run, I would like to add that technological progress is in fact, per definition, the only source of sustained growth in a country. If an economy, or a sector, has reached the point of maximum efficiency within its productive limits, and is using all of its labourers, stagnation of output is bound to occur, unless the 'productive limits' are transposed again, or in other words unless new technologies are introduced.

Measuring technological development

The succes of the various economic models that have been suggested to incorporate technology into the economic world is of course primarily dependent on the way in which the concept is measured. In the 'old days', technology was a rather vague term that could be used to explain TFP growth. However, as attempts to incorporate technology became more serious, a proper way of measuring it had to be found as well. It could be defended to say that most economists have nevertheless confined themselves to the use of various productivity indicators as measures for technological development. Growth of TFP have been popular indicators used by the neo-classical and growth accounting economists. This indicator, much used as it is, has a number of theoretical drawbacks. First of all, TFP is used in growth accounting as a rest factor, meaning that it is not measured itself, but calculated as a residual. It thus refers to 'unexplained' productivity growth, and not to productivity growth caused by technological progress. Secondly, with a more narrow definition of technology, it is not

[9] see Nelson (1964) as mentioned in Thirlwall, *ibid.*, 1994
[10] Verspagen, B., *Uneven growth between interdependent economies - an evolutionary view on technology gaps, trade and growth*, (dissertation), Universitaire Pres Maastricht, 1992

possible to distinguish between the various quality improvements if the growth of TFP is used; consequently, the only proper way of using TFP growth as an indicator for technological development is defining technology as the cause of all productivity improvements.
A more detailed approach sometimes used is the measuring of technological progress by differentiating between prices of the various capital goods used.[11] Since the annual price of a capital good (rental price) is not straightforwardly calculated, Jorgenson uses acquisition prices, divided by the lifespan of the capital goods. In this way he derives a quality index for capital goods based on their rental prices. Although this methodology is definitely an improvement of the earlier mentioned TFP 'method', it is not free from difficulties either. An important feature of technological progress is the fact that, particularly in the long term, prices of all kind of goods can go down, while quality remains or even grows.[12] On the short term, this approach can thus yield valuable results, but on the long term an essential part of technological developments is overlooked. To come to terms with this problem, so-called 'hedonic' price indices have been developed, that account for quality changes in the deflation of prices back to a base year.
In the models of the new growth theories, many new variables have been introduced, all relating to techology. Terms such as 'technological capabilities', 'technology gap' or 'R&D spillovers' are but a few examples. It is theoretically quite plausible that the abovementioned indicators play a role in the economic process, especially when discussing growth of developing economies. However, the measurement of technology has in many cases not been improved. Verspagen, for instance, measures technology and technological capability with his data set comprising labour-productivity, patents and expenditures on R&D.

Because of the problems already mentioned in assessing the role of technology in economic processes, I have attempted to create a new indicator for the level of technology in a country, measured at sectoral level. Because of the sector approach, I have been able to look at the capital-embodied technology from a more technical point of view.[13] In the next paragraphs, the technology used in the textile sector in Indonesia will be described, both technically and economically. A technical description will be followed by the listing of important technical and economical data on the technologies. Finally, I will attempt to construct a 'technology-index', that can serve as an indicator for the level of technology in the Indonesian textile industry.

III-3 Technology in the Indonesian textile industry

In this paragraph, the most important technologies used in the Indonesian textile industry will be described. In investigating these technologies, I had to necessarily confine myself because of time limits. I have chosen to select the two largest subsectors, spinning and weaving, for a closer technical look. These sectors are also the ones most commonly used in research in the textile industry. In table 1 of chapter I it can be seen that these two sectors account for 76% of value added and 69% of employment in the textile sector. It can thus be defended to select

[11] see Jorgenson, *ibid.*, 1995
[12] as an example, the computer industry has seen phenomenal increases in speed and overall performance, while prices of regular personal computers have dropped over the last 15 years.
[13] At country level, this is of course not possible, since there are an almost infinite number of technologies used in as many sectors and subsectors of the economy.

these two industries if one is constrained by time.
My working method in describing the spinning and weaving technologies is focussed on the 'core' technologies of the process. This has been done because of two reasons. First, neither time nor money availability was sufficient to allow a more detailed look into the processing technologies. Secondly, many industrial subsectors are characterised by the use of a certain 'core' tecnology. Most authors, when treating spinning or weaving technology for instance, often refer to the use of spindles and looms, which are the 'hearts' of the spinning and weaving processes, respectively. This approach is thus not only limited to the textile industry, but can also be applied in analyses of other (sub)sectors.
A lot of the technical information in the following sections is derived from publications by Ishida[14] and the UNIDO[15].

Spinning

The process of spinning refers to the transformation of raw fibres, natural or synthetic, into yarn. The use of natural fibres has always been dominated by cotton, with a smaller role for wool. Synthetic fibres have, during the last 20 years, gained in importance. Table III-1 present the use of textile fibres. It can be seen that synthetic fibres have recently taken up almost half of the fibre consumption.

Table III-1 Consumption of textile fibres in Indonesia, 1990 and 1994 (tons)

	Natural fibres	*% of total*	*Synthetic fibres*	*% of total*	*Total*
1990	350,981	63	206,893	37	557,874
1994	395,349	52	368,123	48	763,472

Source: 1989-1994: PT CAPRICORN Indonesia Consult Inc., , januari 1996

The transformation of fibres into yarn can be subdivided into a number of different, that will be described below.

- *Opening, cleaning, blowing and beating of raw fibres*
  In this stage, the bales of incoming raw fibre are opened up after having been compressed, cleaned of dirt leafs and trash, blended and seperated. The object of this process is to obtain a clean, uniform raw material that can be treated further. This is done by transforming the bales of fibre into laps, that can be used for the next stage. During this process blowing and scutching machines are used.

- *Carding*
  The goal of the carding process is to attenuate the laps of fibre into slivers, removing excessively short or immature fibres, and making them parallel. For higher-grade and finer yarns, the combing process is also applied in this stage. The whole process is

[14] Ishida, Teruo, *An introduction to textile technology* (revised edition), Osaka Senken Ltd., Japan, 1991
[15] UNIDO, *Appropriate industrial technology for textiles*, executive director Abd-El Rahman Khane, New York, 1979

carried out by carding (and combing) machines.

- *Drawing*
  The incoming slivers are evened and drawn out to obtain a longer, thinner sliver. The main objective here is to reduce the weight of the slivers; a drawing machine performes the stretching process, using increasingly fast rollers for its operations. The reduction in weight (per yard) of the slivers is called the draft; it is used similarly in roving and spinning.

- *Roving*
  The roving process takes the sliver from the drawing process and continues to make it thinner by the same principle (increasingly fast rollers) as with the drawing process. The slivers are also twisted slighlty to increase strength. The roving process can be omitted if the slivers are fed to an open-end spinning process.

- *Spinning*
  In the spinning process, the slivers are transformed into yarn, that is wound onto bobbins. The thickness of the yarn is called its count. Various types of spinning processes are available, of which ring spinning and open-end spinning are the most common. These technologies, which are the core technologies of the entire spinning process, will be treated in more detail in the next paragraph.

- *Twisting and winding*
  There is no general consensus on the actual end of the spinning cycle - every step after the spinning of the yarn is in fact a prepatory stage for the weaving (or knitting) process. Still, many spinning mills also take up some of this preparation by performing some twisting and winding on the produced yarn. Twisting several yarns together is done to obtain the various specific final products. Winding the yarn on larger cones and removing faults is a process that facilitates further use of the yarn. Several machines are available that combine the winding and spinning process.

Productivity and speed developments of many of the 'side' technologies mentioned have been quite impressive. The UNIDO (1979) mentiones improvements of 400 percent and more in carding and drawing machines.
The relative importance of the several stages in the spinning cycle can be illustrated with table III-2. This table is derived from Pack (1987), and presents the share of (one-shift) factory employment and share of investment for a modern European 'best-practice' plant (a plant that has best productivity) for each of the spinning stages. The third column lists the shares of employment for each stage in a 'developing country' mill, in this case one in the Philippines. Table III-2 suggests that the spinning stage is by far the most important, both investment- and employment-wise. A comparison between the European and Philippine employment shares could even suggest an increase of this importance as productivity increases. The choice of this spinning stage as the core stage, and thus core technology, in the spinning cycle seems therefore justified. Besides this empirical support, the spinning stage is also theoretically the most important in the spinning cycle. The next paragraph will therefore go further into the technologies of yarn spinning.

Table III-2 Relative importance of spinning stages (percentages)

Stage	*Share of investment (a)*	*Share of factory employment (a)*	*Share of factory employment (b)*
Opening	5	8	8
Carding	20	11	13
Drawing	8	4	9
Roving	11	13	16
Spinning	56	64	54
Total	100	100	100

Notes:
a European 'best-practice' firm
b Phillipines firm

Source: Pack, 1987

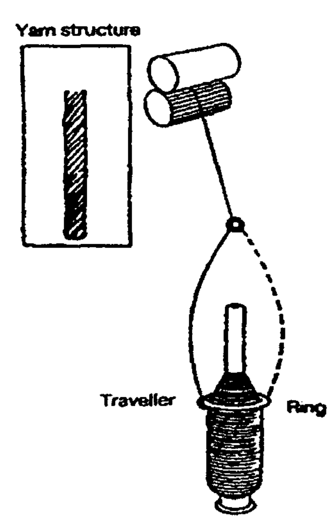
♦ *Yarn spinning systems*

The spinning process, as mentioned earlier, can be performed by various technologies. A yarn producer can chose from ring spinning, open-end rotor spinning, air-jet spinning or open-end friction spinning. In Indonesia only ring spinning and open-end (rotor) spinning are present at large scale. One mill has already got an air-jet system stationed, but is currently not producing with it. One reason for the lack of the most modern spinning systems (i.e. air-jet and open-end friction spinning) in Indonesia is that these systems are still being developed by their producers, and are as such not always 'ready-to-use' without further R&D. I will describe the two main technologies, ring spinning and open-end spinning, below.

Ring spinning

The concept of ring spinning is in fact very old. It was first patented by the American J. Thorp in 1828. It is nevertheless still the most popular spinning technology, both in Indonesia and many other parts of the world. The spinning is carried out on spinning frames, each of which may contain up to 500 separate spindles. Ring spinning machines further attenuate the slivers coming in from the roving process by roller drafting until the required draft is obtained. Simultaneously, the slivers are twisted to gain strength (see figure III-1). The labour needed for this process can be divided into two categories; spinners, who set up the supply of roving (output of the roving process) and doffers, who remove the filled bobbins from the

Figure III-1 Principle of ring spinning



spinning frame and replace them with empty ones.

Although the basic technology has remained the same, improvements in productivity (mainly in speed) have been achieved over the years. The UNIDO for example mention an increase in speed of about 30 percent, although no time interval is given. Their 1979 paper states a maximum spindle speed of 15,000 rpm (rotations per minute), while Ishida's report from 1991 estimates a maximum speed of 25,000 rpm. Productivity developments are still quite modest however compared to the speed increase in the 'side' technologies (see previous paragraph).

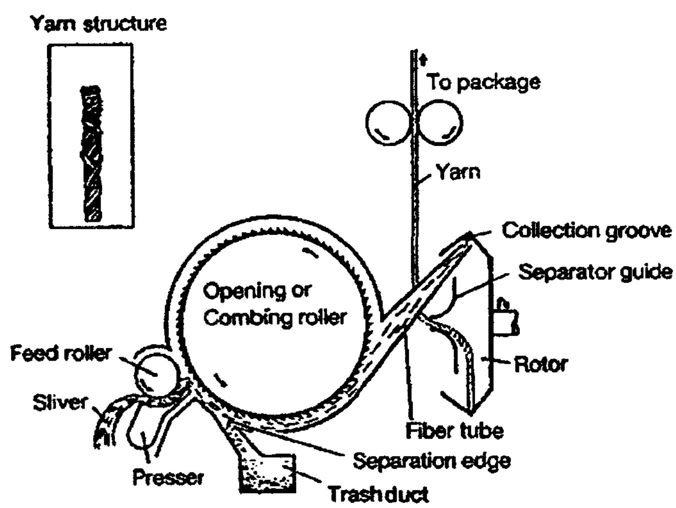
Open-end rotor spinning

Open-end rotor spinning is one of the radically new methods to obtain yarn that have been developed in the 1960s and 1970s. The process is characterised by the fact that no longer the whole bobbin is rotated, but an open end of the yarn is rotated around the axis of the yarn (see figure III-2). The twist insertion is thus performed by a rotor. The main advantage of this system is the greater rotor speed that can be obtained. Maximum speed is estimated at 120,000 rpm in 1991. Another benefit of the open-end technology is the fact that the roving process can be entirely skipped. An important disadvantage of the open-end spinning system is the limitation in yarn-count (yarn thickness). Open-end systems perform adequately for thicker yarn, but become increasingly vulnerable for yarn of larger count (i.e. thinner yarn). This has been an important reason for the limited use of open-end systems in Indonesia. In fact, most open-end systems are used for the production of 'jeans-yarn', i.e. yarn used for the weaving of denim cloth. Use of open-end rotors in recent years has varied with the popularity of denim for garment producers.[16]

Although open-end spinning clearly proceeds with much greater speed, this speed difference can not be used directly for productivity comparisons. Whereas the ring spinning speed refers to winding and twisting, the rotor speed in open-end spinning reflects twisting speed only. Since the winding-speed refers to the speed with which yarn is winded onto its bobbins, this is obviously a better indicator for the productivity of both systems.

Progress in speed and productivity has also been made, but to a lesser extent than with ring spinning. For 1987 90,000 rpm is mentioned as top-speed, although in a different context as the beforementioned estimate dating from 1991.[17]

Figure III-2 Open-end rotor spinning



[16] see expert interviews

[17] This number is derived from Departemen Perindustrian-Bank Indonesia, *Buku pentunjuk industri tekstil 1987*,

♦ *Comparing spinning technologies*

After having reviewed the existing spinning technologies, a comparison between the two technologies can now be made, focussing on speed, output, labour requirements, investment costs, lifespan and product specialisation. I will also present data on the presence of both technologies in the Indonesian textile industry.

- *Maximum speed* of both technologies is, as given earlier, 25,000 rpm for ring spinning and 120,000 rpm for open-end spinning. It should be noted these figures are not directly representative of output differences.

- *Maximum output per spinning unit* (per unit of time) also differs considerably. In a publication of the UNIDO, the difference in output per spindle unit is estimated to be a factor 3.00.[18] We have also seen that performance of the open-end system improves with lower yarn-count. Liliana Acero observes this as well in her analysis of Brazilian spinning plants. With a count of 10s, she finds an output difference of factor 4.42.[19] The fact that both technologies are used for different products (for yarn with a different count) poses a problem in comparing them with respect to maximum output. Maximum output of ring spindles is, unlike output for open-end rotors, not dependent upon yarn count to a great extent. It would therefore not be 'fair' to use maximum output data for open-end rotors below optimal yarn count, while ring spinning is allowed to perform at optimal yarn count. I have therefore chosen to use the data given by Acero in my calculations.

- *Labour requirements* are difficult to find for an equal number of spinning units. Estimates for labour costs or number of persons can be found for equal output, but recalculating this to labour requirements per spinning unit introduces errors related to the utilisation. In other words, it is hazardous to assume that an increase of factor 3 in output would require the same increase in number of labourers, since no information is available on the utilisation rate of the machines involved. Only if all machines used were fully utilised, such an assumption would be justified. I have therefore chosen to work with estimates derived from textile experts, besides one estimate given by Acero (1984). Table III-3 summarises these assessments.

Table III-3 Labour requirements per spindle
(number of labourers, index)

Source	*Ring spinning*	*Open-end spinning*
1	100	70
2	100	79
3	100	74
Average	100	74

Sources: 1+2: interview with experts (see appendix); 3: Acero, 1984

1989, while the 1991 data are derived from Ishida.

[18] This factor has been derived by taking the ratio of the number of spinning units for equal output per system (which was 2400 over 800, for a total output of 1,000 kg daily; count 20s).

[19] Acero, Liliana, *Technical change in a newly industrializing country: A case study of the impacts on employment and skills in the Brazilian textiles industry*, SPRU Occasional Paper Series No. 22, University of Sussex, 1984; calculated using data on production per rotor or spindle per minute (67m/15.15m).

The estimates given are indexed to enable averaging the results. The spinning unit mentioned is therefore not further defined. I have chosen to assign unity value to the 'standard' spinning technology, which is ring spinning in the Indonesian context.

- *Investment costs* for both technologies refers to the price of the respective machines. Since both machines usually are supplied with a different number of spinning units (spindles or rotors), investment costs have to be recalculated to investment costs per spindle. Acero (1984) provides investment costs for both types of spinning machines for Brazilian plants in 1984. By using them for the Indonesian textile sector, it is assumed that prices between the two technologies do not differ between countries, that is no capital subsidies (or equal subsidies) are granted in both countries. Acero uses selling prices of both types of machinery on the local market. In other words, prices that would be paid if the used equipment was sold on the local (second-hand) market.[20] However, prices for the acquisition of new machineries, both for 1980 are also given. I have chosen to use the latter, since these prices are based in the same year and are expected to reflect productivity differences better than prices of second-hand machines of different vintages. One ring spinning frame (380 spindles) would costs 60,000 US$ (1980 prices), while an open-end system (100 rotors) would be worth 240,000 US$. We thus arrive at prices per spinning unit of 157.90 US$ for ring spinning frames, and 2,400.00 US$ for open-end systems.

- For the *lifespan* of the machines, or the average number of years a spinning machine is used, the same procedure has been applied. This resulted in an estimate of 30 years for both types of machinery.

- The *product specialisation* of both technologies is different again. Various authors point at the increasing capital costs of open-end systems with increasing yarn counts. Moreover, experts claim that the open-end systems are now used almost exclusively for the production of 'denim'yarn; thick yarn used to weave denim cloth. Ring spindles can be utilised for all yarn-products. High and low yarn counts, and all blends of natural and synthetic fibres are possible. All this has been summarised in table III-4.

Table III-4 Comparison between spinning technologies

	Ring spinning	***Open-end spinning***
Maximum speed	up to 25,000 rpm	up to 120,000 rpm
Maximum output[a] (index)	100	442
Labour requirements[a] (index)	100	74
Productivity (output per labourer, index)	100	598
Investment costs (per spinning unit, 1980 US$)	157	2,400
Lifespan	30 years	30 years
Product specialisation	all yarn	mainly lower-count yarn

Note:
a per spinning unit

Sources: speed: Ishida, 1991; output and investment costs: Acero, 1984; lifespan and output specialisation: expert interviews

[20] These prices are 30,000 US$ for spinning frames and 204,000 US$ for open-end systems.

♦ *Spinning systems in Indonesia - past to present*

As already mentioned in chapter I, the spinning industry in Indonesia has not been around as long as its weaving counterpart. Hand spinning, using manual spinning systems, had already existed for a long time as a household activity, but it was not until the 1930s that a small industrial spinning sector started to develop. Little progress was made, and it was only at the end of the 1960s, after the New Order government had facilitated importing capital goods, that the spinning sector 'took off' into its rapid growth period, later on spurred by the liberalisation policy-packages of the mid-1980s.[21]
In 1968, at the very beginning of the New Order period, some 481,780 ring spindles were present in the Indonesian spinning industry. 10 years later, this number had already multiplied by more than three times. Growth in the 1980s even exceeded former achievements, and in a few years the total number of spinning units in Indonesia may well be 20 times as large as its 'departure'-total in 1968.
The first data on open-end systems in Indonesia go back to 1976. At that time, some 10,216 open-end rotors were involved in the production process, while 1.24 million ring spindles were being used. Growth of the open-end units has never exceeded ring spindle growth; in fact, the total number of open-end systems exceeded one percent of the total number of ring spindles only in. Table III-5 provides further information on spinning unit totals. It can be seen straight away that it will be a long time before the technologically slightly superior open-end rotors take over the ring spining units, and in fact nobody expects this to happen. Its deteriorating performance with increasing yarn count, and its subsequent products specialisation in thicker yarn, together with its larger investment costs are important reasons for the modest role of the open-end systems in Indonesia. Besides this the ring spinning technology is by no means an obsolete one, and the continued improvements in its speed and in the various side-technologies used, together with its 'universal' applicability, are still important factors explaining the popularity of the ring spinning system.

Table III-5 Spining units in Indonesia, 1968-1994

	Ring spindles		*Open-end rotors*	
	(#)	*Share in production capacity (%)*	*(#)*	*Share in production capacity (%)*
1968	481,780	100.0		
1976	1,238,500	96.5	10,216	3.5
1984	2,545,770	95.2	29,000	4.8
1989	4,903,513	97.8	24,588	2.2
1993	6,500,000	96.4	55,058	3.6
1994	7,000,000	96.3	60,766	3.7

Note:
Production capacity has been calculated as the number of spinning units times their maximum output index (see table III-4)

Sources: Ring spindles 1968-1994: Media Tekstil, 1995; Open-end rotors: 1976 and 1984 from Media Tekstil, 1988, 1989 from Media Tekstil 1991; 1993 from Media Tekstil, 1995; 1994 from Indotextile, 1995.

[21] Hill, Hal, *Indonesia's textile and garment industries - a development in an Asian perspective*, Occasional paper no. 87, Institute of Southeast Asian Studies, ASEAN Econonomic Research Unit, Singapore, 1992

Weaving

The process of weaving refers to the transformation of yarn into woven cloth. The simplest form of weaving is achieved by raising alternate warp yarns and inserting a pick (that also carries yarn). Figure III-3 illustrates this process, while figure III-4 presents three basic weaves. The raising of the ends is normally done by heddles that are controlled by the loom-driving mechanism. For the preparation of the yarn that will be used in the weaving process, a number of stages are necessary. These stages will be briefly described below.

Figure III-3 Principle of weaving

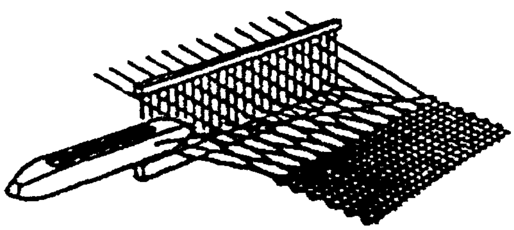
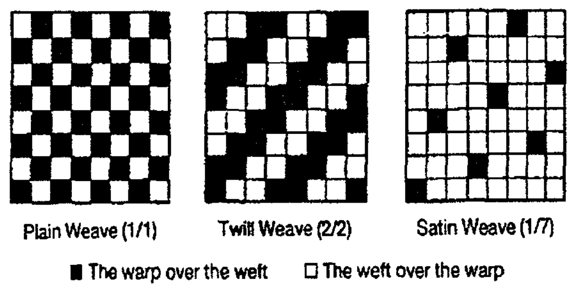


Figure III-4 Three basic weaves



Technically, *twisting and winding* are also preparatory stages for the weaving cycle. Since this stage has already been described in the spinning cylce, it will not be treated further here.

- *Warping and sizing*
  The purpose of warping and sizing is to arrange threads in long length parallel to one another preparatory to further processing. Ends have to be withdrawn from a warping creel and evenly spaced in sheet form.

- *Looming*
  Preparation of the loom warps is the last stage before the actual weaving process can take place. The looming process has long been an expensive and time-consuming activity. Recent developments for the rationalised preparation of warps have reduced the time needed for this process. Complementary machines and apparatus have taken over the more traditional methods of looming. The importance of these machines has increased with the development of high-speed weaving systems.

For the weaving process itself, several technologies can be used. In Indonesia, three main 'generations' of technologies have been used over the years. These three types of machinery will be described in the following paragraph.

♦ Weaving systems

Developments in weaving technologies have been, more than in the spinning sector, focussed on the weaving looms themselves. Because of the limited number of processes in the weaving cycle, major improvements could be achieved best with the core technology of this process.

Developments have been rapid enough to justify the term 'technological revolution', according to Hal Hill.[22] The next paragraphs will describe these core technologies. The ATBM (*Alat Tenun Bukan Mesin*, a mechanised hand loom) was the first machine to be used on a large scale. Various types of shuttlelooms followed, and recently the shuttleless looms have gained considerable importance. They will be described below.

ATBM (Alat Tenun Bukan Mesin, mechanised handloom)
As early as the 1920s, a textile education and research institute in Bandung (nowadays the STTT Bandung) played a key role in the upgrading of traditional handlooms. By mechanising part of the shuttlechanging of the loom, a faster machine was developed, though still operated by 'hand' power. In spite of its reliance on manual power and its high employer-loom ratio (1:1), it was the first piece of weaving equipment used for industrial weaving activity on a broad scale.

Shuttlelooms
Shuttlelooms, or power looms, have been standard technology in many countries for many years, ever since their development in the early 1900s. The main improvement compared with the ATBM is its automatic operation. In steady state, the shuttleloom continuously raises alternate warp ends, and insert a shuttle carrying yarn. As can be understood, the speed of this process is an important indicator for productivity of the machines. The use of a shuttle has always been the most important limiting factor in loom speed, since the kinetic energy of the loom equals one half times its mass times its square velocity ($E = .5\ M\ V^2$). Doubling the speed will therefore require quadrupling the energy transferred to each shuttle move. This is one of the most typical technical problems of the shuttlelooms. Shuttlelooms have been around for some 65 years, and various types have been developed over the years. Increases in productivity and output of this type of machinery is to be expected. Hill (1979) mentions three types of shuttlelooms, each operating at distinctly different levels of speed and output. Data on these differences are not given, however.
Some information on improvements within the shuttleloom production are available. The main conclusion is, however, that developments in design and maximum speed have only been marginal. More than in the spinning industry, efforts have been directed at designing new types of machinery rather than improving the existing types. However, within the 'shuttleloom-sector', various types do exist, each with their own specific speed and output. The most modern version of a shuttleloom is the fully automatic mechanised loom, which features automatic pirn change and stopping in case of warp breakage. The Sulzer loom also is an improved version of the 'conventional' shuttleloom. Hill's choice of technique analysis of the Indonesian weaving industry distinguishes between these various types of shuttlelooms.[23] Although considerable variations do exist between these types of looms, particularly for the operator-to-loom ratio, I will not distinguish between these various types of shuttlelooms in my analysis because of two reasons. First, not enough information is available on these 'intra-technology' variations, and secondly, differences in productivity between the types of technology considered in this thesis reduce the role of variations between shuttlelooms to merely a marginal actor.

[22] Hill, *ibid.*, 1992
[23] Hill, Hal, *Choice of Technique in the Indonesian Weaving Industry*, (dissertation), Australian National University, 1979

Shuttleless looms
Because of the limitations of shuttlelooms in speed and thus productivity, producers of weaving equipment focussed on the development of a loom that was no longer hampered by shuttle use. The result of these efforts were various machines using a number of shuttle-replacing techniques. Most of these machines were introduced in the 1950s.
Rapier looms use a rigid or flexible rapier which reciprocates in and out of the shed. Other than this the weaving principle remains in tact (see figure III-4).
Gripper looms use the principle of weft insertion by a projectile or a carrier. These looms are also known as projectile looms. The projectile or carrier in this loom is picked through a shed.
Jet looms appear in two basic varieties: *air-jet looms* and *water-jet looms*. The principle of this technology is the ejection of a metered length of weft from a nozzle. The nozzle ejection can be performed with jets of air or water. Figure III-5 illustrates the process.
Progress in the maximum speed and yarn insert of shuttleless looms has been made, but a comparison is difficult. Changes of up to 30 percent do exist between various sources, but is is unclear whether these sources refer to exactly the same type of shuttleless looms.[24]

Figure III-4 Rapier loom

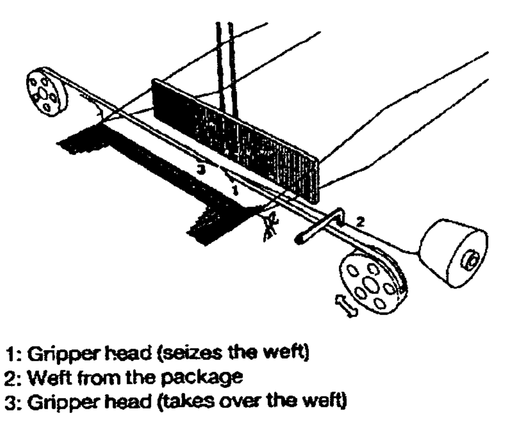
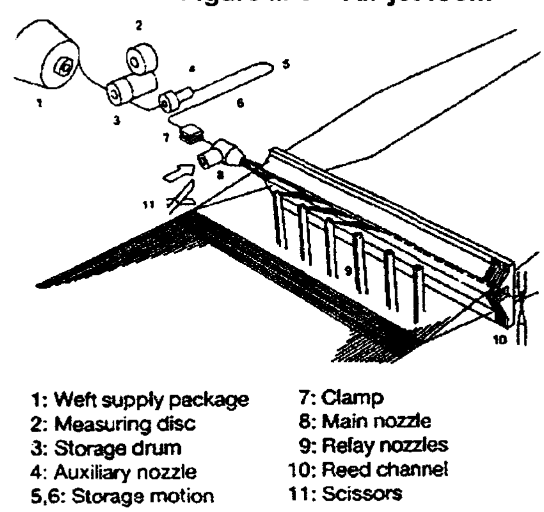


Figure III-5 Air-jet loom



♦ Comparing weaving technologies

In the same way that I have treated the different spinning technologies, I will now compare the weaving technologies discussed above. Again, the focus will be on maximum speed, output, labour requirements, investment costs, lifespan and product specialisation. In the summarizing table at the end of this paragraph, I have again chosen to normalise the ratios between the different technologies. The shuttleloom technology, which has been the most prevailing technology in Indonesia for a long time, has been considered the standard technology, hence the unity numbers for its achievements. In the final equations for productivity and technology indices, the shuttleless looms will be taken as one technology, despite their differences in principe and technical achievements. This has been done because of lack of detailed information on the various types of shuttleless looms, because their output

[24] For air-jet looms for instance, Ishida (1991) lists 600 ppm as maximum speed, while Departemen Perindustrian-Bank Indonesia (1989) mentions 500 ppm.

figures are in the same range, and because this simplification has not been uncommon in the literature. Nevertheless, if separate information was available, I have decided to both list this information, and calculate the average for shuttleless looms using the number of looms present in Indonesia in 1992 (5,004 air-jets, 5,014 water-jets and 7,398 rapiers). Since no gripper looms are present in Indonesia, they are not taken into the calculations. They are listed however because gripper looms are frequently mentioned in the literature. Sources of the technical data are listed below the summarizing table.

- The *maximum* speed of the various technologies can be found in several publications and handbooks on the textile industry. Because the ATBM technology is very old, and it has not been used in many countries for a long time already, data on speed and output of this technology was more difficult to find. However, data on output per loom are still available. Since output per loom is best approximated by the yarn insert (in meters per minute), which is in fact speed times comb-width, I have calculated the maximum speed of ATBMs as the quotient of output per loom and comb-width, which I have considered to be equal to the comb-width of the shuttlelooms. This leads to a maximum speed of about 25 picks per minute (ppm), while standard shuttlelooms operate with a speed of up to 185 ppm. Shuttleless looms score a lot better; gripper looms reach 300 ppm, rapiers 340 ppm, air-jet looms perform with a speed up to 500 ppm and water-jet looms 1,000 ppm. This leads to an average 'score' for shuttleless looms in Indonesia of 576 ppm.

- *Yarn insert* (measured in meters per minute) is a better indicator for productivity, since this also takes the width of the woven cloth into consideration. In fact, it is easily calculated as the speed times the comb-width. Data are 36 m/min for ATBMs, 265 m/min for shuttlelooms, 1,179 m/min for grippers, 1,258 m/min for rapiers, 1,800 m/min for air-jets and 1,900 m/min for water-jet looms. The weighted average for shuttleless looms is 1,599 ppm.

- *Maximum output per loom* has been derived from yarn insert data. Data are in index form to obtain an easier comparison.

- *Labour requirements* (per loom) are again not straightforwardly obtained. Some publications use labour costs as an indicator, but for a technical or a labour productivity analysis the operator-to-loom ratio is to be preferred. The collected data on labour requirements are summarised in table III-6. This table also shows the direction of technological progress in the weaving industry, which is one of labour-saving nature.

Table III-6 Labour requirements for weaving technologies (operators-per-loom, index)

Source	*ATBMs*	*shuttleloom*	*shuttleless looms*
1	1400	100	58
2		100	60
3	1500	100	
Average	1450	100	59

Sources: 1&2: expert interviews; 3: Hill, 1979

- *Investment costs* of the weaving technologies are derived from two sources, since there has not been one moment in time at which all three generations of technologies could be purchased (not being second-hand machines). In his 1979 dissertation, Hill uses four types of weaving machines; one domestically macufactured handloom, and three types of shuttlelooms - one domestically manufactured and non-automatic mechanised, the other two imported, one semi-automatic mechanised and one fully automatic mechanised.[25] Since most looms in Indonesia are imported ones, I have chosen to take the least modern of the two imported looms as the conventional shuttleloom in Indonesia (M_3 in Hill's work). Prices of the looms were given including investment costs in buildings and other supplementary investments. Unfortunately, no exact data on prices of looms only are given. Hill's estimate for total investment costs for handlooms (including supplementary investments) is 61,943 Rp. I have estimated this price to be slightly higher because of the fact that Hill assumes bamboo structures and hand-to-mouth existence with handlooms production, thus arriving at a price of 93,700 Rp (or the equivalent of 100 US$ (1993) instead of 66 US$). Prices of shuttlelooms and shuttleless looms are given in Koesmawan's dissertation.[26] His data are based on previous research performed by Ruwiel. In 1993, the price of a standard shuttleloom was 2,500 US$, while a rapier loom would cost 42,500 US$ and an air-jet loom 40,000 US$. Prices on water-jet looms are not available in the sources mentioned. Averaging the price of an air-jet loom and a rapier loom we arrive at investment costs for shuttleless looms of 41,250 (1993) US$. If we now use the ratio between the price of a shuttleloom in 1993 and in 1979 to calculate the 1993 price of a handloom, we arrive at a price of 100 US$.

- *Lifespan of the machinery* decreases with increasing complexity of the technology in Indonesian textile firms. Shuttleless looms are, in modern factories, only used for a period of about 10 years. After that, efficiency have started to decline, and the machines still have scrap value. They are then often sold to textile firms in other countries, or less advanced firms in Indonesia. Actual lifespan is still hard to etimate, as with open-end spinning systems, because they have not been around long enough to accurately calculate their years of service.[27] Shuttlelooms have been around for a much longer time, and their lifespan comprises on average 30 years. Much older looms, up to 50 years, are also still in use in the smaller firms in Indonesia. For ATBMs, the lifespan is difficult to estimate, since hardly any data are available. We could expect a very long lifespan, but, after the introduction of measures reducing prices of capital goods, they have been replaced quite rapidly.Many of them are still around, however, and are used either for niche markets or reserve capacity of weaving firms. Still, the period that a producer wants to use his or her machinery is actually economically more important than their factual years of service. I have therefore estimated the lifespan of ATBM weaving machines at 40 years.

- *Product specialisation* is not as apparent in the weaving sector as it is in the spinning mills, although differences do exist. The most outstanding technology product link is the water-jet loom, that is exclusively used for synthetic yarn, due to its greater strength. The rest of the machineries described does not have a clear specialisation towards any particular product. Table III-7 captures the previously given information.

[25] Hill, *ibid.*, 1979

[26] Koesmawan, *ibid.*, 1996

[27] It can not be stated that shuttleless looms have a shorter lifespan than other looms, because no information is available on what happens with the machines after they have been resold, or on the scrap value of the machines after 5 or 10 years.

Table III-7 Comparison between weaving technologies

	ATBM	*shuttleloom*	*shuttleless looms*
Maximum speed (ppm)	25	185	576
Yarn insert (m/minute)	36	265	1,599
Maximum output (per loom, index)	14	100	603
Labour requirements (operator per loom, index)	1450	100	59
Productivity (maximum output per employee, index)	1.0	100	1022
Investment costs (1993 US$)	100	2,500	41,250
Lifespan	40 years	30 years	10 years (excluding scrap value)
Product specialisation	-	-	water-jet only for synthetic fibres

Sources: Speed, Yarn insert and output per loom: ATBM - see text; shuttle- and shuttleless looms - Departemen Perindustrian-Bank Indonesia, 1989; Labour requirements: table III-6; Lifespan and product specialisation: expert interviews, Ishida, 1991

♦ *Weaving systems in Indonesia - past to present*

As mentioned already, the first signs of industrial weaving emerged with the introduction of the ATBM, a partly mechanised version of the traditional handloom, in the 1920s. Their number rose rapidly, from 257 in 1930 to some 44,000 in 1940. Power looms had also been introduced in this period, and their total equalled 44 in 1930 and 8,000 in 1940. The 1940s were a period of stagnation for the weaving industry, and possibly even a decline. After the second World War, and the battle for independence, the sector again expanded rapidly. The peak of the ATBM period was undoubtedly 1965, in which total hand looms equalled 324,000. The following year, chaos dominated much of the political and economical life during the communist upsurge and the consequent seizing of power by the New Order regime. After the new government had properly installed itself and had begun its economic reforms, however, the days of the ATBM were counted. Importing power looms became more attractive, and the weaving sector quickly modernised itself. Hill states that the hand loom total fell from its peak to 66,000 in 1975, and saw its role confined to residual capacity and niche market production by the late 1970s. By that time, a new generation of weaving machines had just been introduced in Indonesia. The shuttleless looms were first 'seen' in Indonesia in 1976, totalling 351 pieces. Eight years later this number had already grown to 4,000. Meanwhile, the shuttlelooms were experiencing growth as well, adding up to about 90,000 during the later 1980s. Recently, the 'second transition' has begun to take place. ATBMs were rapidly replaced with shuttlelooms in the 1970s, and shuttleless looms are now replacing shuttlelooms with considerable speed. Taking production capacity into acount, shuttleless looms have already overtaken shuttlelooms. Table III-8 presents the data, while figure III-6 illustrates very clearly the technological developments in the weaving sector over the last 65 years or so.

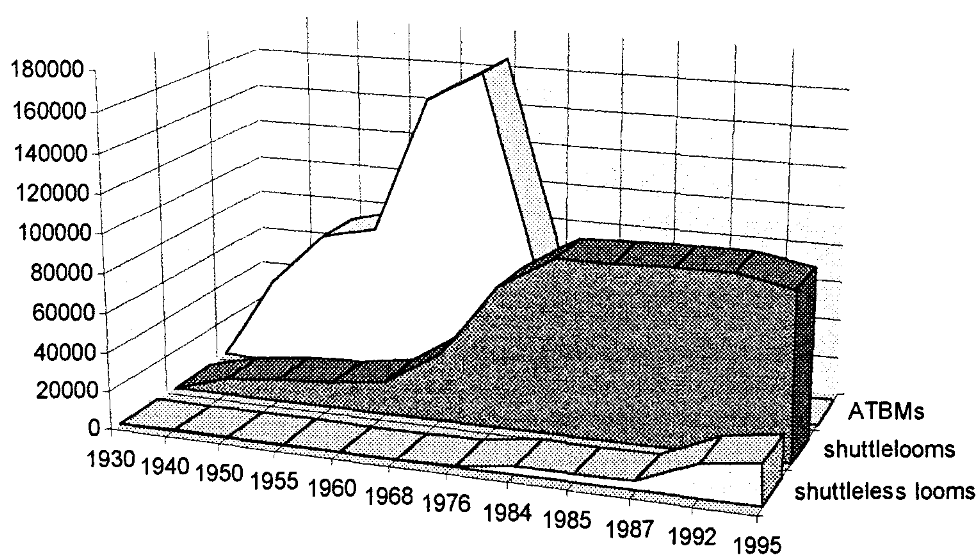
Table III-8 Weaving systems and production capacity in Indonesia, 1930 - 1995

	ATBM (hand loom)		*Shuttleloom*		*Shuttleless looms*	
	(#)	*Share in production capacity (%)*	*(#)*	*Share in production capacity (%)*	*(#)*	*Share in production capacity (%)*
1930	257	45	44	55		
1940	44,000	44	8,000	56		
1950	71,997	47	11,390	53		
1960	150,000	55	16,869	45		
1968	166,000	40	35,335	60		
1976	66,000	11	72,579	86	351	3
1984			90,300	79	4,000	21
1987			91,487	77	4,502	23
1992			91,934	47	17,416	53
1995			86,440	40	21,654	60

Notes:
Data for 1976 (shuttle- and shuttleless looms) assuming that all machinery is imported (shipments).
ATBMs 1976 refer to 1975.
Data for 1992 are taken from an age table. Since not all machines are accounted for, the totals are multiplied by the same number as the ratio of accounted/total in 1995.
Indices for production capacity: ATBM 14; shuttleloom 100; shuttleless looms 603.

Sources: table B-1 (appendix)

Figure III-6 Weaving systems in Indonesia, 1930 - 1995



Future developments

With its swing to export orientation in the mid-80s, the Indonesian textile sector has become an important player in the textile world market. After the government set out to leave the days of import-substitution and protection behind, however, competition has also sharply increased. Most people involved agree that the future developments in the Indonesian textile industry will be largely dictated by developments in the world market. With increasing globalisation, country developments are more and more dictated by international economic relations, and less room for governmental manouvring remains. For Indonesia this will probably imply an increasing emphasis on modernisation, efficiency and high-quality products.[28] As we have seen in chapter I, the Indonesia's wage-related advantage ('cheap labour') is experiencing increasing competition, partly because of rising wages, partly because of new industrialising countries that are able to produce even cheaper (i.e. wages are even lower). Future competitiveness will have to be sought in high-quality products and high-tech production methods.[29]

For spinning, the number of open-end rotors is expected to grow, but they will not catch up with ring spindles for a long time to come. Its technical limitations, resulting in a slightly different product orientation, do not allow a complete replacement of ring spindles by open-end rotors. The newest spinning technologies, air-jet and friction spinning, will eventually also find their way into Indonesia, but not for at least another five years. Indonesia's position in the world market is not yet one of an R&D country, and the latest technologies have not been sufficiently developed to allow a large scale operation of these machines. When these technologies have been 'through-developed' and settled, large scale operation might commence in Indonesia.

For weaving, with its longer history, development are even more bound by world market demands. At the moment, the substitution of old machinery (shuttlelooms) with the next generation of machines (shuttleless looms) is rapidly taking place. In fact, shuttlelooms already are hard to purchase sometimes, and all new weaving factories are now buying the latest equipment to start their production lines. Increasing efforts to improve efficiency can also be observed in the replacement of new machinery. Nowadays, modern firms replace their shuttleless looms after 5-10 years, when efficiency starts to drop. The machinery still holds a scrap value, and the machinery can be sold to companies in other countries. This aptly illustrates the position of Indonesia, which is slowly moving from being a 'low-wage - standard quality' country to becoming a 'medium-wage - high quality' one.

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[28] see a.o. Koesmawan, *ibid.*, 1996 and references from chapter I

[29] see expert interviews

III-4 An index for the Indonesian textile technology

We have seen earlier that using purely economic data to derive an index for technological progress is very difficult, and usually leads to shortcomings in the constructed index. Focussing on technical and machine-specific data only, on the other hand, usually does not provide enough statistical material to construct an index at meso or macro level. However, with the collected data on presence of the various technologies in Indonesia, and their productivity known, a start can be made in constructing such an index. The correct name for the index that is going to be derived would probably *be 'index for the maximum productivity of the machinery used'*. I will, however, use the term *'technology-index'*, which will be given the above mentioned definition. I will first discuss deriving an index based on technical and economic data, and secondly focus on the application of this index in an economic analysis. It should be remembered that the derivation and calculation of an index for 'technology' in this thesis is only possible because of the narrow definition used for the concept of technology. If a more-comprising definition were applied, this would almost inevitably lead to all sorts of theoretical and practical difficulties in measuring 'technology'.

Constructing a technology-index

Deriving one variable containing all technological developments in one industrial sector necessarily requires making assumptions on various technology-related aspects. Summarising these assumptions, developments in the core technologies of the 'machinery and equipment' segment of capital goods in the Indonesian spinning and weaving sector have been assumed to be representative for all technological developments in the sector.
In order to derive a technology-index, a mathematical framework has to be presented first. We have defined technology as the productivity of the machine-park. This implies that the productivity of the machine park multiplied by the number of machines present should yield the productive capacity (or real capital services) of the capital goods. Or,

$$P_t = \frac{PC_t}{N_t} \qquad (3.1)$$

where PC_t refers to the productive capacity at time t, P_t refers to the productivity of the machine-park and N_t refers to the number of machines present. If we now introduce an indicator for the maximum productivity (or maximum output) of the different machines used, we can derive a statement for the productive capacity of the machine-park, which leads to

$$P_t = \frac{\sum P_0^i N_t^i + \sum N_t^i (P_t^i - P_0^i)}{N_t} \qquad (3.2)$$

in which P_t^i is the productivity (maximum output) of the machines of type i at time t. We can thus see that the productivity of the machine-park can be divided into two parts: the changing shares of the different types of machines in the machine-park (the *shift effect*; the first term of the addition), and the changing productivity of one type of machinery over time (the *advance effect*; the second term in the addition). An index for technological progress would be defined as the quotient of the productivity of the machine-park at time *t* and *0*. This results in

$$I_{Tech,t} = \frac{P_t}{P_0} = \left[\frac{N_0}{N_t}\frac{\sum P_0^i N_t^i}{\sum P_0^i N_0^i}\right] + \left[\frac{N_0}{N_t}\frac{\sum N_t^i(P_t^i - P_0^i)}{\sum P_0^i N_0^i}\right] \quad (3.3)$$

and with all variables suffixed *0* being constant, we find the shift and advance effect back in the two terms at the right side of the equation. With these equations it is possible to develop a technology-index, and to estimate the different effects of technological progress. We can in fact write

$$I_{Tech,t} = SE_t + AE_t \quad (3.4)$$

without altering the equation; SE_t now represents the shift effect at time *t*, while AE_t refers to the advance effect.

Shift effect

I will first confine myself to the so called shift effect: the increasing share (in production) of one type of technology at the expense of another. Data for this analysis have already been presented in the previous paragraph. It is of course not necessary to limit the analysis to differences in productivity per unit of machinery. If we would like to find explanations for the large increase in labour productivity over the last 20 years (see chapter I), it could be interesting to look at the differences in labour productivity (differences in output per labourer for the various technologies, that is). It is even possible to regard differences in maximum speed using exactly the same procedure, although this would be less interesting.

Constructing an index for the shift effect can thus be performed by dividing 'the total number of machines weighted by their productivity in the base year' by 'the unweighted total of machines'. Multiplying by the 'base year inverse' of this term ensures unity value in the base year. The shift effect, based on the framework given above and represented here by SE_t, is thus given by

$$SE_t = \left(\frac{N_0}{\sum P_0^i N_0^i}\right)\left(\frac{\sum P_0^i N_t^i}{N_t}\right) \quad (3.5)$$

Table III-9 Index for technology shifts in the spinning and weaving sector (1976=100)

	Spinning	*Weaving*
1940		45.1
1950		43.6
1960		38.6
1968	97.4	48.2
1976	100.0	100.0
1984	101.0	201.8
1987		205.6
1989	99.0	
1992		298.1
1993	100.1	
1994	100.1	
1995		332.3

Sources: see previous tables

Table III-9 presents the constructed indices on the shift effect. It can be seen immediately that there are enormous differences between the spinning and weaving industry with respect to the technologies used. The data on presence of the textile technologies already revealed that while a mild 'technological revolution' has taken place in weaving, progress in the spinning industry has not been embodied in the replacement of older generations of technology. The standard-technology in spinning, the ring spinning frames, are indeed still overwhelmingly present in Indonesia, and this is not expected to change in short- or medium-term forecasts.

Advance effect

As we have seen in the description of spinning technologies however, it would not be justifiable to assume that there has only been a three percent increase in spinning-technology productivity in the last 25 years, and that the *advance effect* has not played a role in technological developments. Considerable progress has in fact been made in the maximum speed of ring spinning frames, and many side-technologies (machines used for drawing, carding, blowing etc.) have undergone speed and productivity increases of over 100 percent. To include these changes (or at least as far as the core-machinery goes) in a technology-index, the productivity increases within one single technology should also be calculated. We have already seen, however, that insufficient information is available to statistically estimate this rate of technological progress. Detailed 'progress-reports' for every type of machinery should be available, stating annual increases in output per machine and other features. Knowing that these reports are not available, two things can be done. It could be decided to entirely drop the advance effect, and only use the data on the shift effect. This would most likely lead to an underestimate of the 'real' technological progress, but would be founded upon the empirical evidence available. Or, it could be attempted to use intuition and the available information to arrive at an estimate of the advances in productivities of the machines, and to construct an index based on this estimate. This would most likely lead to a technology-index that is closer related to the actual technological progress, but would not completely comply to all criteria of scientific research.

I have chosen to do both. I will estimate the rate of advances (the advance effect) using the little information available for both subsectors, but throughout this thesis I will continue to use both the technology indices for my analysis. In this way the reader will be able to decide what index should be preferred.

For the spinning industry, I have estimated an advance effect of 3 percent annually. This estimate is based upon the information presented in the previous paragraphs. I have assumed the 30 percent speed increase of the UN to refer to a period of 10 years, and that the data for 1979 (15,000 rpm) and 1991 (25,000 rpm) are a slight overvaluation, since the 1991 data are from a 'theoretical' Japanese book on spinning technology, which will usually present the top-of-the-line machines. Since the available data also suggest advances in the open-end rotor machines, but lack quantitative estimates, I have seen no reason to assume a different growth rate for these machines.

For the weaving industry, I have estimated an advance effect of 1 percent per year. The progress in speed and output per technology has been less than in spinning, which is confirmed both by the literature and by experts. It is also obvious from the data that the technological focus in the weaving sector has been put more on development of new technologies than on developments within one technology. However, *within* the shuttleloom group, some shift effects have also taken place, which can be seen as a advance in output per loom. Besides this, developments in the shuttleless looms have taken place, be it at a moderate rate. On ATBMs no information whatsoever was available. Since it has been my aim to estimate the advance effect at subsectoral level, it has been assumed that advances in productivity of ATBMs are also one percent annually.

If the advance effect is estimated at sectoral level by an annual growth rate, as has been done above, the second term of the technology-index equation can be simplified using the assumption that

$$P_t^i = P_0^i \cdot \left(1 + \frac{A}{100}\right)^{t - t_0} \tag{3.6}$$

where A represents the (sectoral) advance effect in percentages. This leads to an equation for the second term of the technology-index equation (represented by AE_t) which takes the form of

$$AE_t = \left(\frac{N_0}{\sum P_0^i N_0^i}\right)\left(\frac{\sum N_t^i P_0^i\left(\left(1 + \frac{A}{100}\right)^{t - t_0} - 1\right)}{N_t}\right) \tag{3.7}$$

With the advance effect estimated, we can proceed to the technology indices for the spinning and weaving industry. They are presented in table III-10. As stated earlier, I will continue to present two estimates for technological progress. Index A presents the estimate using only data on the shift effect in the industry, while index B represents an estimate of the technological progress due to both the shift effect and the advance effect. For spinning, the assumption of a advance effect of 3 percent annually clearly has profound implications. Its technological progress is now some 91 percent in 26 years, whereas it only is 2.6 percent without the advance effect. For weaving, the equation used to calculate the role of the advance effect yields a rapidly increasing importance of the advance effect as the shift effect accelerates. The 'logical' reason for this is that when advance effects are embodied in more productive capital goods, the increase in productive capacity will be larger than when these effects are embodied in inferior capital goods.

Table III-10 Technology-index for the spinning and weaving industry in Indonesia, 1940-1995 (1976=100)

	Spinning index			*Weaving index*		
	A	*Contrib. advance effect*	*B*	*A*	*Contrib. advance effect*	*B*
1940				45	-14	31
1950				42	-10	33
1960				38	-6	32
1968	97	-21	76	48	-4	44
1976	100	0	100	100	0	100
1984	101	27	128	201	17	218
1987				205	24	229
1989	99	46	145			
1992				298	53	351
1993	100	65	165			
1994	100	70	170			
1995				332	71	403

Note:
A refers to the shift effect
B refers to the shift effect and the advance effect

Source: appendix table B-2

This results, as table III-10 shows, in an importance of the advance effect in the weaving sector of 71 percent in the last 18 years, which is much more than a 'steady' increase of 1 percent annually would yield. In the 36 years before (1940-1976) the advance effect only constituted a change of 14 percent.

Using a technology-index in economic analysis

Besides using the technology-index created in the previous paragraph for a technological analysis of the textile industry, it can also be a valuable indicator in economic analysis of past performance of the textile sector. Assessing the role of technological progress can be done by using its indicator within a growth accounting framework, as has been discussed in the previous chapter. Since we have defined technology in a narrow way, referring to technology embodied in capital goods, the technology-index can be used as an indicator for the quality of the capital inputs. However, there are a number of theoretical issues that have to be dealt with before we can use of the technology-index created above in a growth accounting analysis.

The technology index presented in the previous paragraph is an index of the quality of capital goods based on the maximum productivity per unit of machinery, which equals maximum output per unit of machinery. If we want to use a technology-index (or rather an index representing the quality of capital goods) in a growth accounting exercise, economic theory would normally dictate that different machines are weighted with the partial elasticity of output with respect to this machine's inputs. However, since we are only taking one type of machinery into consideration, this condition does not apply. Instead, we can use data on the maximum productivity of the machineries involved as a quality-weighting factor. In fact, the technical data on maximum output used are also a very interesting approximation of the marginal productivity of the various machines.

It is important to note that output data can only be used, if the technically maximum output is used. It would be faulty to use the 'economic' productivity of the capital goods, that is output divided by the capital stock, as an indicator for capital productivity. This would lead to a quality index for capital inputs that is economically described by (O/K). Multiplying this index with the the quantity index for capital goods (K) would then result in output (O) as a measure for capital inputs.[30] In a production function, this would lead to 'loops'. If we use *maximum* output (a technical measure based on speed and other technical variables) as an indicator for marginal productivity, however, this problem would be avoided.

We can also see in the tables III-4 and III-7, comparing the spinning and weaving technologies, that there is a considerable difference between the ratios of maximum output and investment costs. This could imply two things: either the acquisition prices of textile machines do not reflect productivity differences, or the measurement of the productivity differences or investment costs has been incorrect. I personally am more inclined to opt for the first possibility. When a product, in this case a textile machine, has been on the market for a considerable time, prices tend to drop because of increased competition in supply and technological innovations leading to cheaper production. In both the spinning and the weaving case, the newest technologies are more expensive than their maximum productivity would suggest (in relation to alternative technologies). This could be explained by the

[30] Since $(O/K)*K=O$

abovementioned hypothesis. In spinning, the higher costs of the open-end technology could also be caused by the fact that the roving stage, and thus the roving machines, can be omitted in the production process.

Aggregating subsectoral results

We now only have to find a way to arrive at one measure for the quality of capital goods, or a technology-index, based on the two indices we have found for the spinning and weaving subsectors. Again, I will assume that technological developments in the spinning and weaving subsectors are representative for the entire textile sector.

Developments in these two sectors first have to weighted to be combined into a single technology-index, via

$$I_{Tech,Tex,t} = v_{S,t} I_{Tech,S,t} + v_{W,t} I_{Tech,W,t} \qquad (3.8)$$

with the *v*s being the weights used. We are now faced with a theoretical problem: how can the distinction between quantitative and qualitative inputs be maintained at sectoral level? At industry level, quantitative inputs can be represented by the number of core-machines. At sectoral level, however, it is not possible to add spinning frames with weaving looms without some form of weights. We will thus lose the purely quantitative series for the textile sector, because the weights used will normally be expressed in monetary terms. The price of output per unit of time per machine would be a valid weighting method. However, information on this is not available. A 'next-best' solution would be the share in the total capital services of the capital services of the subsectors. But, there is drawback here. If we want to maintain the definition $PC_{tex} = I_{tex} N_{tex}$, with I referring to the technology-index for the textile sector and N referring to some quantitative indicator for capital inputs, respectively, we can not use the annual share in capital services of the subsectors as weights. The reason for this is the following. The annual share in total capital services would be calculated by the price of the subsector capital services divided by the price of the total capital services. To arrive at a series for the production capacity of the textile industry again, the technology-index for the textile sector should thus be multiplied by the 'price of the total capital services' again. This 'price of the total capital services' would very much resemble the capital services estimate derived from the Perpetual Inventory Method, including the shift effect. We would thus arrive at an indicator for quantitative capital inputs that would include the shift effect. I have therefore chosen to the 'average price of the machines in a subsector *in a base year*' times the annual number of machines.[31] In the base year, these weights correspond to the share in total capital stock of the capital stocks of the subsectors, but they are not adjusted for shifts in the composition of the capital stock. The weights used are thus given by

$$v_{S,t} = \frac{N_{S,t} p_S}{N_{W,t} p_W + N_{S,t} p_S} \qquad (3.9a)$$

and

$$v_{W,t} = \frac{N_{W,t} p_W}{N_{W,t} p_W + N_{S,t} p_S} \qquad (3.9b)$$

with N referring to the total number of core machines in a subsector at time t, and p referring

[31] It would have been better here to use the rental prices, calculated as acquisition prices divided by the lifetime of the capital goods. Unfortunately, insufficient information on this is available.

to the average price (investment costs) of the machines in a subsector in a base year. The average prices p in a base year are thus defined as

$$p_S = \frac{\sum N_{S,\tau}^{i} p_S^{i}}{\sum N_{S,\tau}^{i}} \tag{3.10a}$$

and

$$p_W = \frac{\sum N_{W,\tau}^{i} p_W^{i}}{\sum N_{W,\tau}^{i}} \tag{3.10b}$$

with p^i being the prices of the i-th type of machine, and N_τ^i being the total of the i-th type of machines in the base year τ. We have thus derived an equation for the composite technology-index for the textile industry, using total number of machines and relative shares in capital stock as weights for the technology-indices of the subsectors.

Prices of the various machines, which are given at different times, also have to be devaluated to a base year, to enable a comparison. The base year for the prices of textile machines has been chosen as 1993; Koesmawan's data on the investment costs of weaving machineries are already in 1993 prices[32], and Acero and Hill's data on textile machines are converted to 1993 prices by using the conversion rate and wholesale price indices for electrical machinery.
Finally, a base year for the composition of the textile capital stock should be chosen. The first year of the analysis, in this thesis 1975, would be a logical choice, although no convincing arguments can be given. Because the choice of a composite base year is arbitrary, I have selected 1990 as a base year, since the composition of the textile capital stock is more representative for the whole period than 1975. The difference is largest in the weaving capital stock; in 1975, no shuttleless looms are present (1975 is the only year in which shuttleless looms had not yet been introduced in Indonesia), while a large but rapidly diminishing number of ATBMs were still present (by 1980, ATBMs had already disappeared).

As a final issue, we need to make the technology-index an annual series. Annual data are not available for the presence of machines in the textile sector, so I have chosen to 'intrapolate' the missing years in the presence of textile machinery. This is done under the assumption that years for which no information is given do reflect linear increases in numbers of machines. Even though this assumption can be easily attacked, I do not expect the errors that can be generated because of this to be any other than only marginal.
Table III-10 presents our final annual technology-index. I have also presented, as a summary on the derived technology-index, a listing of all assumptions made 'along the way' below.

- *Technology* has been defined in a narrow way, as being embodied in capital goods.
- The spinning and weaving subsectors have been assumed to be representative for the entire textile sector.
- Considering technological developments, the developments of the 'core' machineries have been assumed to represent developments in all capital goods.
- Maximum output per unit of time has been used as an indicator for the productivity of the machine-park, and thus as an indicator for technological progress.

[32] Unfortunately, Koesmawan does not explicitly state this. His data are derived from Ruwiel (1993), which has lead me to assume his prices are in 1993 US$.

- In combining technological progress of the spinning and weaving sector, the share of the core machineries in the total capital stock (calculated as all core machineries in spinning and weaving, weighted with their investment costs) are used.

Table III-11 A technology-index for the Indonesian textile sector, 1975-1995

	Spinning			*Weaving*			*Textile sector*	
	Weights	*Technology-index*		*Weights*	*Technology -index*		*Technology-index*	
		A	*B*		*A*	*B*	*A*	*B*
1975	0.10	100.0	100.0	0.90	100.0	100.0	100	100
1976	0.15	99.7	102.7	0.85	112.1	113.4	110	112
1977	0.18	100.0	106.1	0.82	128.4	131.4	123	127
1978	0.22	100.1	109.4	0.78	148.8	154.0	138	144
1979	0.26	100.3	112.9	0.74	175.0	183.2	156	165
1980	0.29	100.6	116.7	0.71	209.8	222.1	178	191
1981	0.30	100.8	120.3	0.70	214.0	229.1	180	196
1982	0.33	100.6	123.7	0.67	217.9	236.0	179	199
1983	0.34	100.7	127.5	0.66	221.6	242.7	181	204
1984	0.35	100.8	131.5	0.65	225.1	249.4	182	209
1985	0.34	100.6	135.3	0.66	230.5	258.2	186	216
1986	0.35	100.5	139.1	0.65	229.9	260.5	185	219
1987	0.35	100.4	143.1	0.65	229.3	262.7	185	221
1988	0.41	99.4	146.0	0.59	252.6	292.6	190	233
1989	0.49	98.7	149.3	0.51	274.6	321.7	189	238
1990	0.49	99.1	154.4	0.51	295.5	350.1	199	254
1991	0.50	99.4	159.5	0.50	315.3	377.8	207	268
1992	0.51	99.7	164.9	0.49	334.2	404.9	216	283
1993	0.54	99.8	169.9	0.46	346.9	425.0	214	288
1994	0.56	99.9	175.1	0.44	359.6	445.6	215	295
1995					372.5	466.7		

Sources: Appendix table B-2

III-5 Evaluation of the technology-index

First of all, it should be stressed again that the derivation of the technology-index presented in the previous paragraph has only been possible because of the narrow definition used for the concept of technology. If a broader definition were used, such as the definitions presented in the first section of this chapter, conceptual and measurement problems would immediately arise.

Spinning and weaving account for 76 percent of value added and 69 percent of employment in the textile sector. Therefore, the assumption that these sectors are representative for the entire textile sector can be defended. It can however not be guaranteed that developments in the other subsectors (i.e. knitting) have been similar to those in spinning and weaving.

Core machineries in the spinning and weaving sector are without doubt the most important machines used in these sectors. Most literature on the subject confines itself to the treatment of these machineries in their sections on technology and its developments. Statistical evidence on textile investment confirms the role of machinery and equipment as the most important segment of textile capital goods, and the core machineries take up most investment. Investment in the spinning stage (of the spinning process) demands 56 percent of total investment. We have also seen however, that developments in 'side' machines have sometimes been more rapid than progress in spinning machines.

In the weaving sector no shares are known, but since weaving looms are one of the few machines used in the weaving process, it is most likely they also cover the lion's share of investment in machinery and equipment. The use of maximum output as an indicator for productivity of the machines considered seems justified. It is indeed important to use technical measures here, and not actual output per unit of capital, because otherwise the created technology-index would be unsuitable for use in an economic framework. In the spinning industry, we have seen that product specialisation for the different technologies exists. This makes the comparison between the two technologies more difficult, and casts some shadow over the validity of the comparison. Nevertheless, I have considered the final product of the two technologies to exhibit enough similarities to enable their comparison. Besides this, both technologies are in fact used for the same product (i.e. yarn with the same count), and existing literature (Acero (1984), UNIDO (1979)) applies similar comparisons.
Finally, by aggregating the results of the subsectors into one textile technology-index, the pure dinstinction between quantity and quality of capital inputs is lost, because some form of weighting has to be used. The large differences between technological developments in the various subsectors also indicates that the aggregated index might have less 'explanatory power' as the indices for the spinning and weaving sectors seperately.

IV Human Resources

"The most valuable of all capital is that invested in human beings"
Alfred Marshall

"The mind is not a storehouse to be filled but an instrument to be used"
unknown

In this chapter, human resources will be discussed in a manner broadly similar to the treatment of technology in the previous chapter. First, a definition of the concept of human resources will be sought. Secondly, the concept of human resources will be discussed with respect to its determinants, its role in economic growth and its role in technological developments. After this, we will take a closer look at the developments of the level of human resources in the Indonesian textile industry, which will result in a human resources-index. Finally, this index will be evaluated and its assumptions discussed.

IV-1 Definition

The concept of *Human Resources* has in fact been introduced using a slightly different terminology. In the 1960s, authors like Gary Becker and Thedore Schultz began investigating into the economic returns of education, and developed the concept of *Human Capital*. The idea that, besides investment in physical capital, investments in human beings in order to increase their productive potential was an important engine of economic growth quickly gained acceptance in the 1970s and 1980s. Unfortunately, not all authors have made the effort to give an elaborate definition of human capital. This might be partly due to the lack of controversy on the definition of the concept. All economic authors use a working definition that takes the form of 'the productive potential of an individual', or 'the stock of skills and knowledge embedded in an individual that enables a productive life'. The issue of the productivity of an individual or a labour force is thus the core of the concept of human capital.

Gradually, the term human capital has been replaced by *Human Resources*. This concept does not differ essentially from human capital. The concept of human resources is derived from the view that organisations consist of various kinds of resources. The three kinds that are usually distinguished are physical, financial and human resources. Gilley (1989) gives the following definitional framework:

> 'Physical resources *are machines, materials, facilities, equipment, and component part of products.....* Financial resources *refer to the liquid assets of an organization....* Human resources *refer to the people employed by an organization.'*[1]

The concept of human resources thus refers to the productivity of an individual or a labour force, as does human capital.

For our definition of human resources, we will not deviate from these given concepts. *Human resources* in this thesis will refer to the productivity of an individual or labour force. As we have seen in the theoretical intermezzo, it will at the same time be used as the quality of labour inputs.

IV-2 The determinants of human resources

Using the definition just derived, the determinants of the level of human resources should thus be seen as all factors that contribute to the productivity of employees. It can be

[1] Gilley, Jerry W. and Eggland, Steven A., *Principles of human resource development*, Addison-Wesley publishing company, Reading Massachusetts, 1989

understood intuitively that a variety of determinants can be distinguished. Literature on the subject gives numerous factors, most of which can be categorised as education, training, experience, physical health or emotional health.
It can be easily understood that improvements in one's health or diet can be important in raising one's productivity. Becker writes

> *"One way to invest in human capital is to improve emotional and physical health. In Western countries today earnings are much more closely geared to knowledge than to strength, but in an earlier day, and elsewhere still today, strength has a significant influence on earnings."*[2]

Emotional health is becoming an increasingly important issue in the HRD programmes that many private firms are running to increase job satisfaction and productivity amongst their employees. Here also, we can apprehend the importance of emotional health - depressed or stressed employees, for instance, tend to perform inferiorly compared to their emotionally more healthy colleagues.
Working experience is another factor that can easily be understood to contribute to a worker's productivity. Longer experience to perform a certain job or task usually goes hand in hand with a faster or more effective way of performing it. This is in line with the economic reward for employees, which is virtually always rising with increasing age.
Education, and to some extent on-the-job training, have been by far the most discussed determinants of the level of human resources. Many authors have used education as the sole determinant for human resources, while some others have tried to incorporate some indicator for training within firms. Both these factors are indeed of great importance in increasing the stock of skills and knowledge embedded in the labour force, and will therefore be discussed separately below.

Education

Education has been present in any society since the origin of man; teaching ones children to become responsible, productive members of a society has always been considered to be of great importance. With the coming into existence of the modern nation-states education has gained a prominent place in the agenda of policy-makers anywhere, and is for many countries the single biggest item on the national budget. Reasons for the importance of education are manyfold, including economic, political, sociological and psychological ones[3]:

- The stimulation of economic growth and development
- The contribution to modernising the mentality and attitudes of a society
- The stimulation of citizenship, the contribution to political education and the promotion of national integration in developing countries
- The reduction of social inequality and the improvement of social mobility
- The contribution to individual development and emancipation

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[2] Becker, G. S., *Human Capital - a theoretical and empirical analysis, with special reference to education*, Colombia University Press, London, 1964
[3] see Szirmai, A. E., *Economic Development - Trends, Problems, Policies, Practice*, Prentice-Hall, London, 1997. Throughout this section, excerpts from Szirmai's work are used.

Out of this wide variety of objectives, we will focus mainly on economic growth and development. The relation between educational activities and one's economic productivity has been subject to a lot of investigation and debate. Implicit in these discussions is the assumption that education in some way improves the ability of its recipients to produce economic goods and services, and thus contributes to the level of human resources. Criticism on this assumption has been put forward as well, taking its most extreme form in the *screening theory*. Critics claim, amongst others, that the correlation between educational attainment and level of income can not be assumed to be causal of nature without further evidence. Furthermore, formal education is considered merely a transformer of native ability and socio-economic status into degrees, instead of the cause of productivity improvements in individuals - the former are considered to be more valid determinants of productivity of labourers. More radical versions of the screening theory suggest that (higher) education is in fact no more than a process in which the attitudes and personal traits belonging to the (higher) functions within an organisation are taught.

On the other hand, screening theory itself has not been free from criticism. Among the most serious shortcomings of this theory is the observation that self-employed enterpreneurs with more education earn more than the self-employed with less education. Furthermore, if education was only a process of teaching attitudes and personal traits, income differences between different levels of education should vanish after a certain period of time, because employers could assess the productivity differences between their employees themselves.

At the roots of the criticism of the human capital approach is the question whether the subjects that are taught at school are actually being used on the workfloor. This topic has lead to discussion on the subjects that have to be taught at the different educational levels. The difference between vocational and general education is at the heart of this matter. Various authors have argued for more specific forms of (vocational) education, that can teach certain job-specific skills better than general education. Others claim that education improves the productivity of workers more indirectly, and that its main contribution is that it enables individuals to '*learn to learn*'. In a 1983 publication, De Bevoise presents empirical evidence on labour-productivity and education in the United States, and argues that it can not be maintained that all education improves productivity unconditionally.[4] A balance between vocational and general education should be found to maximise the contributions of both kinds of education to worker's productivity.

At this point, some empirical information on the Indonesian situation can be presented. The educational structure in Indonesia allows a comparison between students with equal years of education, with both vocational and general education.[5] Table IV-1 presents this information. As in De Bevoise's publication, no unambiguous conclusions can be drawn from these data. If we assume that income is a valid indicator for the productivity of an employee (which is by no means self-evident), then students at the SMP (junior high school, 3 years) are better off following vocational education, while SMA students (senior high school, 3 years) perform better (considering annual earnings) if they have received a general education.

Although the factual evidence is rather scarce, I personally would support the assumption that education is an important determinant in one's productive capacities. Most theories and empirical findings indicate that education plays a role in equiping an individual with the necessary knowledge, skills, motivation and frame of mind to lead a productive life. I will

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[4] Bevoise, Wynn De, *The contribution of education to economic productivity - Schooling in a technological society*, ERIC, Eugene Or., 1983

[5] For more information about the Indonesian educational system, see next sections in this chapter.

herefore include educational changes in my analysis of the level of human resources in Indonesia.

Table IV-1 Income by vocational and general education in Indonesia, 1990
(percentage of employees in the income categories)

Income category (1990 Rp per month)	*Average*	*SMP (junior high school)*		*SMA (senior high school)*	
		general	*vocational*	*general*	*vocational*
< 10000	10,000	0.3	0.2	0.3	0.4
10000 - 14999	12,500	0.8	0.2	0.4	0.8
15000 - 19999	17,500	1.5	1.0	0.8	1.2
20000 - 24999	22,500	2.4	1.9	1.0	1.0
25000 - 29999	27,500	2.4	2.9	1.1	0.9
30000 - 39999	35,000	8.4	5.5	2.8	2.8
40000 - 49999	45,000	7.2	6.5	4.2	3.3
50000 - 74999	62,500	21.9	18.7	14.9	12.3
75000 - 99999	87,500	21.0	20.8	19.6	19.6
100000 - 149999	125,000	19.0	21.0	22.6	29.9
150000 - 199999	175,000	9.3	13.2	16.0	17.1
200000 - 249999	225,000	3.1	4.8	7.0	5.7
250000 - 299999	275,000	1.2	1.6	3.9	2.6
300000+	300,000	1.5	1.8	5.4	2.4
Total number of students		2,148,649	387,639	2,435,033	2,839,565
Average income by educational attainment		94,604	106,028	128,984	122,595

Source: BPS, Keadaan pekerja/karyawan di Indonesia, 1990

On-the-job training (Human Resource Development)

Another factor that is frequently mentioned as being a determinant of the level of human resources is the training of employees by employers, the so-called on-the-job training. In business economics and management studies, these training programmes have become known as *Human Resource Development* (HRD).
Three fundamental components of HRD are identified: individual development (personal), career development (professional), and organizational development. Lawrie (1986) lists four purposes of HRD:[6]

1. Training new employees
2. Training employees to perform new duties and responsibilities
3. Improving competencies and skills of employees in current positions
4. Preparing employees for upward mobility and personal growth

Becker (1964) devoted an important part of his book to the subject of on-the-job training.[7] To start with, he present an important assumption in his (and many others') model: the assumption of marginal expenditures (wages) equaling marginal receipts (marginal product).

[6] Lawrie, J. *Revitalizing the HRD function. Personnel, 63* (6; June 1986), pp. 20-25

When talking about investment expenditures and receipts extend over more than one time period. Therefore, the general equilibrium demands that the *net present value* of expenditures and receipts equal. Or,

$$\sum_{t=0}^{n-1} \frac{R_t}{(1+i)^{t+1}} = \sum_{t=0}^{n-1} \frac{E_t}{(1+i)^{t+1}} \qquad (4.1)$$

with E_t being the expenditures for training and R_t being the receipts from this training (that is, the additional receipts that would not be received had the training not been given), all at time t. We now assume that training is only given during the initial period. This will mean that expenditures during other periods will comprise only wages, and future receipts will equal future marginal products. If we now define G as being the discounted difference (within one time period) between the marginal product at that time and the wage paid by that firm at that time (so as the discounted future gains for the organisation that provides the training), C as being the total costs of the training period, comprising outlay on training and opportunity costs (earnings foregone by a student), and MP'_0 as what could have been produced had there not been any training, we arrive at the equation

$$MP'_0 + G = W_0 + C \qquad (4.2)$$

So the difference between G and C measures the difference between cost and return from training. After this introduction, Becker introduces two forms of training: general training, that raises a worker's general productivity (which he or she can use in other firms as well), and specific training, that teaches skills only useful in the specific firms that provides the training.

With general training, a worker is always able to 'take his skills and run', in other words to quit his job and offer his higher productivity elsewhere. This prevents firms from paying for training themselves. In fact, as Becker points out in his introduction as well, the on-the-job training is paid for by the workers. They accept a wage lower than their initial productivity in their training period, so that they can reap the future benefits of their training by receiving higher wages.

With specific training, employers have no need to fear the disappearance of 'human investment' because labourers can not quit their job to go and make more money elsewhere, since the skills they have acquired are of no use anywhere else. The only risk involved in specific training for the investor is the turnover of labour, meaning that labourers can still quit their job for various reasons, thus 'robbing' the employer of future benefits. The share that employers are willing to invest will be based largely on this expected labour turnover.[8] In any way, the shares of training paid for by employers and employees remains a very difficult one to investigate, since marginal products, opportunity costs and future benefits are not straightforwardly determined.

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[7] Becker, G. S., *ibid.*, 1964

[8] It should be said however, that the difference between general and specific training is not always straightforward. Besides that, the 'extreme' asssumption that labourers completely pay for their general training themselves is contradicted by some empirical facts. A famous example is computerfirm IBM, at which new employees spend up to two years in full-time training before they start working. If they had to pay for this training themselves, they would acutally have to give money to IBM, since the opportunity cost alone of this form of training equals their complete salary.

IV-3 Human resources and economic growth

In the previous paragraph, we have seen that the level of human resources is determined by a number of factors. The ones that have been subject to most investigation were education and on-the-job training (or Human Resource Development). Health care has been used in a limited amount of publications only as an indicator for human resources. One of these is a paper by Hicks, who relates health care (measured by life expectancy) to economic performance. His conclusions are that human capital (or human resources) should also encompass health care, since statistical analysis confirms the importance of this item. However, no indication of the proper 'mix' between investments in education and health care are given.[9]
In the following section, the contribution of education to economic growth will be discussed in detail. We can distinguish between two levels at which education and HRD contribute to economic growth. At the micro-level, education and training serve as productivity-enhancers, which will results in higher output because of increased productivity of the labourers. At the macro-level, other benefits of education can also become present. This will be described below.

Education and economic growth

> *'One of the strongest associations in developing countries is between levels of per capita income and the proportion of the population in primary education...'*[10]

The relation between economic performance and educational activities has been subject to a lot of investigation and debate. Economists like Solow and Denison have propagated the idea of investment in human capital to point at the insufficiency of capital investment as the sole engine of growth in the fifties, when rather extensive investment efforts did not yield the expected results in some, mostly developing, countries. These theories were later on propagated by economists like Becker, Schultz and Psacharopoulos, who have extensively investigated the economic effects of education.
The concept of investment implies the idea of a certain 'stock' that is built while investing, and a certain 'return to investment'. The return on this investment can then be calculated by comparing the additional benefits of the investment with the situation before. Common measures that are used to determine the effectiveness of a certain investment are the 'net present value' and the 'rate of return', indicators also widely used in other areas of economic appraisal, e.g. feasibility studies.[11] Costs and benefits of educational investments can be further divided into private and social items.[12] Private costs are the funds that an individual has to allocate to its own education. Private benefits are, evidently, the additional income that an individual receives during his productive life because of the extra education received.

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[9] Hicks, Norman, *Economic growth and Human Resources*, World Bank Staff Paper no. 408, July 1980
[10] Thirlwall, A. P., *Growth and development - with special reference to developing economies*, The MacMillan Press Ltd. Hampshire, 1994
[11] see a.o. Behrens, W. and Hawranek, P. M., *Manual for the preparation of industrial feasibility studies*, UNIDO Vienna, 1991
[12] for a more elaborate discussion see Machlup, Fritz, *Education and economic growth*, New York University Press, 1975, p.40

Private costs typically comprise costs of the services of educational staff and materials needed and earnings foregone by the student while being educated. Social costs refer to all educational costs borne by society, e.g. subsidies on education. Social benefits are the additional benefits that a society receives because of the higher level of education of its workforce. As we shall see later, this item is subject to considerable debate.
Within this framework, various authors have put in efforts to collect empirical information to calculate these appraisal indicators. One of the first was Gary Becker, who calculated the private rate of return on investment in college education, comparing white, male US college graduates with their peers in high school and measuring income differentials.[13] He derived an estimate of the private rate of return of some 14.5% in 1939, and 13% in 1949. In another study, using partly social rates of return, Shultz found that in Bogota, Colombia the rates of return varied significantly. For women in primary education this rate was even zero. Vocational education proved to be the best investment here, while higher education only saw rates of return of 3 percent (men) and 4 percent (women). In India social rates of return were found to be bleak in comparison with capital investment.[14] Another scientist who has published extensively on the subject of returns to education is George Psacharopoulos. In a 1986 article, he presents data on the educational attainment levels of most countries in the world.[15] His results once again indicate the importance of education; the countries with the least years of schooling of the labour force are part of the regions Africa and South Asia.
In a growth accounting framework, using education as a factor input, the work of Denison has become a classic. In his first publication on the topic, his estimates are that education contributed 15 percent to economic growth over the period 1950-1962 in the United States. In Northwest Europe, this contribution was only 5 percent.[16] Combined with the contribution of "advances in knowledge", this contribution would even be as high as 38 percent in the United States and 21 percent in Northwest Europe. In his later work, he repeats this exercise for the United States for the period 1929-1973. He finds that education contributes 14 percent, and added with his "advances in knowledge" this contribution becomes 38 percent.[17]

♦ *Social benefits*

There is, however, still another factor to be dealt with in measuring the effects of education on economic performance: the effects of education upon innovativeness, usually assumed to exert its influence by means of Research and Development. The benefits of this R&D would therefore be labelled *social benefits*, since they do not benefit any single individual but rather society as whole.
Schultz, in tackling this subject, divides R&D activities into two categories: activities carried out to make profit and non-profit efforts.[18] R&D for profit is usually carried out by businesses and is therefore expected to be in an equilibrium or perfect competition situation, in which

[13] Gary S. Becker, *Human Capital - a theoretical and empirical analysis, with special reference to education*, published by National bureau of economic research, distributed by Colombia University Press, New York, 1964, p.88
[14] data from Machlup, Fritz, *ibid.*, 1975
[15] Psacharopoulos, George, *The educational composition of the labour force: an international comparison*, in: International Labour Review, 125, 5, 1986, pp. 561-574
[16] Denison, Edward F., *Why growth rates differ*, 1967
[17] Denison (1979) derived from Hicks, Norman, *Economic growth and Human Resources*, World Bank Staff Working paper no. 408, July 1980
[18] Theodore W. Schultz, *Investment in human capital - the role of education and research*, The free press, New York, 1971

the costs and benefits are determined by the market itself and do therefore not need to be taken into account seperately. It is the R&D that is not for profit that can yield external benefits that would not be taken into account when looking at the private costs and benefits of education. He does however not reach any quantitative conclusions regarding the subject. Becker (1964) takes a slightly different approach; he attempts to arrive at upper and lower limits of the contribution of this 'social benefit' of education using growth accounting.[19] His lower limit is given by his original private rate of return for college graduates (13%). Becker uses the 'unexplained' part of growth in national income given by Denison as a basis for his upper limit.[20] Assuming all of the unexplained growth can be regarded as a social benefit of education, Becker arrives at an upper limit of 25% (private rate of return for college graduates). Although the difference is still, as Becker puts it, "embarrassingly large", it does give a certain indication as to the extent of the social benefits of education. Verspagen, in an attempt to arrive at an econometric model, implicitly incorporates these social benefits into his model. For differentials in levels of national product, Verspagen introduces a variable labelled 'exogenous rate of knowledge growth'. If this variable differs inbetween two countries, the less developed country can never perform a complete catch-up.[21]

IV-4 Human Resources and Technology

The literature on the link between human resources and technology abounds with statements such as "training is a necessary condition for innovation". It can easily be understood that the implementation of a new production process (or parts of it) can not be done without instructing the employees as to what to do with it. Jerome Rosow and Robert Zager, for instance, state that

> *As one examines the case histories referred to in this book, it becomes clear that the amount of training required to profit from a new technology varies directly with the amount and diversity of new knowledge embodied in it. (Technology and knowledge are new insofar as they are new to the* user.*)*[22]

Historical and comparitive evidence is also available, most notably from Howard Gospel (1991)[23]. The historical approach would provide further strength to the overwhelming importance of education (general as well as specific) in a country's long-term technological development, wrapped up in phrases such as *"Economic historians have long pointed to weaknesses in education and training in Britain and how they may have retarded economic growth."* One contributor, comparing Britain with Japan, reaches the conclusion that '...*While*

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[19] Becker, Gary S., *ibid.*, 1964

[20] His estimate for an upper limit is derived from Denison's *Sources of economic growth in the United States*, 1962

[21] Bart Verspagen, *Uneven growth between interdependent economies - an evolutionary view on technology gaps, trade and growth* (proefschrift), Universitaire Pers Maastricht, 1992. In his model, a necessity for catching up (for developing countries) is an initial difference in levels of technology (*T*) that is not too large. However, a difference in growth rates (of production) will not cease to exist until the growth rates of the levels of exogenous knowledge (ß) have equalled.

[22] Jerome M. Rosow and Robert Zager, *Training - the competitive adge - introducing new technology in the workplace*, Jossey-Bass Publishers, San Francisco, 1988, (p. 4)

[23] Howard F. Gospel (ed.), *Industrial training and technological innovation - a comparative and historical study*, Routledge, London, 1991

these caveats certainly deflate many of the exaggerated comparisons there is general agreement that Japan produces about two and a half times as many graduate engineers per head of population as Britain.'[24] About training engineers for management, Hidemasa Moriokawa claims that '...*By working together with blue-collar workers at the workplace, engineers are not only able to test the value of their knowledge but are also able to see at first hand which theory will work in practice. In addition, they are able to form the kind of close, often informal, relationships with blue-collar workers that will later make them more effective managers with a broader view of the company as a whole. This approach to training Japanese engineers has been an important factor in Japan's competitive strength in world markets.*' Or, once again battering the British system, Howard Gospel and Reiko Okayama conclude that '...*The British system served well initially in the nineteenth century and had the advantage of being cheap. However, historical and contemporary studies would suggest that the training system has, relative to other countries, been less conducive to innovation and economic performance.*'
With respect to technology transfer, an often important carrier of technological progress (especially in developing countries), Koesmawan lists four conclusions given by Santikarn (1981), who investigated transfers in the Thai textile industry.[25] The most interesting ones are that, in the case of joint ventures, transfer of technology was limited unless the local entrepeneur had an industrial background or education, and that the superiority of foreign firms compared to local ones was based on workers and management rather than on machinery. Mlawa concludes, after his investigation into the Tanzanian textile industry, that one of the prime-movers in explaining the disastrous development of the Tanzanian textile efforts was the "technology-policy vacuum" in government policies. There were no attempts towards self-reliance whatsoever, which kept the high degree of dependency very much alive.[26]

Out of these various sources, it can be concluded that human resources and technological innovation should go 'hand in hand' in the economic development of a country. Most authors suggest that improvement in the level of human resources is a prerequisite for succesful technological innovation. Verspagen's 'technological capabilities', which can be translated as a measure for human resources, has the exact same function. In the next section we will, amongst others, take a look at the role of human resources in technological progress in the Indonesian textile industry.

IV-5 Human Resources in the Indonesian Textile Industry

In this paragraph, information about human resources in the Indonesian textile sector will be presented. With this information, we want to derive an index for the level of human resources in the textile industry that can be used in the final chapter. Before we focus on the determinants of human resources in the Indonesian textile sector, I will give a more general introduction to human resources in Indonesia.

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[24] Kevin McCormick, in: Gospel, Howard, *ibid.*, p. 60
[25] Koesmawan, *ibid.*, 1996
[26] Mlawa (1983) taken from Koesmawan, *ibid.*, 1996

Human resources (*Sumber Daya Manusia*) is one of the central topics of academic and policy discussion in Indonesia at present. In *Repelita VI*[27] human resources and HRD are considered a spearhead in development. Discussions on the economic future of Indonesia are filled with references to the level of human resources and its development. Soeharsono, for instance, distinguishes the quality of human resources as the most important determinant of competitive advantage in the global market, and places HRD as the single most important task for the Indonesian government in order not to fall behind in the global economy.[28] Newspaper articles frequently mention human resources and its determining role in economic growth.[29] A variety of Indonesian publications also point at the core position of HRD as an engine of growth for the future. In a summarising article, Gede Raka takes stock of HRD efforts in Indonesia.[30] Raka observes a focus at policy-making level, but a lack of commitment in organisations, besides a low quality of HRD efforts. In his opinion, low wages are still considered to be advantageous for Indonesia, which is an obstacle to the development of human resources in this country. Moreover, short-term thinking is still prevailing at business-level. He pleas for a broad education (more general than vocational education), and for improvements in team-working and information-processing.

This brief review serves merely to illustrate the attention human resources have been getting in recent years. In our following analysis we will confine ourselves to the two factors education and on-the-job training, in accordance with most of the literature on the subject.

Education of the employees

As a first step towards a human resources-index, we will take a look at the level of educational attainment of the employees in the Indonesian textile industry. There are two aspects of educational attainment we can investigate; the developments of the average educational attainment (or average years of education received), and the distribution of educational attainments among the employees. In order to perform a meaningful analysis of the educational situation, first we need to discuss the system of education in Indonesia.

♦ The system of education in Indonesia

In Indonesia, formal general education given at schools starts with primary education, or *Sekolah Dasar (SD)*, when children are six years of age. As in many other countries, this schooling lasts for six years, after which pupils can enter the junior high school, or *SMP*. Junior high school has two divisions, a general one and a vocational one. At this level, pupils

[27] *Rencana Pembangunan Lima Tahun*, five-year plans of government policy w.r.t. economic development. Repelita VI covers the period 1994-1999.

[28] Soeharsono Sagir, H., *Perekonomian Indonesia 1996, Menjelang Era Perdagangan Bebas AFTA (2003) and APEC (2020) (Kajian Perspektive Makro) [the Indonesian economy in 1996, with respect to the era of free trade AFTA (2003) and APEC (2020) (macro-economic perspective*), prepared for the seminar Developing countries in the global economy - falling down or catching up, UNISBA, Bandung 2 October 1996

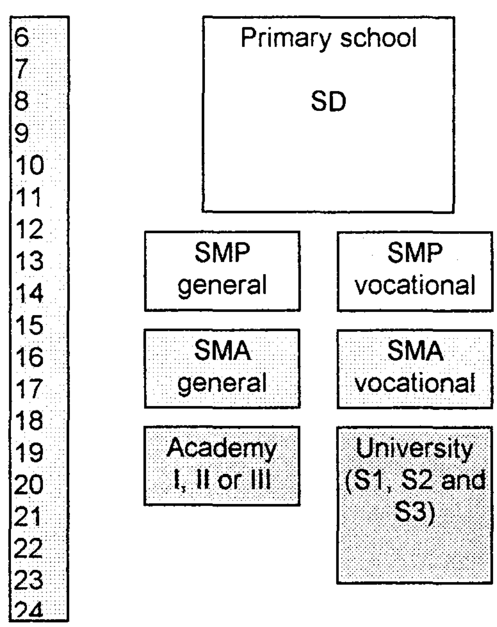
[29] e.g. *Esensi pengembangan SDM adalah pendidikan*, from Konsultan, September 1993; *Komitmen besar dicurahkan untuk peningkatan kualitas Sumber Daya Manusia*, from Kompas, 23/1/97; *Mendidikan perempuan untuk menganggur?*, from Kompas, 9/1/97

[30] Raka, Gede, *Permasalahan dan tantangan pengembangan sumberdaya manusia untuk bidang lintas sektoral [problems and challenges of HRD for the cross sectoral field]*, PPT-ITB, Bandung, 1993

enroled in vocational education are only a small percentage of total pupils at this level.[31] After junior high school, pupils can enter senior high school, or *SMA*. At this level two divisions exist as well, again a general and a vocational one. The proportion of pupils attending each type of senior high school is about the same.[32] After secondary education, which consist of SMP and SMA, students can either go to an academy (a form of college or '*hogeschool*') or to university. At the academy level, a diploma is awarded to students after each year completed. These diplomas are named using the number of years of academy education. The maximum number of years is three, and hence there are three types of diplomas; diploma I, II and III. University requires a mimimum of four years of academic education. At university level, the system comprises three phases; the bachelor's phase (S1), the postgraduate phase (S2), and the research phase (S3). Statistics on educational attainment do not subdivide among these phases, however. As in most countries, numbers of students in each phase drop - only a very small number of students are in S3, while most students are in the S1 phase. Figure IV-1 presents this system of formal education.

One of the advantages of this schooling system is that it allows a precise measurement of years of education an individual has completed. After SD, one has completed six full years of education, while after SMA, for instance, one has finished 12 years of education. In this manner, averages for the total years of education can be derived. The differences between vocational and general education clearly exist, but as we have seen earlier nothing clear can be said about the differences in 'productivity enhancement'. Having examined the system of education in Indonesia, we can now proceed to investigate the educational attainment of the workers in the textile industry.

Figure IV-1 Education system in Indonesia



[31] In 1994, the total number of labourers having completed general education at SMP was 9,352,524, while the total number of labourers having finished the vocational SMP was only 1,147,528, or 12%.

[32] In 1994, totals for SMA were 10,814,028, of which 45% had completed vocational education (see previous footnote).

♦ *Educational attainment in the textile industry*

The textile industry is usually considered to be a 'low-tech' industry, implying that the technology used requires a large proportion of employees with a relatively low level of education.[33] Unfortunately, no precise information on the distribution of educational attainment in the textile sector is available. However, something can be said about the presence of graduates in the textile industry. Table IV-2 presents this information. It can be seen that the share of graduate employees is indeed rather small - only 2.34 percent of all employees have a higher education degree. The same source presents information on the total number of firms that hire graduate employees, which was only 15 percent in 1990. Besides this low share, the total number of firms in the textile industry was given at 3,958, which gives reason to suspect the data are for the textile and garments industry rather than for the textile industry alone.[34]

Table IV-2 Graduate employees[a] in the Indonesian textile industry, 1991

	Natural and engineering sciences	*Social and human sciences*	*Total*
Research & Development	350	425	775
Engineering & production	3,300	1,275	4,575
Other	450	5,400	5,850
Total[c]	4,100	7,100	11,200
Share in total employment[b] (%)	0.86	1.48	2.34

Notes:
a Graduate employees are defined as employees with a finished academy degree (D3), or one of the university degrees (S1, S2 or S3).
b Total textile employment in 1991 was 479,025 employees.
c Data are possibly for the textile and garment industry.

Sources: BPPT-RISTEK-PAPITEK-LIPI, 1994; total employment from BPS, 1991

Another aspect of education of Indonesian textile employees is the development in their educational attainment through recent history. As said before, no detailed information is available for the textile sector only. We are therefore forced to use data on the total manufacturing industry, that should thus be assumed to be representative for developments in the textile sector. This assumption can be defended with two arguments. First, the data are used to examine the developments of average years of education. Even though the textile industry is a low-tech industry, and could therefore employ labourers with a lesser education, the *changes* in the average years of education over a time period are not influenced by that. In other words, by looking at changes we eliminate the 'initial level' problem. Secondly, the

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[33] see BPPT-RISTEK-PAPITEK-LIPI, *Indikator Ilmu Pengetahuan & Teknologi Indonesia 1994 [indicators for natural science and techonology in Indonesia, 1994]*, 2nd edition, 1994. Besides textiles other industries like food processing, paper, and non-ferroneous metals are considered to be low-tech.
[34] Since the number of firms in the Indonesian textile industry according to the BPS was around 2,000 (see appendix)

textile industry is one of two largest manufacturing industries in Indonesia. I therefore do not expect changes in the average number of years of education in the textile industry to differ greatly from the manufacturing average. Table IV-3 presents the data.

In 1976, 32 percent of the manufacturing labour force had not received any education, and only 26.9 percent possessed some educational diploma! Moreover, only 0.4 percent of all manufacturers had received higher education, and only 8.4 percent any secondary education. In 20 years time, this situation has changed significantly. Only 8.2 percent has now not received any education, while a group of 72.9 percent is in possession of some schooling qualification. Furthermore, the share of labourers with academic education has risen to 2.4 percent, while 37.0 percent has received secondary education. Using the average number of years belonging to the various educational attainments, the average years of education can be calculated for each year. In 1976, manufacturing employees had received an average of 3.21 years of education; in 1995, this average had increased to 6.81 years.

Table IV-3 Educational attainment and average years of education of the total manufacturing labour force in Indonesia, 1975-1995

	no schooling	*not yet completed primary school*	*primary school*	*junior high school*	*senior high school*	*diploma I/II*	*academy/ diploma III*	*university*	*total*	*average years of educa-tion*
Average years of education completed	0	3	6	9	12	13.5	15	16		
1975										
1976	32.0	42.1	17.4	4.0	4.0	0.0	0.4	0.0	100.0	3.21
1977	27.1	37.1	25.6	6.1	3.8	0.0	0.3	0.2	100.0	3.71
1978	30.8	39.0	21.1	5.1	3.7	0.0	0.3	0.0	100.0	3.39
1979										
1980										
1981										
1982	24.8	33.3	29.1	6.7	5.6	0.0	0.2	0.2	100.0	4.09
1983										
1984										
1985										
1986	14.5	26.5	35.9	11.7	10.6	0.1	0.4	0.3	100.0	5.39
1987	12.3	25.8	37.3	11.5	11.6	0.1	0.9	0.5	100.0	5.67
1988	11.2	24.3	38.4	13.3	11.7	0.2	0.6	0.3	100.0	5.80
1989	11.4	24.6	39.0	12.0	12.0	0.2	0.5	0.4	100.0	5.75
1990										
1991	9.1	19.0	39.0	15.3	15.9	0.2	0.7	0.7	100.0	6.44
1992	9.1	19.0	38.8	16.0	15.5	0.2	0.7	0.7	100.0	6.44
1993	9.4	19.1	38.9	14.6	15.9	0.3	0.8	1.0	100.0	6.45
1994	7.6	18.7	39.4	15.3	17.0	0.2	1.0	1.0	100.0	6.66
1995	8.2	18.9	35.9	14.5	20.1	0.2	1.0	1.2	100.0	6.81

Sources: BPS, Keadaan angkatan kerja di Indonesia, appropriate years

Human Resource Development

Unfortunately, hardly any material is available at sector level on training and HRD activities in the textile industry. Because of this, a number of interviews with textile firms have been carried out in order to obtain an idea about their efforts with respect to HRD and the role of human resources and technology in production and decision-making. This paragraph will present the results of field studies carried out at five textile factories in Indonesia, and will put special emphasis on the efforts of HRD that are made by these companies.

♦ *Outcomes of the field visits*

Before the results are presented, the empirical background of the field visits must be mentioned. Since my thesis deals with medium- and large-scale textile sector, the population of my field work has been all medium and large-scale firms (20 employees or more) present in the textile industry (ISIC/BPS 321) in Indonesia (2,017 in 1994). As a research-unit, a single firm in the population is defined as such.

Ideally, the sampling procedure followed should randomly draw a number of firms from the population. However, various sources have pointed at the great difficulties in approaching textile firms and conducting interviews as an 'outsider'.[35] I have therefore chosen to use an 'intermediary'; all field visits have been carried out at companies that were affiliated with the West Jawa *SDP (Skill Development Project)*, situated in Bandung.[36] Because of this deviation from pure randomness, the results should be expected to be biased upwards, since all companies concerned had already links with training providers (the SDP), and were therefore clearly already putting in efforts with respect to HRD. Unfortunately it is not known whether all textile companies fit a similar description; the results should thus be considered with care.

The method of data-collection was using questionnaires. A total of ten factories have been visited. Because of time-constraints, only five questionnaires have been returned. All companies that were visited were given questionnaires after a short introduction of the objectives and backgrounds of the research. The questionnaires were usually returned in a following visit. In all cases, the questionnaires were given and filled in by personnel managers (middle-level management). The questionnaires and answers can be found in the appendix.

Since only five responses are available, the statistical analysis possibilities of the outcomes are extremely limited. I have thus confined myself to frequency-analysis, which serves merely to give an indication of possible trends in the textile sector. The function of these outcomes should be therefore seen more as an indication of the contents of HRD, and the attitudes towards HRD, technology and education. Table IV-4 presents some general information on the firms visited. A summary of the outcomes of the field visits is given below.

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[35] Koesmawan (1996) for instance, reports an sample of 100 firms that were contacted, out of which only 5 responded. In the end, he succeeded in interviewing 19 firms.

[36] The Skill Development Project is a government-run project, lead by the Ministry of Manpower, that conducts training and HRD activities for firms in the designated area.

Table IV-4 General information

Firm	*Number of employees*	*Year of establish-ment*	*Location*	*Activities*	*Annual production (yards cloth / tons yarn)*
1	2,560	1965	Bandung	weaving	60 million yard
2	220	1974	Cimahi	weaving	5.5 million yard
3	2,179	1973	Bandung	spinning and weaving	23.5 million yard*
4	885	1989	Bandung	spinning and weaving	45 million yard/ 9,600 tons
5	2,518	1977	Majalaya	weaving	39 million yard

Notes:
* data on yarn production missing

Source: questionnaires

- Most companies visited were already employing the 'modern' technologies, especially the weaving firms. The history of investment patterns clearly shows that most investments in modern technologies have occured in the last 5 to 10 years. This pattern is further confirmed by other experts.

- All companies questioned provided some form of training to their employees. The questionnaire distinguished between training for newly recruited employees, training when introducing new technology and general training. All companies carried out all three forms of training.

Table IV-5 - Types of training

Firm	***Type of training***		
	new employees	*introducing new technology*	*general*
1	x	x	x
2	x	x	x
3	x	x	x
4	x	x	x
5	x	x	x

Source: questionnaires

- Newly recruited employees are usually trained in work discipline, 'house rules' of the company, working motivation and operating the machines. In many companies, operating the machines was still mainly learnt on the job, i.e. while at work. Some companies had older employees teaching the newly recruited ones. This training can last from 2 days to 2 weeks, and can also be 'integrated' with working (before and after official working hours).

- When new technologies (i.e. new machines) are introduced, typically workers and supervisors/technicians are trained in using the new equipment. This training is often provided by the supplier of the machinery. It can also happen that supervisors are trained, who in their turn train the operators. Problem-solving is, together with operating the machinery, an important item in this form of training. The duration of this training is mainly dependent upon the supplier, but usually lasts about 2 weeks, after which operators may receive further on-the-job training.

- General training is not frequently given to the low-level management (operators). This form of training will generally be given to the middle-level management, and will also be aimed at top-management. Typical training-objects are leadership, problem-solving and decision-making. Training might be given by consultants, and is usually carried out in visits.

- A typical feature of training programs is that they have only started very recently, that is in the 90s. The company with the 'oldest' training programs was one who only started in 1990. Eversince their start there is usually a gradual expansion of training activities, and some companies already have established their Human Resource Management department. Typical HRD expenditure can range (depending on the size of the company) from 10 to 100 million Rupiahs a year. Per employee this boils down to about 8 to 56 thousand Rupiahs (56 thousand Rp equals around 24 US$) per employee per year. As a comparison, in 1994 (2-3 years ago) the average level of annual wages was 1,960 thousand Rp.

Table IV-6 HRD activities

Firm	*Start training programs*	*HRM department*	*Expansion HRD activities*	*Annual expenditures on training per employee (Rp.)*
1	1991	x	yes, more professional over the years	7,812
2	1994	x	yes, general improvements	45,455
3	1990		yes, TQC introduced and employees sent to seminars and workshops	18,357
4	1994	x	yes, general expansion because of succes	56,497
5	1995	x	-	39,714

Source: questionnaires

- Another important feature of Indonesian, or rather Bandung textile companies is their high rate of labour turnover. The average score was 9.4 percent per year, with a range of 2.2-12.7 percent. There is no immediate indication that this high level of labour turnover decreases the willingness of management to provide training[37], although the fact that general training is only provided for middle and top-level management might be partly due to this phenomenon. Some companies at present use the high rate of labour outflow to decrease their number of labourers to increase efficiency.

[37] See the appendix for a listing of all outcomes of the questionnaires

- Without exception, the management of textile companies values training as very important, while estimates of costs and benefits (in productivity) of training are overwhelmingly positive.

Table IV-7 Assessment of training importance

Type of training:	*very unimportant*	*unimportant*	*not important, not unimportant*	*important*	*very important*
New employees	0	0	1	1	3
Introducing new technology	0	0	0	0	5
General	0	0	0	4	1

Source: questionnaires

- Education is usually deemed to be moderately important in employees capabilities and their need for training. The amount of education received does not seem to reduce the need for training when introducing new technology. Two firms mention an improvement in the amount of education received of new employees over the last 5 to 10 years. This is due mainly to the fact that they have started hiring better qualified personnel.

- With respect to the relation between technology and human resources, training when introducing new technologies is considered absolutely necessary. This observation further strengthens the argument that improvements in technology have to be accompanied by improvements in human skills and knowledge, or human resources. Furthermore, the present level of human resources plays an important part in decisions about the purchase of new technology with a lot of firms.

Table IV-8 Necessity of training for new technology and the role of HR in decisions on new technology

	totally unnecessary	*unnecessary*	*in between*	*necessary*	*absolutely necessary*
Training for new technology	0	0	0	2	3
	totally unimportant	*unimportant*	*in between*	*important*	*very important*
Role of HR in decisions on new technology	0	0	0	2	3

Source: questionnaires

- Although training is deemed necessary, the effectiveness of training on the reliability, availability and utilisation of the machines in usually valued “not effective, not uneffective”.

- The influence of the government is not considered to be very important directly, although import taxes (for new technology), minimum wages and training provision, as well as the stable political climate, are mentioned as factors of influence.

Concluding, we can say that the first serious HRD efforts are being made now by some companies, although all parties involved agree that it is still too little. An interesting example for the effectiveness of training and HRD is the story of a smaller textile company, that hired a personnel/HRD manager only three years ago. Ever since, the top management has seen productivity rise considerably, and are now not willing to let this manager go, although he expressed the wish to look for other career options.

After this exposition of the education of the textile employees and the HRD activities carried out by the Indonesian textile firms, I would like to conclude this section with some remarks made by the various textile managers and experts that were interviewed. There seems to be a general consensus that the level of human resources is still 'lagging behind' the level of technology at present in the Indonesian textile industry. Most experts and managers agree that the level of human resources is still insufficient to put the improved productivity of the machine-park to full use. In a forthcoming research, the STTT Bandung performs an analysis based on the 'technometric' methodology developed by the United Nations, in which firms or sectors are compared to the so-called 'best-practice' firms. This comparison is made at four levels: technology, organisation, information-control and human resources. At each level, a firm or sector is awarded a score ranging from 0 to 1, where 1 indicates maximum proximity to the best-practice firm. In this particular research, the Indonesian spinning industry 'scores' 0.60 for technology, and 0.25 for human resources. This result confirms the general opinion at present that human resources have not improved at the same rate that technology has. In many managers' expectations for the future, the level of human resources will play a key role in securing the continued progress of the sector. It is not possible in this thesis to investigate the extremely complex relation between human resources and technology in detail. We have seen that human resources are often considered a prerequisite for technological growth, and that it plays an important part in decisions on the acquisition of new technology. Furthermore, increasing the level of human resources via training is considered essential when introducing new technology or when employing new workers.

IV-6 Constructing a human resources-index

If we now want to derive an index for human resources, we can use an analogous framework with that in the previous chapter. Expressing the productive capacity (human resources) of the employees, we find

$$PC_t = P_t L_t \qquad (4.3)$$

with PC_t being the productive capacity, P_t being the productivity and L_t being quantitative labour inputs, all at time t. Since labour inputs can not be further subdivided as capital can (into machines with different productivity), the quantitative labour inputs can be dropped from the equations. For the human resources-index, we can write

$$I_{HR,t} = \frac{P_{L,t}}{P_{L,0}} \qquad (4.4)$$

with $I_{HR,t}$ being the human resources index (time t), and P_L is an indicator for the productivity of the labourers. If the definition of human is interpreted as a 'storehouse' which can be 'filled' with contributions by human resource-increasing activities (education and HRD), and if we assume that these seperate activities are not cross-related, $P_{L,t}$ can be written as

$$P_{L,t} = P_{L,0} + \Delta P_{EA,t} + \Delta P_{HRD,t} \qquad (4.5)$$

where ΔP_{EA} is the contribution of the change in educational attainment, and ΔP_{HRD} is the contribution of HRD to the productivity of the labourers at time *t*. The contribution of a quality factor (educational attainment or HRD) can be written as the productivity at time *t*, including the contribution in productivity of that particular quality factor, minus this productivity at time *0*, or by the definition $\Delta P_{EA,t} = P_{EA,t} - P_{EA,0}$. Of course, a parallel equation can be derived for HRD. If we now assume that the level of productivity in the base-year is a constant and not augmented by any contributions, we get

$$P_{EA,0} = P_{HRD,0} = P_{L,0} \qquad (4.6)$$

and ultimately we can derive

$$I_{HR,t} = \frac{P_{EA,t}}{P_{L,0}} + \frac{P_{HRD,t}}{P_{L,0}} - 1 = I_{EA,t} + I_{HRD,t} - 1 \qquad (4.7)$$

with I_{EA} and I_{HRD} being the indices for educational attainment and HRD, respectively. The level of productivity in the base year ($P_{L,0}$) can be measured by the labour-productivity in that same year.

Educational attainment

The way to construct an index representing changes in the educational attainment (or average years of education) of a labour force has been developed by Denison.[38] As a first step in this routine, we have already presented data on the education attainment of textile workers in the previous section (see table IV-3). These have in fact been the first steps in Denison's methodology to incorporate changes in educational attainment into a growth accounting exercise. However, one problem still lies ahead; it can not be assumed without empirical evidence that every year of education contributes equally to the productivity of the labourers (the level of human resources). In his 1967 publication, Denison chooses to use data on the income level of employees related to their educational attainment as weights. This is done based on the assumption that income differentials are a good approximation of productivity differences. Denison himself struggles with the question whether the differences in earnings between employees can be attributed to the difference in education, or whether some native abilities of the employees should be held responsible. He decides to use the 'educated guess' that three-fifths of income differentials can be attributed to differences in educational attainment. Other authors have, however, criticised this method, particularly because the real question here is not so much whether income differentials are caused by differences in education but more whether income differentials are truly representative of productivity differences. Assuming a labour market of perfect competition, wages equal the marginal product of the labourers. Therefore, if this assumption is made income differentials do

[38] Denison, Edward F., *Why growth rates differ*, The Brookings Institution, Washington DC, 1967

represent differences in productivity; the validity of this assumption can be questioned however.[39] Nevertheless, we will use this assumption in this analysis, because it enables us to use available data on income and educational attainment to derive weights for the various educational levels. The educational attainment index can be calculated using the equation

$$I_{EA,t} = \frac{\sum EA_t^i w_0^i}{\sum EA_0^i w_0^i} \qquad (4.8)$$

where EA^i refers to the share of the labour force in educational attainment group i at time t, with w^i referring to the wages of educational group i in a base year. The term at the right side of the equation equals the term in the human resources-index equation, that was presented earlier. Table IV-9 presents the derived weights and the constructed index of education attainment. I have used data on income and educational attainment from both 1977 and 1990 as weights, to perform a very rough sensitivity-analysis on the obtained indices. Weighted educational attainment using 1977 weights grows by 71 percent in 20 years, whereas using 1990 weights results in a growth of a mere 41 percent. There is no information about the situation on the labour market in both years. I have therefore chosen to use the average of these two years as the weighing factor to be used in further analysis.

Human Resource Development

Including a measure for HRD in the index for human resources confronts us with a major problem: data on HRD efforts are not available at sectoral level, and at firm level only five firms have been interviewed. Besides this, information is only available for one year, whereas we need a time series for our analysis. A statistically defendable decision would therefore be to not include any indicator for HRD in the human resources-index because of this lack of data. I have, however, not done so, because of two reasons.

First and foremost, I consider HRD in any sector to be too important to be overlooked or neglected in an analysis at sector level. During my research period, I have been strongly convinced that HRD is one of the most important determinants in productivity developments in the textile sector in Indonesia, although its role in economic and technological development is not entirely clear yet. Secondly, and relating to this first reason, I would like to consider this section a challenge to future researchers in this area. Leaving HRD completely out of the analysis would probably mean that this factor will be overlooked much easier than if it were to be included data-base. As with the technology-index, I will continue to list two human resources indices, one based on the progress of educational attainment solely, and one including productivity improvements due to HRD in the textile sector.

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[39] Table I-2, for instance, shows that in the textile industry, labour productivity and wages have not developed equally.

Table IV-9 Educational attainment of the total industrial manufacturing labourforce, 1975-1995

	no schooling	not yet compl. primary school	primary school	junior high school	senior high school	diploma I/II	academy/ diploma III	university	Average income 1990 weights	Average income 1977 weights	Average income average (1990-1977)	Attainment index 1990 weights	Attainment index 1977 weights	Attainment index average (1990-1977)
Monthly income														
1990	43,606	53,063	67,952	96,350	125,545	141,743	189,579	204,994						
1977	7,225	9,801	14,406	26,785	33,820	43,241	52,663	89,589						
1975														
1976	32.0	42.1	17.4	4.0	4.0	0.0	0.4	0.0	57,849	11,606	34,728	100	100	100
1977	27.1	37.1	25.6	6.1	3.8	0.0	0.3	0.2	60,299	12,463	36,381	104	107	106
1978	30.8	39.0	21.1	5.1	3.7	0.0	0.3	0.0	58,608	11,868	35,238	101	102	102
1979														
1980														
1981														
1982	24.8	33.3	29.1	6.7	5.6	0.0	0.2	0.2	62,589	13,226	37,908	108	114	111
1983														
1984														
1985														
1986	14.5	26.5	35.9	11.7	10.6	0.1	0.4	0.3	70,854	16,046	43,450	122	138	130
1987	12.3	25.8	37.3	11.5	11.6	0.1	0.9	0.5	72,944	16,759	44,852	126	144	135
1988	11.2	24.3	38.4	13.3	11.7	0.2	0.6	0.3	73,415	16,918	45,167	127	146	136
1989	11.4	24.6	39.0	12.0	12.0	0.2	0.5	0.4	73,010	16,766	44,888	126	144	135
1990														
1991	9.1	19.0	39.0	15.3	15.9	0.2	0.7	0.7	78,337	18,688	48,513	135	161	148
1992	9.1	19.0	38.8	16.0	15.5	0.2	0.7	0.7	78,308	18,707	48,508	135	161	148
1993	9.4	19.1	38.9	14.6	15.9	0.3	0.8	1.0	78,660	18,880	48,770	136	163	149
1994	7.6	18.7	39.4	15.3	17.0	0.2	1.0	1.0	80,083	19,337	49,710	138	167	153
1995	8.2	18.9	35.9	14.5	20.1	0.2	1.0	1.2	81,836	19,989	50,913	141	172	157

Sources: Weights: appendix table D-2; educational attainment: table IV-3

♦ *Calculating an HRD-index*

As a framework for 'guestimating' the influence of HRD on the level of human resources, I will start with the framework presented by Becker (1964). A first assumption that thus has to be made is that costs of training programmes equal their discounted returns over the number of years that firms can benefit from these investments (perfect competition on the 'HRD market'). Data on expenditures on HRD are available via the questionnaires. I have used data on labour-turnover to calculate the average time period that a worker in the textile industry is working in a textile firm. This also implies we have to assume that all training is specific (meaning that no additional marginal product can be gained if the employees 'move firm' within the textile sector). To simplify calculations, we also assume that training that is provided in a certain year starts to yield additional returns only in the years after. We thus arrive at

$$E_\tau = \sum_{t=\tau+1}^{t=\tau+n} R_t^\tau = \sum_{t=\tau+1}^{t=\tau+n} \frac{R^\tau}{(1+i)^{t-\tau}} \qquad (4.9)$$

where E_τ are the expenditures on HRD in the base-year τ, R_t^τ are the (additional) returns in year t due to training in year τ, n is the total number of years firms can benefit from additional returns, R^τ being the improvement in productivity (=marginal product) due to HRD efforts, and i is the discount percentage. Additional returns from HRD in a certain year are thus formed by the accumulated expenditures on HRD in previous years (as long as these expenditures have not been made more than n years ago).
If we add these returns to the productivity of labourers in a base-year, we can derive an index by dividing the sum of the base-year productivity and these returns by the productivity in the base-year, or

$$I_{HRD,t} = \frac{P_0 + R_t^\tau}{P_0} \qquad (4.10)$$

In this way, we can derive an index for the contribution of HRD in the level of human resources.

The data for expenditures on HRD will be taken from the questionnaires. Since the development of HRD activities are very recent in nature, I have decided to assume that expenditures on HRD start in 1980, and not in 1975. Again, sound statistical back-up for this assumption is not available. I have further assumed a linear development of HRD expenditures per employee, meaning that from 1980 until 1996, expenditures on HRD per employee grow with a fixed amount of money each year. Total expenditures are thus dependent upon this development and total employment in the textile industry. The average expenditures on HRD from the questionnaires were 33,567 Rp (1996).
Data for the time period that firms can profit from HRD investments will be calculated using the labour-turnover ratios. I have assumed that this labour-turnover ratio does not change over time, i.e. that it has been at a steady level for the last 20 years. The weighted average (using number of employees) of the labour-turnover ratio is 9.4 percent. This implies that in 11 years, the entire labour force of a firm has been replaced by new workers. I have therefore assumed that firms can profit from investments in HRD during 10 years after their initial expenditures (in the first year, employees receive the training).

The discount percentage represents the rate of return that an investor can expect if he would put his money away at a banking institution. I have therefore taken the deposit rate in Indonesia as discount percentage. Since we are using constant prices, this percentage has to be adjusted for inflation. Using the wholesale consumer price index as an adjuster, we arrive at an average deposit rate of 11 percent in Indonesia over the period 1989-1992 (which was the most recent period that data were available for).[40]

We have seen that a level of the productivity of workers is needed in order to create an index. The level of labour-productivity in the base year is availd indicator for this productivity. This figure is derived from the economic data from chapter I. We find that the level of gross value added per employee is 385,000 Rp. Since we have to use constant prices, prices should either be calculated in 1975 (labour-productivity) or in 1996 (prices of expenditures on HRD) prices. I have used the wholesale price index for textiles as a deflator, since productivity is expressed as the value of textile value added. The index for 1996 has been estimated using linear regression for the period 1990-1995. Applying this index to convert the base-year productivity (P_0) from 1975 to 1996 prices, we obtain 1,655,000 Rp (1996 prices).

We have thus assumed all the data and information needed, and we can proceed with the actual calculation. Table IV-10 presents the constructed index.

Table IV-10 Constructing a HRD index for the Indonesian textile industry, 1975-1996

	Expenditures per worker (1996 Rp)	*HRD returns (accrued)*	*HRD index*
P_0 (1996 Rp)			1,655,000
1975	0	0	100.0
1980	0	0	100.0
1981	2,098	0	100.0
1982	4,196	321	100.0
1983	6,294	931	100.1
1984	8,392	1,802	100.1
1985	10,490	2,907	100.2
1986	12,588	4,223	100.3
1987	14,686	5,730	100.3
1988	16,784	7,409	100.4
1989	18,881	9,242	100.6
1990	20,979	11,215	100.7
1991	23,077	13,313	100.8
1992	25,175	15,524	100.9
1993	27,273	17,836	101.1
1994	29,371	20,149	101.2
1995	31,469	22,462	101.4
1996	33,567	24,775	101.5

Sources:
HRD expenditures: questionnaires
P_0: GVA per employee 1975.
Returns calculated using equation (4.9); index calculated using equation (4.10)

[40] Data taken from IMF, *International Financial Statistics*, May 1996

Using a human resources-index in economic analysis

In the theoretical intermezzo it became clear that the concept of human resources bears close resemblance to the 'economic' quality of labour, and can as such be used in growth accounting without many theoretical problems. Since we have not first developed indices at subsector-level, no weighing needs to be performed to construct an index for the whole textile sector, as had to be done in the chapter on technology. Education and training measures are used as indicators for workers' productivity, so we need not worry about creating loops in the growth accounting function, which would be a problem had we used (economic) labour-productivity as a measure. The only issue that still needs to be addressed is the creation of an annual series of indices, which is needed to perform a growth accounting exercise with. I have chosen to follow the same procedure as in the previous chapter, which implies linking missing values by intrapolation between values of 'neighbouring' years. Table IV-11 presents this index, of which the outcomes have been discussed already earlier. Finally, I will list the assumptions made in order to come to this index of the level of human resources below.

- *Human Resources* is defined as the productivity of the labourers, or the quality of labour.
- The level of human resources in the Indonesian textile industry is determined by the amount of formal education and on-the-job training workers have received. Other factors, such as health and working experience, do not influence human resources developments
- Changes in the amount of education received by the textile workers is determined by changes in the educational attainment of the total manufacturing labour force, and weighted by the average wage per educational attainment 'segment' of the Indonesian labourers. Quality of education has not been taken into the analysis.
- Contributions of (changes in) educational attainment and HRD are independent variables.
- Labour wages in 1977 and 1990 have been assumed to approximate a labour market situation of perfect competition, in order to derive weights that can be used to weight additional years of education.
- Human Resource Development (HRD) has been assumed to be a linearly growing process, starting in 1980. The assumptions used to derive a HRD-index are:
    - Information on HRD expenditures and labour-turnover ratios derived from the questionnaires are representative for the entire textile sector in 1996.
    - Expenditures on training programmes equal their accumulated discounted returns (or, costs of training programmes are 'earned' back back by the firms; no additional benefits are made)
    - All training is specific and can not be used in other textile firms
    - All training that is given in one year starts yielding benefits in years to come, and not yet in the same year
    - The discount percentage is based on the deposit rate in Indonesia, adjusted for inflation
    - The labour-turnover ratio is constant and not time-dependent
    - The consumer's price index for Indonesia for 1995 and 1996 is estimated using linear regression over the period 1990-1994

Table IV-11 Human Resources-index for the Indonesian textile industry, 1975-1995

	HR index		
	Educational attainment	*HRD*	*combined*
1975	100.0	100.0	100.0
1980	106.4	100.0	106.4
1985	125.4	100.2	125.6
1990	141.5	100.7	142.1
1995	156.4	101.4	157.8

Sources: previous tables; calculated using equation (4.7)

IV-7 Evaluation of the human resources-index

In this last paragraph, the outcomes and assumptions that are the foundation of the human resources-index created will be discussed.

Our human resources-index, which should be an indicator for the labour-productivity of the textile sector, has grown by some 58 percent if we include HRD activities in the analysis. Compared to the growth of economic labour-productivity (output per employee), which has grown over 550 percent (1975-1993), this growth is modest. It should be remembered, however, that economic labour-productivity is in fact a summation of all quality changes in the production process. No labourer would be able to increase his production without the proper machines to work with, or the organisational structure to produce in.

The definition of human resources as the productive potential of an individual or a labour force, and thus as the quality of labour inputs is in line with most of the literature on the subject and seems logically correct. The derived index is thus not as dependent upon the applied definition of human resources as the technology-index (chapter III) is. Constructing indices for the level of human resources has in fact had a long history, starting with Denison (1967).

The exclusion of determinants like health care and working experience is possibly damaging for the validity of the index. On working experience, it can be said that no observations have been mentioned about the change in age or in working years of the textile workers. The textile industry in Indonesia has, for a long time already, been an industry for young workers, that shift easily from one factory to another (firms experience a high labour-turnover ratio). Improvements in health care may have contributed to increases in the level of human resources, since Indonesia has been a country in which its industrial population has been paid barely sufficient to provide for their primary necessities.[41] Rises in wages may, in this context, result in the reduction of malnutrition and the improvement of diets, which can considerably increase a person's ability to perform a task in an industrial organisation.

I have discussed the assumption that changes in the amount of education received of the total manufacturing labour force are representative for the textile employees earlier in this chapter.

[41] An independent calculation in 1996 resulted in an 'absolute' mimimum of 10,000 Rp a day to provide for basic needs, while the industrial *Upah Regional Minimum* (regional minimum wage) was set on some 7,500 Rp daily, and the government itself paid their lowest-ranked employees only 4,000 Rp a day.

Since the textile sector is the largest manufacturing sector, and we are looking at changes rather than absolute levels, this assumption seems justified.
Quality of the education received is an issue mentioned frequently by authors dealing with the economic effects of education. As obvious a factor of importance as it may be, as difficult it is to measure. Some researchers use the price of education as an indicator for its quality, but this is rather hazardous, since prices of services can not be easily assumed to reflect quality or productivity differences. These prices are often based on the overall level of purchasing power in a country, so that services in developing countries will almost always be less expensive than services in an industrialised country. However, the quality of education and the subjects taught can not be neglected in contributing to the productivity of an individual. Moreover, there are some forms of education at present in Indonesia that are not taken into the statistics of educational attainment. Private schooling, particularly in the form of after-school courses in subjects like computer-science and english, can sizeably improve the opportunities of future employees at the labour market, and can thus be considered to be increasing an individual's productive abilities. These factors might result in an undervaluation of the level of human resources by the indicators used.
Because of the special nature of the economic 'good' labour, I personally do not expect many labour markets around the world to comply to the condition of perfect competition, which has been assumed in deriving an educational attainment index. We have seen in chapter I (figure I-3) that wages and productivity do not go hand in hand in the Indonesian textile sector, although they do move in equal direction. This could, although does not necessarily has to be, an indication for deviations from this assumption, and could be another distorting factor in the validity of the human resources index, although the direction of this deviation is not clear.
The index for HRD activities is, as stated before, not based upon sound empirical evidence, and should therefore be treated with care. We have seen that HRD is linked to technological developments, since a sufficient level of human resources is required for a new technology to be succesfully introduced. Because of the complexity of this link, however, it is not possible to say that improvements in the productivty of the machine-park require an equal improvement in the productivity of labour, because this would ultimately result in the quadrupling of output, while the new technology's maximum output has only doubled. The used index thus seems to be 'the best that can be done' with the available information. More data, as well as more knowledge on the link between technology and human resources is needed to improve the HRD index.

V Economic analysis

$$\left(VA_{\tau_2} - VA_{\tau_1}\right)_K = \frac{\sum_{t=\tau_1}^{t=\tau_2} r_{K_t^*} \left(\frac{\alpha_t + \alpha_{t-1}}{2}\right) VA_{t-1}}{VA_{\tau_2} - VA_{\tau_1}}$$

In the previous chapters, we have investigated the two topics of the research question, technology and human resources in the Indonesian textile industry, and we have derived indices for the development of these items in recent history. In this chapter, we will estimate the role of technology and human resources in the Indonesian textile sector by using the economic framework of growth accounting. First, the growth accounting framework will be completely specified. Secondly, the quantitative capital and labour inputs will be discussed and estimates will be given for the last 20 years. Finally, a growth accounting exercise will be performed for the period 1975-1994, and the main conclusions with respect to the outcomes will be drawn.

V-1 Deriving the growth accounting equations

In the theoretical framework of this thesis, the 'standard' equation to be used in growth accounting was already given. In a discrete form, this equation was expressed by

$$r_O = \left(\frac{\alpha_t + \alpha_{t-1}}{2}\right) r_K + \left(\frac{\beta_t + \beta_{t-1}}{2}\right) r_L + r_{TFP} \qquad (5.1)$$

as was discussed in chapter II. The rs refer to the growth rate of the variables in subscript. The growth rate of a variable X_t is expressed in a standard manner;

$$r_{X_t} = \frac{X_t - X_{t-1}}{X_{t-1}} \qquad (5.2)$$

As a first step, I have assumed constant returns to scale. Secondly, I have assume the presence of a situation of perfect competition and profit maximalisation on the textile labour market. If this condition is fulfilled, the partial elasticity with respect to labour can be expressed by the share of labour costs (employment costs) in the value of gross value added. Or,

$$\beta_t = 1 - \alpha_t = \frac{w_t Employ_t}{VA_t} \qquad (5.3)$$

with w_t being the average level of wages at time t, and $Employ_t$ referring to employment. These steps lead to an equation in the form of

$$r_{VA} = \left(\frac{\alpha_t + \alpha_{t-1}}{2}\right) r_K + \left(\frac{2 - \alpha_t - \alpha_{t-1}}{2}\right) r_L + r_{TFP} \qquad (5.4)$$

with VA expressing Gross Value Added. Furthermore, we have seen that the factor inputs can be given by distinguishing between their quantitative and their qualitative parts, which is represented by

$$X_t^* = X_t \cdot I_X \qquad (5.5)$$

with X_t^* referring to a quality-adjusted factor input, X_t representing the quantitative part of the factor input and I_x representing the quality-adjustments. If we want to distinguish between the contribution of the quality-adjustments and the quantity component, we can write the factor inputs used in the growth accounting exercise as

$$X_t^* = X_t + (X_t I_X - X_t) \tag{5.6}$$

In this way, the input of a production factor can be expressed as the contribution of the quantitative part plus the contributions of the various quality-adjustments.
It is now possible to write the 'working equation' of the production function that is the foundation of this growth accounting exercise as

$$\frac{VA_t - VA_{t-1}}{VA_{t-1}} = \left(\frac{\alpha_t + \alpha_{t-1}}{2}\right)\frac{K_t^* - K_{t-1}^*}{K_{t-1}^*} + \left(\frac{2 - \alpha_t - \alpha_{t-1}}{2}\right)\frac{L_t^* - L_{t-1}^*}{L_{t-1}^*} + \frac{TFP_t - TFP_{t-1}}{TFP_{t-1}} \tag{5.7}$$

with the remark that the quality-adjusted factor inputs can be resolved into factors using the equations given above.

In the tradition of growth accounting, Total Factor Productivity (TFP) will be used as a rest factor; all other variables will be estimated, while the assigned contribution of TFP will be 'whatever is left'. Furthermore, if we want to assess the contribution of the production factors to economic growth over a longer time period (than one year), real contribution to growth in value added is needed. From the previous equation can be derived that the share of one of the production factors, say capital, in growth of value added over a certain time period can now be expressed by

$$\left(VA_{\tau_2} - VA_{\tau_1}\right)_K = \frac{\sum_{t=\tau_1}^{t=\tau_2} r_{K_t^*}\left(\frac{\alpha_t + \alpha_{t-1}}{2}\right) VA_{t-1}}{VA_{\tau_2} - VA_{\tau_1}} \tag{5.8}$$

where τ_1 and τ_2 are the boundaries of the time period considered, and $(VA_{\tau 1}-VA_{\tau 2})_K$ refers to the contribution of capital to the growth in value added over the time period in question. Naturally, the same procedure applies for the share of labour inputs in growth of value added.

V-2 The quantitative parts of the factor inputs

In the previous chapters, the qualitative parts of the factor inputs labour and capital (human resources and technology, respectively) were discussed, and indices were derived. In the theoretical framework, a foundation for the measurement of the quantitative parts of the factor inputs was presented. Quantitative labour inputs are represented by total hours worked, while quantitative capital inputs will be represented by the number of core-machines in the textile industry. For both production factors, we will take a closer look at these indicators below.

Labour

As an indicator for quantitative labour inputs, total hours worked (on a weekly basis) will be used. The theoretical issues concerning this choice have already been discussed previously, and we have seen that there are not many theoretical objections against the use of this variable. Total working hours can be calculated using data on employment and average working hours. An index representing average hours worked (in analogy with the quality indices used for quality-adjustments) may be used to be multiplied with employment figures. Both data series will be (briefly) discussed below.

- *Employment*

Data on employment in the Indonesian textile industry have been taken from the sources of the *Biro Pusat Statistik (BPS)*. The number of employees refer to the total number of persons engaged in the textile industry.

- *Average hours worked*

The sources of the BPS also present data on "*total working hours (per week) on main job*", divided by type of main industry. As with educational attainment, it is thus not possible to derive an indicator that refers only to the textile sector, but we will have to make use of the available information on total manufacturing industries. The same objections and justifications apply as for the educational attainment index. Table V-1 presents the available information and the derived index for average weekly hours worked. Intrapolation has been used to 'fill in' the missing years in the statistical series. As can be seen, some 9 percent variation in the last 20 years is recorded in weekly hours worked. A development that might be expected with increasing prosperity, namely a gradual reduction of weekly hours worked, seems present until 1985; after this year, workers start putting in more hours per week again. It is not clear whether this development is related to the policy reforms and liberalisation measures of the mid-80s.

Capital

The measure that will be used to represent quantitative capital inputs will be the number of core-machines in the Indonesian textile sector. At subsector level this is straightforward, since this is merely an addition of the number of core-machines. At sector level however, it is not possible to add core-machines that are used in completely different production processes (e.g. spinning frames and weaving looms) without some form of weighing. In the chapter on technology, we have seen that the correct way to apply weights for the various subsectors involved the use of a 'average machine-price in a subsector' measure in a base year, which could then be multiplied by the number of core-machines in the various subsectors at different times. In chapter III, we found that

$$I_{Tech,Tex,t} = \left(\frac{N_{S,t}\overline{p}_S}{N_{W,t}\overline{p}_W + N_{S,t}\overline{p}_S} \right) I_{S,t} + \left(\frac{N_{W,t}\overline{p}_W}{N_{W,t}\overline{p}_W + N_{S,t}\overline{p}_S} \right) I_{W,t} \qquad (5.9)$$

If we now want to arrive at a series for the textile sector taking the form of

$$PC_{Tex,t} = I_{Tex,t} \cdot N_{Tex,t} \qquad (5.10)$$

we should thus multiply with

$$N_{Tex,t} = N_{W,t}\bar{p}_W + N_{S,t}\bar{p}_S \qquad (5.11)$$

which will be our series for quantitative capital inputs. Using these equations to calculate the two average machine prices of the spinning and weaving sector in 1990, we find p_s=136 US$ (per spindle) and p_W=7,064 US$ (per loom).

Concluding this section, the quantitative factor inputs can be found in table V-1, for both labour and capital. For capital, the 'heavy' weights for the weaving industry exerts an important influence on the weighed number of core-machines in the textile sector. The rapidly decreasing number of ATBMs in the second half of the 1970s determines the diminishing number of total core-machines in textiles. Only after 1980 the continuous rapid increase in spinning frames leads to a consistent augmentation of the core-machines series.

Table V-1 Quantitative factor inputs, including average hours worked on main job for Indonesian manufacturing workers, 1975-1995

	Labour					Capital
	Average weekly hours worked	*Annual avg. weekly hours worked*	*Average hours worked index*	*Employ-ment*	*Quantitative labour inputs*	*Weighted textile core-machines*
1975		42.70	100.0	186,350	186,350	1,154,487
1976	42.07	42.07	98.5	211,716	208,634	1,152,361
1977		41.45	97.1	219,248	212,861	1,076,316
1978		40.83	95.6	214,305	204,939	1,003,445
1979		40.21	94.2	211,064	198,764	926,726
1980		39.59	92.7	228,036	211,423	836,473
1981		38.96	91.3	234,799	214,272	875,786
1982	38.34	38.34	89.8	233,139	209,360	936,710
1983		38.71	90.7	226,454	205,335	980,077
1984		39.09	91.5	240,393	220,075	1,018,604
1985		39.46	92.4	298,652	276,019	1,023,972
1986	39.83	39.83	93.3	310,247	289,446	1,030,537
1987	40.14	40.14	94.0	326,202	306,659	1,037,596
1988	40.47	40.47	94.8	355,209	336,695	1,176,812
1989	39.86	39.86	93.4	397,691	371,314	1,390,426
1990		40.90	95.8	416,400	398,862	1,438,337
1991	41.93	41.93	98.2	479,025	470,446	1,511,916
1992	41.53	41.53	97.3	544,984	530,090	1,563,257
1993	41.23	41.23	96.6	582,192	562,160	1,666,807
1994	40.51	40.51	94.9	611,291	580,009	1,733,073
1995	41.82	41.82	97.9			

Sources: Average weekly hours worked: BPS, Keadaan angkatan kerja di Indonesia, appropriate years.
Employment: appendix table A-1.
Weighted textile core-machines: data on presence from appendix table B-2, calculated using equation (5.11)

V-3 Performing a growth accounting analysis

The gross value added data used have already been presented in chapter I, and can be found in the appendix. As we have seen there, data for 1994 present a doubling of gross output and gross value added data, without a similar rise in capital or in labour inputs. Because of the important influence of these data on the outcomes of the growth accounting exercise, I have decided to treat these data with some suspicion and also present results excluding data for this year.

With the factor inputs, the share of employment costs in gross value added, the gross value added and the mathematical equations ready we can now perform a growth accounting analysis. The contributions of the factor inputs to growth in value added have been categorised in four time periods:

- **1975-1994**: the complete time period for which data are available.
- **1975-1993**: excluding the 'suspicious' data for 1994, which leads to an important reduction in TFP contribution.
- **1975-1982**: based on the time periods distinguished by Wibisono (1987), this is the period of import-substitution (and government intervention).[1]
- **1983-1993**: the period of export promotion and liberalisation of textile regulations.

Table V-2 Growth accounting for the Indonesian textile industry, 1975-1994 (percentages)

	1975-1994	***1975-1993***	***1975-1982***	***1983-1993***
Value Added (total growth, constant Rp)	6,817,913,041	3,707,926,750	300,421,972	3,407,504,778
Average annual growth rate (%)	19.5	16.9	12.4	22.0
Labour inputs	9.4	15.9	9.0	16.5
Employment	5.6	9.5	8.6	9.6
Average hours worked	-0.4	-0.3	-4.6	0.0
Human Resources	4.1	6.8	5.0	6.9
Educational attainment	4.0	6.6	5.0	6.8
HRD	0.1	0.2	0.0	0.2
Capital inputs	23.6	37.9	39.2	37.8
Number of machines	4.7	7.5	-10.1	9.1
Technological progress	18.8	30.4	49.3	28.7
Shift effect	10.1	16.9	38.8	15.0
Advance effect	8.8	13.4	10.5	13.7
Total Factor Productivity	67.1	46.2	51.9	45.7
including HRD and advance effect	75.9	59.8	62.3	59.5

Sources: appendix table E-3; contributions calculated using equation (5.8)

[1] Wibisono (1987), as quoted in Koesmawan, *Textile export marketing and technology acquisition efforts in the Indonesian textile industry: a case study*, University of Twente, Enschede 1996

The outcomes of the growth accounting exercise performed for the time period 1975-1994 are given in table V-2. A few interesting observations can be made regarding the results. First of all, the overwhelming difference between the first and the second column can be seen. Including 1994 in the analysis leads to a contribution of Total Factor Productivity that is some 21 percent higher, since value added in this one year has almost doubled, while factor inputs only showed gradual growth. If we focus on the period 1975-1993 with its subperiods 1975-1982 and 1983-1993, it can be seen that growth rates of gross value added differ considerably between subperiods. The often heard argument that Indonesian textiles have 'exploded' since export orientation became government policy is confirmed by the higher growth rate of the 'export promotion' period 1983-1993.

For textile performance over the last 18 years (1975-1993), we see that labour inputs have contributed some 16 percent to growth in value added, while capital inputs contributed some 38 percent. The unexplained economic growth, assigned to TFP, constituted some 46 percent of total growth. For labour inputs, the most important contributor was employment, which conduced 9.5 percent to growth in value added. Increases in the level of human resources was responsible for 6.8 percent increase, while the progress in educational attainment alone contributed some 6.6 percent to economic growth. For the two subperiods, no clear changes can be observed in labour inputs. Their contribution to economic growth increased, which was caused by increased contributions of both employment and the level of human resources. The average hours worked was the main determinant of this difference, contributing a negative -4.6 percent in the period of import-substitution, and not contributing anything in the export promotion phase.

Capital inputs have conduced 37.9 percent to economic growth in the period 1975-1993. The bulk of increases in capital services in this period came from technological progress. Increases in amount of capital goods only contributed a modest 7.5 percent of total economic growth. In fact, in the time period 1975-1993 the amount of core-machines was reduced, and its contribution to economic growth was a negative -10.1 percent. Shift effects were most important in this period, contributing almost 50 percent of all economic growth. The rapid replacement of old ATBMs and the introduction of the advanced shuttleless looms are the main responsibles for these developments. The period 1983-1993 is more determined by the growing influence of the spinning sector; its rapid increase in production capacity by investment in more spindles became an important determinant in growth of capital inputs. The advance effect also became slightly more important, from a contribution of 10.5 percent in the first subperiod to 13.7 in the second.

Nevertheless, a large part of the economic growth in the Indonesian textile industry remains unexplained. If data on value added for 1994 are in fact correct, and the careful estimates for technological progress and the level of human resources are used (excluding the advance effect and HRD efforts), some 76 percent of all economic growth can not be attributed to increases in the factor inputs labour and capital. Even in the most 'advantageous' subperiod, using the largest estimates for technology- and human resources-index, some 45.7 percent of economic growth remains to be attributed to inputs in production. One of the reasons for the size of this unexplained part of economic growth might be the aggegation over subsectors, which are distincly different in technological nature, as we have seen in previous chapters. If this were true, a growth accounting analysis at subsector level (i.e. accounting for growth of the spinning and weaving industry separately) should yield an economic growth that is better accounted for. These exercises have been performed in the next two tables, V-3 and V-4.

Table V-3 Growth accounting for the Indonesian spinning industry, 1975-1994
(percentages)

	1975-1994	*1975-1993*	*1975-1982*	*1983-1993*
Value Added (total growth, constant Rp)	1,967,537,622	1,118,651,546	110,358,174	1,008,293,372
Average annual growth rate (%)	23.5	21.2	22.1	19.6
Labour inputs	8.1	14.8	14.8	14.8
Employment	5.1	9.5	14.9	8.9
Average hours worked	-0.3	-0.3	-2.7	-0.1
Human Resources	3.2	5.6	2.6	5.9
Educational attainment	3.2	5.5	2.6	5.8
HRD	0.1	0.1	0.0	0.1
Capital inputs	44.3	68.6	73.3	68.0
Number of machines	23.0	36.7	50.5	35.2
Technological progress	21.3	31.9	22.8	32.9
Shift effect	-0.1	-0.2	0.6	-0.3
Advance effect	21.3	32.1	22.2	33.1
Total Factor Productivity	47.6	16.7	11.9	17.2
including HRD and advance effect	69.0	48.9	34.1	50.5

Source: appendix table E-4

Table V-4 Growth accounting for the Indonesian weaving industry, 1975-1994
(percentages)

	1975-1994	*1975-1993*	*1975-1982*	*1983-1993*
Value Added (total growth, constant Rp)	3,584,841,406	1,425,348,995	165,760,846	1,259,588,149
Average annual growth rate (%)	18.6	14.2	11.5	17.4
Labour inputs	6.9	13.9	-4.0	16.3
Employment	3.6	6.9	-4.5	8.4
Average hours worked	-0.3	-0.3	-4.5	0.3
Human Resources	3.5	7.3	5.0	7.6
Educational attainment	3.4	7.1	5.0	7.4
HRD	0.1	0.2	0.0	0.2
Capital inputs	15.2	34.4	27.6	35.3
Number of machines	-0.3	-0.7	-24.0	2.4
Technological progress	15.5	35.1	51.6	32.9
Shift effect	11.2	25.7	44.5	23.2
Advance effect	4.3	9.4	7.1	9.7
Total Factor Productivity	77.9	51.7	76.4	48.4
including HRD and advance effect	82.3	61.2	83.5	58.3

Sources: appendix table E-5

Indeed, there are some important differences between the two subsectors. For spinning, the importance of capital accumulation becomes clear. Over the period 1975-1993, some 68.6 percent of economic growth can be explained by increases in capital services. With 14.8 percent accounted for by labour inputs, only 16.7 percent remains unassigned to factor inputs with their quality-adjustments. The shift effect in this industry, as we have seen before, does in fact contribute negatively to economic growth, since the ratio between ring spindles and open-end rotors has actually grown over the last 20 years (i.e. ring spindles have increased more rapidly than open-end rotors). The advance effect, estimated at 3 percent annually, contributes an important part, as does the total number of machines. For labour, employment is again the most important contributor with 9.5 percent in 18 years, while improvements in educational attainment accounts for 5.5 percent of economic growth.
For weaving, the story for capital goods appears to be the other way around. The number of machines has contributed negatively to economic growth (because of decreases in their total), while the shift effect is the most important factor in accounting for economic growth. In the period of import-substitution the shift effect actually accounted for over 50 percent of economic growth, although this share was reduced by the diminishing size of the capital stock. In this same period, employment also contributed negatively. For all periods, the size of the unexplained economic growth (or TFP) is very large. In the first subperiod, more than 75 percent of economic growth can not be accounted for, while in the second subperiod almost 50 percent of growth can not be assigned to growth of the factor inputs.

As a final part of this growth accounting analysis, I will list the assumptions made in order to come to these results. They are:

- A *growth accounting* framework is used. This framework assigns economic growth to its production factors, but does not take developments at the demand-side of industrial developments into account (see next section).
- *Constant returns to scale* are assumed in the Indonesian textile industry. This implies that so-called scale effects are not expected to play a role in economic performance.
- A situation of *perfect competition and profit maximalisation* is assumed at the labour market (which allows the calculation of the partial elasticity of value added with respect to labour by taking the share of employment costs in total value added).

V-4 Evaluation of the results

In chapter I, we have seen that textile firms are growing increasingly bigger, and that the bigger firms, via various mechanisms, have better access to capital, modern technologies and foreign buyers. This would suggest the existence of economies of scale, be it not from the supply side. Still, larger firms usually do perform better with respect to labour-productivity.[2] The assumption of constant returns to scale should therefore be considered with some care, and is certainly not an 'obvious' assumption when discussing the Indonesian textile industry.
Perfect competition and profit maximalisation have already been assumed in the previous chapter in order to come to an index for educational attainment and consequently for the level

[2] A comparison of Small-Scale Industries (SSI), for instance, and medium and large firms will usually yield a picture of a more productive group of larger firms.

of human resources. An assessment of these assumptions can be found in the previous chapter as well.

Data collection

The available data on gross value added constituted a first indication of the validity of the results, that are only as reliable as the data used (and, of course, the applied theories in order to come to the final results). Data on gross value added in 1994 rose sharply, while factor inputs only showed a gradual increase. Because of this discrepancy between the data series, much of the growth in 1994 could not be accounted for, and 'ended up' in the TFP contribution.

Throughout my stay in Indonesia I have been warned by several people against the use of data from the BPS. The most important problem, it seems, was that the BPS was a government office, and information provided by the firms was not always accurate, since taxes were also based on the information that was given out. There are a number of commercial data organisations in Indonesia, that claim to have the ability to deliver data that are a closer approximation of 'real' figures, since these organisations pay for obtaining the data and do not deliver to the government. However, the price tag of data series provided by these organistations proved to be above my budget. Moreover, the coverage of the BPS statistics is quite good, and all information that I was looking for at sectoral level was readily available. These data were thus, given time and money constraints, the best possibility for obtaining an image of the developments in the Indonesian textile industry. It should nevertheless be noted that large errors could occur in these data, if the claimed procedure of data-collection by the BPS would lead to giving out false information on output and value added by firms.

Demand and other factors

One of the most important disadvantages of the growth accounting framework concerns the lack of attention for demand factors in the production process. If a firm can produce at very high speed, with great accuracy and quality, but no one wants to buy their products (because of whatever reason), it will necessarily have to decrease its production, although labour and capital inputs will remain at equal level. A first measure to include these effects is the incorporation of utilisation rates of the machineries in the analysis, to obtain a more precise picture of the amount of capital services used. For labour, this would be extremely hard, since this would involve keeping hourly track of the activities of labourers in a firm or factory.

Among the most important problems for the Indonesian textile industry at present, a number of demand factors are mentioned by textile managers and experts. Marketing is often put forward as an important lack in management capacities. Also, the lack of organisation between firms allows prospective buyers to 'shop around' for the cheapest price, which often leads to meagre deals for the textile firms. The role of the government is not so much quoted as a problem, but frequently as one of 'running behind the facts'. Government efforts to assist in raising the level of *Sumber Daya Manusia* (human resources) has only booked some progress very recently, and many smaller firms are still complaining about the difficulties in financing replacement of capital goods.

VI Conclusions and Recommendations

In the previous chapters, a lot of information has been presented on various aspects of the Indonesian textile industry. In particular, technological developments and the improvements in human resources have been discussed, and indices for their progress have been constructed. These indices have been used to estimate the role of technology and human resources in the economic performance of the Indonesian textile industry in the period 1975-1994. In this chapter, I will use the outcomes of this analysis (and other sources to arrive at some conclusions about the historical developments, the present situation and the future prospects for the Indonesian textile sector and to answer the research questions posed in the introduction.

VI-1 Some conclusions

1) Output, value added and labour-productivity have grown dramatically in the last 20 years

Gross output in the Indonesian textile industry has grown 14 times in the period 1975-1993. Gross value added increased over 15 times and labour-productivity increased some 5.5-fold. The fact that labour-productivity has grown with a slower pace than output and value added suggests that part of the economic growth has been 'expansive' in nature; part of the increases in output and value added can be attributed to increases in the amount of the factors of production.

2) The textile sector has transformed from a domestic supplier into a large export producer

Starting in the early 1980s, the textile industry has expanded and shifted an important part of its efforts from the then protected domestic market to the export markets. As foreign investment regulations were relaxed and export barriers removed, an increasing part of Indonesian textile production began to be exported. Together with the removal of export and import barriers and the increased foreign investment starting in the mid-80s, the Indonesian textile industry has been integrated into the global textile market, and is thus bound by its developments. Up to 40 percent of textile production is destined for exports, and global competition requires adapting to the demands of the global market.

3) Growth of worker's wages has not kept up with growth in labour-productivity

Although wages have increased 3.8-fold since 1975, they have not kept up with growth in labour-productivity, which was 5.3 times. This means that the share of labour in value added has diminished, and the share of capital (interests and profits) has, per definition, increased.

4) The role of technological progress has been important, but diverse

Technological progress can be defined as the maximum productivity of the capital goods and can be divided into two effects: the shift effect (replacement of one type of machinery by another) and the advance effect (replacement of older machines by newer, more productivity machines of the same type). In Indonesian spinning, there has not yet been a replacement of one type of machinery by another. The advance effect has been much more important. In the period 1968-1994 it caused an increase in the quality of the spinning machine-park of 70 percent. For 1975-1993, the advance effect contributed 31.9 percent to economic growth, against a 36.7 percent contribution by the increase in the number of spinning units. The shift effect contributed -0.2 percent. For weaving, the advance effect is much less important than the shift effect. For the period 1940-1995, the shift effect has increased productivity of the loom-park in Indonesia over 700 percent, while the advance effect constituted a change of 85 percent. In economic growth, the shift effect contributed 25.7 percent in the period 1975-1993, while the advance effect added 9.4 percent.

5) The role of human resources in economic performance has been limited

Human Resources can be defined as the productivity of an individual or labour force. Although the average years of education received by textile workers has increased from 3.21 years in 1976 to 6.81 years in 1995, this has led to an increase in the quality of labour inputs (human resources) of only 56.4 percent. HRD activities contributed a 2 percent increase only, and the derivation of this percentage has not been based upon sufficient statistical information. In economic performance, this resulted in a contribution of 6.9 percent points to economic growth in period 1975-1993, with 6.8 percent for improvements in educational attainment and 0.2 percent due to HRD. In this period, growth of employment 'caused' a growth in value added of 9.5 percent points. However, many experts and managers assert that the level of human resources is very important in working effectively with modern technologies and in decisions about new technologies that can be used by textile firms. It seems that, although its economic significance is limited, the relation between technology and human resources is a very important one in Indonesian textiles.

6) Human Resource Development is slowly becoming an important topic in textile management

Training new employees or training for new technologies is happening in most Indonesian textile firms at present. All of the five firms interviewed provided training to their employees. Typical contents of these training programmes are discipline, house rules, operating the machines, motivation and company loyalty. Training when new technologies were introduced was also given, in which operating the new machines, problem-solving and maintenance were usual topics. This training was considered to be necessary by managers for their firm's performance. Special training programmes on leadership, decision-making, problem-solving and communicating were also given, but usually only to middle- and high-level management. HRD efforts are quite recent in nature, and only a few companies have seperate HRM (Human Resource Management) departments. Expenditures on training for employees range from 7,800 Rp to 56,500 Rp per employee, which is (in the 'best' case) some 3 percent of employment costs.

7) Contribution of TFP growth to value added has decreased in the last 20 years

If the period 1975-1993 is subdivided into two periods, the contribution of growth of Total Factor Productivity has decreased. In the period 1975-1982, its contribution was 51.9 percent in the Indonesian textile industry, while this contribution in the period 1983-1993 was 45.7 percent. This decline is caused by a strong fall in the weaving industry, where TFP growth contributed 76.4 percent in the first period, and only 48.4 percent in the second period. In the spinning industry, contribution of TFP growth has actually risen slightly, from 11.9 percent to 17.2 percent.

8) Textile firms are increasingly becoming larger

The average number of employees per firm in 1975 was 68; in 1994, an average textile firm employed 303 workers. Together with this development, managers and experts claim that larger firms hold advantages over smaller firms in 'modernity', productivity, and HRD efforts. Reasons for this include the better availability of finance capital and the existence of political links.

9) Indonesian textiles are losing competitiveness to low-income countries

With the rapid transition of Indonesia from a low-income to a middle-income country, wages have risen as well. Experts claim that countries that are still at a lower level of industrialisation, such as China and Viet Nam, have already taken over part of the 'standard'-quality production of textiles in the global market because of their lower level of wages. Some Indonesian firms find it increasingly harder to find buyers for their textile products. Particularly the smaller firms have a hard time competing with the vast number of domestic and international firms.

10) Two markets can be distinguished within the global textile market

Past research has shown that Indonesian textile firms that are producing for textile markets in 'affluent' countries (Europe, United States, Japan) are technologically more modern than other textile firms. Moreover, countries that would be expected to have a very unprofitable competitiveness-position, such as Germany and Italy, are still heavily involved in textile production. It appears that textile consumers in more affluent countries are prepared to pay more for textile-quality, design and production-speed, amongst others. Some developing countries that are producing textiles are not (yet) able to produce textiles of equal quality and design. Modern technologies are a prerequisite for the production of high-quality textiles. We can thus distinguish a 'high-quality'-market, characterised by higher production costs and a higher level of value added and a focus on design and fast, flexible production, and a 'standard-quality'-market, characterised by low-cost production. Demand for the latter can be found predominantly in the developing countries.

VI-2 Recommendations

Based upon these conclusions, some recommendations can be made for policy-makers and textile management in Indonesia. If the observed trends will continue in the near future, the Indonesian textile industry might find itself in a difficult situation in the years to come. I will therefore suggest a few lines of action to take for the Indonesian textile industry, that might be initiated either by the government (departments of industry and finance), or by the management of the many Indonesian textile firms.

1) The Indonesian textile industry should refocus from low-cost standard products to products of higher quality and value added

Industrial development in Indonesia will probably continue with a high pace in the near future. The accompanying rise in industrial wages will further weaken international competitiveness for standard-quality products. At the market for high-quality products, Indonesia's competitiveness position is far better, since its main competitors here are countries like Korea, Taiwan, Malaysia and even Japan, Germany and Italy. This refocusing is necessarily accompanied by the use of modern production methods such as the use of computer control and the integration of Total Quality Control (TQC). Already, larger firms are applying for ISO standards (9000 and 14000), and modern technologies are used for production.

2) Older types of technologies shoud be replaced by modern technologies

We have seen that the replacement of older types of machines by modern types has already played an important role in the weaving industry. For spinning, the introduction of new, fully compatible machines could take a few more years, since the most modern technologies (air-jet and friction-jet spinning) have not been completely developed. It is expected, however, that open-end rotors will play an increasingly important role in the production capacity of Indonesian spinning. For weaving, we have seen that the shift effect has played an important role already, and a mild 'technological revolution' has taken place in the last 30 years. The replacement of the large number of shuttlelooms should continue. The use of these modern technologies is a prerequisite for the production of high-quality products with a higher level of value added.

3) Human Resource Development should become a central issue in textile personnel management

As we have seen in the conclusions, HRD efforts have been limited in the Indonesian textile sector. Its importance in production and decisions about new technologies has also been mentioned frequently. If the level of human resources is indeed a condition '*sine qua non*' for technological progress, refocusing on high-quality products will have to be accompanied by increases in the human resources of the textile labour force. The government can play an important role in supporting HRD programmes and providing additional training to textile employees, as is happening at a limited scale already. The current line of government policies, in which human resources are receiving more attention, should be continued, and government departments should invest in training programmes.

4) Wages in the Indonesian textile industry should be increased

Indonesian wages are no longer able to compete with wages in low-income countries like China, Viet Nam or Bangladesh. Also, the share of employment costs in value added has in fact decreased. Indonesia has long been characterised by a highly unequal income distribution. Moreover, current Indonesian textile wages are hardly sufficient to provide for the basic needs of workers. Maintaining a low level of wages will, in the long-term, not be a sustainable option because of the competition of other low-income countries. To increase wages would have beneficial effects at macro, sectoral and firm level. At macro level, domestic demand could increase due to improved purchasing power, and employees could invest more in human resources-related aspects such as health and a balanced diet. Also, the income-distribution would become more equal. At sectoral level, workers with a higher level of education could be employed. At firm level, motivation of the employees could improve, and the labour-turnover ratio may drop, which makes it more beneficial to invest in HRD.

5) The government and textile organisations should play a coordinating role in guiding these transitions

Finding new international buyers, purchasing modern technology, changing the range of products and investing in employees are all processes which have to be guided by experts to be succesful. Coordination by textile organisations (such as the API) and the appropriate government departments should be provided, and the emphasis should be placed on 'problem-solving', providing information and preventing adverse effects of this restructuring. The government interests in the textile sector are high, since textiles supply much-needed foreign exchange. Besides this, employment and value added are amongst the highest of any Indonesian industrial sector. Since economies of scale appear to be prevailing to some extent, the government should make every efforts to facilitate obtaining investment capital, so that firms have the opportunity to invest and grow.

These transitions might well become the 'third transition'. First, Indonesian textiles were made into an industrial activity for larger firms (after the installation of the New Order government) in the late 1960s. Secondly, the path of export promotion was chosen after the textile industry had matured in the early 1980s, and Indonesian textiles became an important export product. Now, Indonesian textiles are faced with a new challenge under changing circumstances. Hopefully, the textile industry will be able to provide employment and generate industrial output for a long time to come in Indonesia.

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Appendix

Appendix A - Economic data for the Indonesian textile industry

Table A-1 Economic data for the Indonesian textile industry (ISIC 321), 1975-1994

	Price index (1975=100)	*Price index (1990=100)*	*Gross Output ('000 current Rp)*	*Input costs ('000 current Rp)*	*Indirect taxes ('000 current Rp)*	*GVA factor cost ('000 current Rp)*	*GVA factor cost (1990 '000 Rp)*	*Employment costs ('000 current Rp)*	*Employment (#)*
1975	100	30.1	286,089,277	211,758,431	2,589,296	71,741,550	238,181,946	30,997,812	186,350
1976	103	31.0	313,016,224	212,898,453	2,344,852	97,772,919	315,151,545	34,049,579	211,716
1977	111	33.4	349,916,096	251,283,068	2,649,846	95,983,182	287,084,833	37,592,171	219,248
1978	117	35.2	443,406,027	311,213,826	4,269,075	127,923,126	362,995,537	45,338,094	214,305
1979	153	46.1	612,280,337	427,872,352	6,910,141	177,497,844	385,158,720	56,520,912	211,064
1980	182	54.8	841,299,914	570,918,115	6,903,024	263,478,775	480,631,612	77,249,089	228,036
1981	194	58.4	939,204,812	644,217,154	7,201,191	287,786,467	492,500,552	98,485,803	234,799
1982	209	63.0	1,004,971,416	658,381,635	7,528,881	339,060,900	538,603,918	110,258,600	233,139
1983	223	67.2	1,138,501,687	781,327,395	7,832,310	349,341,982	520,096,583	125,478,926	226,454
1984	239	72.0	1,660,220,238	1,086,458,036	7,629,657	566,132,545	786,426,799	144,927,759	240,393
1985	250	75.3	2,388,387,124	1,596,623,459	29,250,515	762,513,150	1,012,617,463	206,670,495	298,652
1986	261	78.6	3,021,580,304	1,922,355,681	52,468,019	1,046,756,604	1,331,506,485	236,090,286	310,247
1987	292	88.0	3,890,461,807	2,717,356,160	60,200,283	1,112,905,364	1,265,358,154	264,283,245	326,202
1988	306	92.2	4,968,990,421	3,646,137,376	82,036,159	1,240,816,886	1,346,245,772	335,219,470	355,209
1989	319	96.1	7,156,000,000	4,946,000,000	90,450,478	2,119,549,522	2,205,926,148	417,973,241	397,691
1990	332	100.0	7,881,000,000	5,473,000,000	84,979,648	2,323,020,352	2,323,020,352	497,598,000	416,400
1991	348	104.8	10,471,000,000	7,552,000,000	-10,000,000	2,929,000,000	2,794,333,333	771,709,275	479,025
1992	359	108.1	13,347,000,000	9,255,000,000	0	4,092,000,000	3,784,245,125	1,224,579,048	544,984
1993	368	110.8	14,815,000,000	10,441,000,000	0	4,374,000,000	3,946,108,696	1,178,356,608	582,192
1994	379	114.2	20,884,000,000	12,828,000,000	1,000,000	8,055,000,000	7,056,094,987	1,367,457,967	611,291
1995	413	124.4							

Sources:
Wholesale price index:
1975-1990: Szirmai (1993) form BPS, Indikator Ekonomi 1984, 1990, 1993 and Hill (1991, table 1); 1991-1995 from BPS, Indikator Ekonomi, maret 1996 (1983=100)
Gross output, Input costs, indirect taxes, GVA at GVA at factor cost, Employment, Employment costs and Number of establishments:
1975-1994: BPS, Statistik Industri, appropriate years
Exports and Imports:
BPS, Statistik perdagangan luar negeri Indonesia, Ekspor/Impor, jilid II, appropriate years
Exports 1985-1988: Thee Kian Wie, 1991

Table A-1 (continued)

	GVA / employees (1990 '000 Rp)	Number of est. (#)	Average employees per est.	Average wages (1990 '000 Rp)	Labour-productivity /wages	Employment costs as % of output	Exports (SITC 65, current US$)	Imports (SITC 65, current US$)
1975	1278	2754	68	552	2.3	10.8		
1976	1489	2308	92	518	2.9	10.9		
1977	1309	2105	104	513	2.6	10.7		
1978	1694	2022	106	600	2.8	10.2		
1979	1825	1945	109	581	3.1	9.2		
1980	2108	1957	117	618	3.4	9.2		
1981	2098	1892	124	718	2.9	10.5		
1982	2310	1822	128	751	3.1	11.0		
1983	2297	1755	129	825	2.8	11.0		
1984	3271	1669	144	837	3.9	8.7	200,474,680	125,587,125
1985	3391	2033	147	919	3.7	8.7	219,700,000	
1986	4292	2028	153	968	4.4	7.8	278,700,000	
1987	3879	2031	161	921	4.2	6.8	417,500,000	
1988	3790	2137	166	1024	3.7	6.7	582,600,000	
1989	5547	2160	184	1094	5.1	5.8	839,134,167	510,724,242
1990	5579	1828	228	1195	4.7	6.3	1,241,263,690	785,086,887
1991	5833	1794	267	1537	3.8	7.4	1,755,278,020	885,676,135
1992	6944	1881	290	2078	3.3	9.2	2,837,480,948	1,100,222,091
1993	6778	1953	298	1826	3.7	8.0	2,636,904,348	1,124,467,573
1994	11543	2017	303	1960	5.9	6.5	2,498,040,141	1,169,960,101
1995							2,713,400,463	

Table A-2 Fixed Capital Transactions for the Indonesian textile industry, 1975-1994

	New purchases ('000 Rp)	*Second hand purchases* ('000 Rp)	*Construction, repair and maintenance* ('000 Rp)	*Total investment* ('000 Rp)	*Sales of used items* ('000 Rp)	*Wholesale price index machinery & transport eq.* (1983=100)
1975	46,453,395		4,278,650	50,732,045		41
1976	29,643,491	8,317,600	6,039,916	44,001,007	1,515,543	41
1977	37,874,625	2,538,468	4,949,748	45,362,841	345,910	44
1978	344,681,224	2,028,597	3,377,887	350,087,708	1,249,877	47
1979				350,568,009	4,450,374	68
1980				107,378,921	3,743,110	76
1981	68,208,800	28,650,278	10,282,748	107,141,826	1,371,688	85
1982	85,770,270	29,065,083	5,188,223	120,023,576	874,929	89
1983	125,663,723	32,070,156	31,024,580	188,758,459	6,413,335	100
1984	86,655,006	52,873,925	33,020,148	172,549,079	1,591,764	112
1985	77,013,402	31,873,606	53,220,078	162,107,086	41,429,806	125
1986	59,571,787	21,923,984	18,446,205	99,941,976	7,658,420	136
1987	138,126,105	37,218,389	20,039,360	195,383,854	9,877,298	156
1988	230,499,225	45,678,416	26,551,923	302,729,564	33,359,932	166
1989	631,798,508	905,920,064	53,220,078	1,590,938,650	171,612,446	179
1990	1,103,743,166	650,461,066	108,950,272	1,863,154,504	100,539,329	194
1991	1,731,993,734	270,298,886	213,571,120	2,215,863,740	60,695,564	221
1992	1,258,026,065	279,930,192	137,238,238	1,675,194,495	42,049,217	230
1993	1,105,575,317	189,375,837	165,934,197	1,460,885,351	69,288,670	247
1994	1,411,699,493	196,261,791	84,706,294	1,692,667,578	33,482,040	263

Source:
BPS, Statistik Industri, appropriate years
Wholesale price index machinery and transport equipment: BPS, Indikator Ekonomi, various years

Table A-3 Fixed capital formation by type of capital stock, 1985-1994 (all prices in '000 current Rp)

Year	Type	*New purchases*	*Second-hand purchases*	*Construction, repair and maintenance*	*Total investment*
1985	Land		4,272,412	229,624	4,502,036
	Buildings	8,037,960	4,629,698	12,359,401	25,027,059
	Machines	58,828,058	15,893,682	10,899,467	85,621,207
	Vehicles	2,884,834	2,184,596	2,580,217	7,649,647
	Other	7,262,550	4,893,218	22,713,770	34,869,538
	Total	77,013,402	31,873,606	48,782,479	157,669,487
1986	Land		1,942,534	85,885	2,028,419
	Buildings	6,382,555	3,623,369	9,168,423	19,174,347
	Machines	46,843,139	12,055,180	6,258,906	65,157,225
	Vehicles	3,799,632	1,884,624	263,357	5,947,613
	Other	2,546,461	2,418,277	2,669,634	7,634,372
	Total	59,571,787	21,923,984	18,446,205	99,941,976
1987	Land		2,509,585	56,962	2,566,547
	Buildings	13,011,277	7,060,066	15,927,052	35,998,395
	Machines	111,060,347	22,978,426	3,407,061	137,445,834
	Vehicles	6,300,639	1,251,753	276,876	7,829,268
	Other	7,753,842	3,418,559	371,409	11,543,810
	Total	138,126,105	37,218,389	20,039,360	195,383,854
1989	Land		18,464,682	423,245	18,887,927
	Buildings	74,302,383	10,409,979	29,096,794	113,809,156
	Machines	503,829,088	819,084,081	22,618,044	1,345,531,213
	Vehicles	36,939,521	25,165,872	514,095	62,619,488
	Other	16,727,316	32,775,450	567,900	50,070,666
	Total	631,798,308	905,900,064	53,220,078	1,590,918,450
1994	Land		95,188,396	110,564	95,298,960
	Buildings	96,625,370	3,893,046	43,995,211	144,513,627
	Machines	1,246,620,060	81,910,816	37,627,284	1,366,158,160
1990	Land		106,496,518	1,777,497	108,274,015
	Buildings	85,016,979	100,201,631	65,108,648	250,327,258
	Machines	877,775,303	396,217,191	34,670,230	1,308,662,724
	Vehicles	21,956,345	12,764,028	2,594,889	37,315,262
	Other	118,994,539	34,781,698	4,799,008	158,575,245
	Total	1,103,743,166	650,461,066	108,950,272	1,863,154,504
1991	Land		77,725,668	682,859	78,408,527
	Buildings	132,111,248	22,858,336	107,133,812	262,103,396
	Machines	1,519,966,236	162,315,236	56,487,512	1,738,768,984
	Vehicles	27,941,707	4,048,245	1,042,333	33,032,285
	Other	51,974,543	3,351,401	48,224,604	103,550,548
	Total	1,731,993,734	270,298,886	213,571,120	2,215,863,740
1992	Land		82,166,889	444,242	82,611,131
	Buildings	107,028,162	35,799,054	93,061,852	235,889,068
	Machines	962,184,083	152,749,907	39,132,762	1,154,066,752
	Vehicles	104,694,137	3,886,119	1,153,840	109,734,096
	Other	84,119,683	5,328,223	3,445,539	92,893,445
	Total	1,258,026,065	279,930,192	137,238,235	1,675,194,492
1993	Land		35,808,677	134,403	35,943,080
	Buildings	72,223,341	10,792,201	93,951,471	176,967,013
	Machines	939,023,681	120,862,458	59,848,653	1,119,734,792
	Vehicles	22,709,260	6,921,113	359,712	29,990,085
	Other	71,619,035	14,991,388	11,639,958	98,250,381
	Total	1,105,575,317	189,375,837	165,934,197	1,460,885,351
1994	Vehicles	26,267,108	12,042,921	283,817	38,593,846
	Other	42,186,955	3,226,612	2,689,418	48,102,985
	Total	1,411,699,493	196,261,791	84,706,294	1,692,667,578

Source:
BPS, Statistik Industri, appropriate years

Table A-4 Number of establishments, gross value added and employment at 5-digit ISIC level for the Indonesian textile industry, 1975-1994

	32111 (Yarn and thread manufacturing)			32112 (Weaving mills)			32113 (Bleaching, dyeing, printing, finishing)		
	# est	VA	employ	# est	VA	employ	# est	VA	employ
1975	52	10,914,310	20,559	1,787	43,647,472	149,021	76	2,488,747	7,104
1976	61	13,531,154	33,024	1,338	62,750,226	120,332	93	2,558,826	8,142
1977	62	24,581,598	30,805	1,192	51,741,266	114,975	78	4,429,535	6,876
1978	68	35,980,374	38,781	1,155	68,041,339	117,386	77	4,937,997	6,665
1979	70	54,138,958	39,026	1,061	91,262,762	115,053	74	5,443,926	6,811
1980	76	97,350,339	43,309	1,056	120,150,623	129,779	78	14,644,904	7,268
1981	73	86,149,987	44,080	1,038	147,392,561	130,192	71	13,707,148	7,079
1982	80	92,369,554	47,373	995	195,784,507	128,277	65	6,521,682	5,529
1983	78	108,129,026	43,567	953	180,244,344	126,869	60	9,979,067	5,129
1984	78	164,334,895	52,083	907	317,283,866	131,728	53	10,255,896	5,000
1985	94	285,170,167	65,625	1,030	336,663,835	156,302	60	19,073,559	6,157
1986	91	365,057,975	67,247	1,004	482,570,319	164,891	58	25,762,876	6,080
1987	90	418,394,597	69,449	1,010	477,943,603	173,992	59	51,095,210	8,138
1988	102	429,185,287	77,558	1,050	559,896,890	179,296	65	10,307,401	5,349
1989	105	759,306,456	83,437	1,057	961,334,300	198,189	67	16,394,614	6,108
1990	141	827,606,597	101,478	637	943,050,412	184,562	130	174,164,953	23,126
1991	172	1,070,206,384	127,058	639	1,072,168,552	205,968	130	164,285,865	25,083
1992	201	1,006,088,598	136,674	676	1,724,729,791	234,522	174	419,052,492	32,541
1993	195	1,279,642,177	141,888	729	1,739,955,786	243,785	145	255,890,773	31,033
1994	191	2,288,337,074	136,827	749	4,259,488,264	276,831	133	220,398,689	27,003

Note: The classification of subsectors is taken from the BPS. It might differ from the orginal ISIC classification, but this has been done to adapt the classification to local conditions. In 1992, a new classification was introduced at the 5-digit level. The classification is as follows:
111 - spinning mills; 112 - threads; 113 - finished yarn; 114 - weaving mills; 115 - finished textiles; 116 - printed textiles; 117 - batik; 121 - made-up textiles except wearing apparel; 122 - made up textiles for health purposes; 123 - gunny bags; 129 - other sacks; 130 - knitting mills; 140 - carpet and rugs; 151 - rope and twine; 152 - goods made of rope and twine; 160 - capok; 190 - other textiles.
Combinations have been made to fit the previously used classification:
111+112+113, 115+116, 121+122, 123+129, 151+152.

Source: BPS, Statistik Industri, the appropriate years.

Table A-4 (continued)

	32115 (Gunny and plastic bags)			32120 (made up textile except garments)			32130 (Knitting mills)		
	# est	*VA*	*employ*	*# est*	*VA*	*employ*	*# est*	*VA*	*employ*
1975	21	5,438,177	10,862	122	1,708,071	7,032	158	2,278,777	12,160
1976	21	3,376,461	9,235	125	1,114,807	7,438	134	2,980,096	11,709
1977	20	2,521,504	9,409	107	2,302,391	7,048	127	3,512,369	10,225
1978	19	3,767,856	9,087	118	2,434,252	7,193	122	4,511,032	10,934
1979	20	6,643,319	10,276	119	4,850,074	7,093	129	5,519,247	11,763
1980	22	7,574,278	10,305	126	4,934,388	9,131	128	7,584,076	13,176
1981	23	10,538,383	10,830	121	9,382,094	9,872	125	8,269,113	13,868
1982	23	12,367,087	10,886	105	8,381,534	9,888	125	10,762,150	13,858
1983	24	14,644,559	11,622	97	9,732,438	8,122	130	13,357,611	14,387
1984	23	15,425,200	10,796	91	11,495,919	9,006	133	23,113,730	15,937
1985	33	22,565,812	12,493	200	20,100,243	14,874	196	43,784,805	23,602
1986	32	30,125,617	12,378	222	32,971,683	16,955	198	74,619,200	24,009
1987	30	30,403,698	12,915	223	32,963,194	16,005	219	77,849,918	27,725
1988	30	28,388,709	13,325	233	34,953,307	16,064	243	141,573,450	44,020
1989	30	42,173,970	14,533	246	38,284,250	20,609	250	234,803,880	53,213
1990	19	22,719,565	10,406	210	50,689,018	21,659	263	195,917,438	44,977
1991	12	12,511,602	7,505	200	54,700,476	23,066	237	300,948,123	59,271
1992	17	19,801,752	8,909	194	91,181,397	21,403	233	586,218,400	75,299
1993	17	32,585,279	9,338	199	146,666,915	27,903	246	510,650,212	89,361
1994	20	37,437,893	9,670	189	140,910,080	25,955	312	509,085,457	91,883
1995									

Table A-4 (continued)

	32140 (Carpets and rugs)			32150 (Cordage and twine)			32160 (Capok)		
	# est	*VA*	*employ*	*# est*	*VA*	*employ*	*# est*	*VA*	*employ*
1975	6	117,140	395	21	237,534	1,698	24	149,984	2,003
1976	6	161,265	483	20	387,612	1,365	41	453,113	3,071
1977	7	605,396	490	16	245,650	1,119	44	294,326	2,072
1978	7	625,095	407	14	528,761	847	41	275,231	1,923
1979	6	546,091	440	15	351,667	992	40	374,970	1,500
1980	6	1,246,039	403	19	645,616	1,377	39	476,617	1,655
1981	6	797,324	478	18	837,679	1,379	40	557,865	1,635
1982	7	411,160	459	16	778,902	1,339	39	734,660	1,590
1983	7	552,346	499	16	1,050,810	1,258	38	1,491,307	1,967
1984	7	1,042,538	471	17	2,217,226	1,429	38	1,351,328	2,668
1985	5	6,000,294	570	15	2,209,395	1,402	62	2,619,632	3,147
1986	5	3,157,482	580	13	3,165,847	1,416	61	5,821,160	3,314
1987	5	1,630,195	510	15	3,581,068	1,674	60	6,132,031	3,230
1988	9	4,727,440	1,022	20	6,438,474	1,068	70	6,475,765	3,565
1989	10	16,546,783	1,165	21	6,507,387	2,495	78	15,146,412	3,911
1990	10	37,495,185	1,430	46	24,635,972	9,285	83	4,862,637	4,049
1991	11	22,093,182	1,884	44	28,982,855	9,080	87	4,227,599	4,564
1992	10	48,684,834	1,864	51	37,685,795	10,555	80	6,839,441	4,051
1993	11	54,380,504	2,227	49	46,181,205	11,011	77	6,279,716	4,168
1994	12	49,943,295	2,230	44	55,014,920	11,061	81	9,776,683	4,411

Table A-4 (continued)

	32190 (Other textiles)			321 (Total)		
	# est	*VA*	*employ*	*# est*	*VA*	*employ*
1975	5	647,593	658	2,754	71,741,550	231,980
1976	4	675,039	615	2,308	97,772,919	215,057
1977	3	635,498	521	2,105	96,009,130	198,715
1978	4	601,776	303	2,062	127,927,389	209,893
1979	4	1,339,015	346	1,945	177,497,844	208,675
1980	4	893,918	383	1,957	263,478,775	232,071
1981	4	1,010,889	359	1,892	287,786,467	234,799
1982	4	1,159,163	355	1,822	339,060,900	233,139
1983	5	1,016,707	389	1,755	349,291,982	226,454
1984	5	4,845,650	387	1,669	566,132,545	240,393
1985	7	1,522,594	819	2,033	762,513,146	298,652
1986	7	2,825,644	890	2,028	1,046,756,604	310,247
1987	7	1,557,168	854	2,031	1,112,905,364	326,202
1988	8	2,002,448	1,126	2,137	1,240,818,886	355,172
1989	9	3,807,080	1,190	2,160	2,118,818,630	397,691
1990	14	9,847,636	1,155	1,828	2,324,909,655	416,398
1991	16	37,735,329	2,542	1,794	2,792,822,579	479,025
1992	26	25,816,485	4,529	1,901	4,014,692,380	542,736
1993	35	72,395,506	6,538	1,953	4,186,615,994	582,197
1994	41	135,272,990	9,433	2,017	7,753,004,776	611,291

Appendix B - Technologies in the Indonesian textile industry

Table B-1 Textile machinery in Indonesia, 1930 - 1995

Year	*Spinning*		*Weaving*						
					Shuttleless looms				
	Ring spindles (#)	*Open end rotors (#)*	*ATBM (hand loom) (#)*	*ATM (shuttle loom) (#)*	*Air-jet (#)*	*Water-jet (#)*	*Gripper (#)*	*Rapier (#)*	*Total (#)*
1930			257	44					
1940			44,000	8,000					
1950			71,997	11,390					
1955			78,857	12,697					
1960			150,000	16,869					
1965			324,000	27,000					
1966									
1967									
1968	481,780		166,000	35,335					
1969	481,780								
1970	481,780								
1971	481,780								
1972	552,468								
1973	631,284								
1974	729,620								
1975	869,660		66,000						
1976	1,238,500	10,216		72,579					351
1977	1,394,268								
1978	1,573,224								
1979	1,724,072								
1980	1,776,046								
1981	1,923,044								
1982	2,227,910								
1983	2,404,522								

Table B-1 (continued)

Year	***Spinning***		***Weaving***						
					Shuttleless looms				
	Ring spindles (#)	*Open end rotors (#)*	*ATBM (hand loom) (#)*	*ATM (shuttle loom) (#)*	*Air-jet (#)*	*Water-jet (#)*	*Gripper (#)*	*Rapier (#)*	*Total (#)*
1984	2,545,770	29,000		90,300					4,000
1985	2,545,770			90,498					4,579
1986	2,571,080								
1987	2,600,000			91,487	476	1,005		3,021	4,502
1988	3,480,000								
1989	4,903,513	24,588							
1990	5,108,000								
1991	5,500,000								
1992	5,729,545			91,934	5,004	5,014		7,398	17,416
1993	6,500,000	55,058							
1994	7,000,000	60,766							
1995				86,440	6,143	8,315		7,196	21,654

Notes on weaving machines:

Data for 1976 assuming that all machinery is imported (shipments)
For 1987, number of cop change looms is 17,556
Data for 1992 are taken from an age table.
Since not all machines are accounted for, the totals are multiplied by the same number as the ratio of accounted/total in 1995.

Sources:
Spinning: Ring spindles 1968-1994: Media Tekstil, Indonesian spinner's guide 1995, Jakarta, 1995
Open-end rotors: 1976 and 1984 from Media Tekstil, Industri serat sintetis Indonesia, 1988; 1989 from Media Tekstil, Indonesian spinner's guide 1991, 1991; 1993 from Media Tekstil, Indonesian spinner's guide 1995, 1995; 1994 from Indotextile, Perkembangan dan prospek industri pemintalan di Indonesia, 1995.
Weaving: 1976, 1984 and 1985 from Media tekstil, industri serat sintetis Indonesia, 1988; ATBM and ATM 1930-1968: Departemen perindustrian-Bank Indonesia, 1987; ATBM 1975: Hal Hill, 1992; 1987 from Departemen industri-Bank Indonesia, 1987; 1992 and 1995: Indotextile, Perkembangan dan prospek pasar mesin tenun di Indonesia, 1996.

Table B-2 A technology-index for the Indonesian textile sector, 1975-1995

	Spinning					***Weaving***						***Textile sector Technology index***	
	Ring spindles	*Open-end rotors*				*ATBMs*	*shuttle-looms*	*shuttle-less looms*					
Invest.* costs *(1993 US$)	126	1,911	***Share in capital stock***	***Technology index***		100	2,500	41,250	***Share in capital stock***	***Technology index***			
***Max. output** (index)*	100	442		***A***	***B***	14	100	603		***A***	***B***	***A***	***B***
***Vintage effect** (%)*			136.886		3.00				7064.21		1.00		
1975	869,660	7,868	0.10	100.0	100.0	78,500	67,924		0.90	100.0	100.0	100	100
1976	1,238,500	10,216	0.15	99.7	102.7	66,000	72,579	351	0.85	112.1	113.4	110	112
1977	1,394,268	12,564	0.18	100.0	106.1	49,500	74,794	807	0.82	128.4	131.4	123	127
1978	1,573,224	14,912	0.22	100.1	109.4	33,000	77,009	1,263	0.78	148.8	154.0	138	144
1979	1,724,072	17,260	0.26	100.3	112.9	16,500	79,224	1,719	0.74	175.0	183.2	156	165
1980	1,776,046	19,608	0.29	100.6	116.7	0	81,440	2,176	0.71	209.8	222.1	178	191
1981	1,923,044	21,956	0.30	100.8	120.3		83,655	2,632	0.70	214.0	229.1	180	196
1982	2,227,910	24,304	0.33	100.6	123.7		85,870	3,088	0.67	217.9	236.0	179	199
1983	2,404,522	26,652	0.34	100.7	127.5		88,085	3,544	0.66	221.6	242.7	181	204
1984	2,545,770	29,000	0.35	100.8	131.5		90,300	4,000	0.65	225.1	249.4	182	209
1985	2,545,770	28,118	0.34	100.6	135.3		90,498	4,579	0.66	230.5	258.2	186	216
1986	2,571,080	27,235	0.35	100.5	139.1		90,993	4,541	0.65	229.9	260.5	185	219
1987	2,600,000	26,353	0.35	100.4	143.1		91,487	4,502	0.65	229.3	262.7	185	221
1988	3,480,000	25,470	0.41	99.4	146.0		91,576	7,085	0.59	252.6	292.6	190	233
1989	4,903,513	24,588	0.49	98.7	149.3		91,666	9,668	0.51	274.6	321.7	189	238
1990	5,108,000	32,206	0.49	99.1	154.4		91,755	12,250	0.51	295.5	350.1	199	254
1991	5,500,000	39,823	0.50	99.4	159.5		91,845	14,833	0.50	315.3	377.8	207	268
1992	5,729,545	47,441	0.51	99.7	164.9		91,934	17,416	0.49	334.2	404.9	216	283
1993	6,500,000	55,058	0.54	99.8	169.9		90,103	18,829	0.46	346.9	425.0	214	288
1994	7,000,000	60,766	0.56	99.9	175.1		88,271	20,241	0.44	359.6	445.6	215	295
1995							86,440	21,654		372.5	466.7		

Sources: see table B-1, table III-4 and table III-7

Appendix C - Expert interviews

Arifin Suadipradja

Sekolah Tinggi Teknologi Tekstil (STTT), Bandung
(researcher and lecturer on the spinning industry at STTT Bandung)

1. The recent history of spinning technologies has seen an equal growth rate of ring spindles and open-end (OE) rotors. In fact, the ring spinning technology is still very much alive, with new side-technologies being regularly introduced. Much of these new side-technologies are already used in Indonesia. The OE technology has a higher productivity, but suffers from quality limitations. Since this technology is not able to produce the finest yarn, it is usually used for jeans production.

2. The most advanced technologies in spinning, mainly the friction spinning and the air-jet spinning, are not yet used in Indonesia. This is mainly because these technologies are still being developed. There is one mill in Jakarta that has AJ spindles, but they are currently not being used.

3. The lifetime of spinning machines, both ring spindles and OE rotors, is at least 20 years. In Indonesia ring spindles of 50 years and over are still being used in some factories. The efficiency of new machines is about 95%, of old machines still 80%.

4. There are differences in labour needs for the various technologies. For one OE machine (216 rotors), 1 or 2 operators are enough. For one ring spinning machine (400 spindles) 3 to 4 operators are required during the doving process, less can operate during other stages.

5. Productivity differences also exist. The installed capacity of a ring spindle is about 20,000 rpm, the capacity of an OE machine is 130,000 rpm. These figures can however not be used for comparison straight away since the data for ring spinning refer to winding, and OE data refer to twisting. The estimated productivity difference between the two technologies is factor two, and producitivity per employee is factor 4 (with OE machines being the more productive ones). Air-jet spinning can perform up to 10 times better than ring spinning.

6. All spinning machines in Indonesia are imported, mainly from Europe. There is not yet a spinning machine industry in Indonesia.

7. R&D on new technologies is non-existing in Indonesia. However, there are various mills conducting research on improving productivity, and modifying existing machines.

8. At the moment, Indonesia's comparitive advantage in low labour costs is partly offset by higher hidden costs. This situation could however improve, since the Bank of Indonesia is conducting research on how to improve the situation for organisations.

9. In the near future (next 5 years), Indonesia will not see the emergence of large mills using air jet or friction technology. After these technologies have been completely developed, they will be introduced in Indonesia. OE machines might grow faster than ring spinning equipment, but because of the quality

limitations they will not outnumber the ring spindles. Investment in ring spinning will still continue. R&D is expected to increase to reduce dependency on foreign technology.

10. Training and HRD are still low in the spinning industry. At most 10% of all companies organize regular training activities.

Wagimun Nitiwijoyo
STTT Bandung
(Director of STTT Bandung)

1. On the history of the weaving industry, it can be remarked that it is already very old in Indonesia. In the late twenties the first ATBMs were introduced, followed by the ATMs a few years later. In the late 60s, the change in government pollicies gave rise to the rapid overtake by ATMs. At the end of the 70s, the first OE rotors were introduced. Recently, there has been rapid investment in shuttleless looms, now growing much faster than shuttlelooms. New factories in Indonesia will now start with the latest technology, and not buy shuttlelooms. The introduction has been very rapid.

2. The lifetime of ring spindles is on average about 20-30 years, although very old machines are still in use. For the OE rotors, the same is expected, but this can not be said with certainty yet because of the recentness of this technology. For weaving shuttlelooms, the lifetime could be ranging from 20-50 years. In medium and high level industries, the lifetime is up to 20 years.

3. The labour needs for modern weaving technologies are less than for traditional looms (shuttlelooms). Shuttleless looms could theoretically be operated with 2.5 times less labourers, although this situation does not occur in Indonesia (no optimal efficiency).

4. Productivity differences also clearly exist. In speed, handlooms can produce about 0.5 m/h, ATBMs 1.5 m/h, shuttlelooms 5 m/h, and shuttleless looms 10-15 m/h. Recalculated to arrive at productivity differences per employee (shuttleloom = 1), ATBMs score 1/80, ATM 1, and shuttleless looms 2-4.

5. There is one weaving machine production company in Indonesia (PT Texmaco). It started in 1985 with shuttlelooms, and now produce also shuttleless looms like air jet and water jet looms.

6. Hidden costs can be a problem, because costs can be high. Management is at the moment still a problem. Since factories are built by traders and not by industrial people, there can be a lack of technological vision. Compared with Malaysia, there are many old industries in Indonesia. Sometimes replacing the old machinery can be a problem.

7. In the future, Indonesia will have to follow developments on the global market. New technologies that will be introduced have to be adopted. There are already many activities on this area. Much foreign investment is also present, most noteably from Japan and South Korea, investing in higher tech plants.

8. The level of human resources, noteably the technical HR, is still quite low. It is often difficult to mach manpower with the jobs. Training is still low in Indonesian textile; of the 2300 or so textile companies, perhaps 10% conduct regular training. The government takes a role in HRD as well, since training is provided. The department of labour and also industry are involved. It is however not enough. Training is often part of the personnel department. Normally, new employees are trained by following coworkers on the job.

9. There is a definite relation between size an modernity. Bigger plants, with larger capital, have more modern technologies and better skilled people.

10. The LTR can be high. In the smaller parts, it can be up to 10%. In the more modern companies, it is generally lower. This high level of LTR provides a problem for training. Time can also be a constraint.

11. The modern companies prefer operators with SMA. Less modern factories also take in less educated employees.

12. There is definite relation between advancedness of a factory and the level of education demanded for employees.

13. R&D activities are still low, and skilled people are still hard to find. Foreign companies conduct R&D in the home country. In the future, R&D activities are expected to increase.

Fritz Kidarsa
Bandung
(Textile technology and management consultant)

1. In the last 5 years or so, the weaving industry has very rapidly started to use the most modern technologies, as has the spinning industry. This also because quality demands are high in the industry, and wages have risen over the last years. The shuttlelooms dating back to before 1985 are not able to deliver the demanded quality anymore. Their yields are 30% grade A, 60% grade B and 10% grade C. Newer shuttlelooms yield 65% grade A, 35% grade B and 5% grade C. New factories only buy modern technologies, traditional shuttlelooms are even hard to get nowadays. The water-jet technology is used espeically for syntetic fibres. In some ways, the direct operation of the modern machines has become easier; there are indicators telling the operators when to apply maintenance. In spinning, the OE technology died almost completely about two years ago (1993-1994), and is now again rising becuase of the recent jeans boom.

2. The lifetime of traditional shuttlelooms is 20-30 years. However, machines of 40 years are also still used in the smaller factories. The modern technologies in weaving have a lifetime of only 5-10 years. After this period, the efficiency drops but the machines still have a scrap value, so they are replaced by newer ones. In spinning, many old ring spindles can still be found. For the OE machines, no lifetime can be given yet.

3. Producicitivity per worker of texile machines:
ATBM - 1 m/workerhour
shutteloom - 40 m/workerhour
rapier - 250 m/workerhour
AJL - 400-500 m/workerhour
WJL - 400 m/workerhour (only syntetic)
Ring spindles - 1
OE rotors - 2

4. Labour needs per 100 units (weaving parts or spindles):
ATBM - 100-120
shutteloom - 8-9
AJL - 5
WJL - 5
rapier - 5
Ring spindles - 5
OE rotors - 3-4

5. Rapier machines are already produced in Indonesia (Texmaco). Shuttlelooms have not been produced there. Texmaco is at the moment doing air-jet production as well. There is cooperation between Texmaco and Sower (Fr.), that started in 1993. R&D is now carried out in France on replacing the band system with a telescopic one.

6. The weaving industry will in the future continue its rapid replacement of old machinery. Shuttlelooms are even hard to get now. Rapier machines have the benefit of softer cloth, while water-jets are only used for syntetic fibre.

7. MFA and export quotas can in the future become a problem for the textile industry. However, the competition from other low-wage countries (Bangladesh, Vietnam, China) is also a problem. The US will probably retain its cotton-biased quotas, since they are the producers of cotton used in Indonesia.

8. Hidden costs can be a problem for companies. However, it will be very difficult to solve this problem, since it is very interwoven in the Indonesian businesses. They are not expected to decline sharply in the near future.

SDM

1. In general, training activitities are still very low. New employees are often expected to learn the job themselves. For new technology, training is given, usually by the producers of the new machines. Especially for the lower level (operators), training is not often given. For higher management, training is conducted. This also interacts with the observation that new technology require more skilled maintenance workers, but are less demanding for the operators.

2. Large factories are in general the more modern ones. The decisive factor is often the starting capital. With large capital, big investments in modern equipment are possible. Nowadays, it can be said that 'the small industries are eaten by the big industries' (smaller industries are either disappearing or becoming large factories).

3. Training activities and efforts have been improving over the years, but are still low.

4. The LTR of private companies is very high, from 5% to 8% a year. The LTR is also seen as an obstacle in training provision. The LTR is especially high in the lower management (operators etc.). In the higher regions, it is not. This coincides with the higher level of training provision in the industry for higher management.

5. The law, and thus the government, is often 'running behind the facts', and is often too late in adequately codifying apt laws. Many companies have their own way of negotiating with the employers, and draft their own contracts. Even with the minimum wage recently introduced in Indonesia, this still happens a lot.

6. The lower level employees can have any education from SD to SMA. The middle level management will probably have an SMA education, while the top management is from university or ST(TT). There is a relation between educational requirements and advancedness of the technology that is used in a factory. It is also noted that the low tech textile factories are disappearing, thus educational requirements rise.

7. R&D is already carried out in the textile industry. There is some on technology, and a lot on energy saving. Energy requirements of modern technology are much lower than that of traditional machines. There are already laboratories in the bigger factories. R&D is also carried out on waste , efficiency, design and others.

8. The biggest problem for the textile industry at this point is marketing. The big export boards already exist, but are not enough. Purchasers still go from factory to factory to bargain. The bargaining position of the factories is thus quite bad, because of the dividedness. There is need of organisation of the producers to increase this bargaining power.

9. It can be concluded that the textile industry in Indonesia is 'growing up'. The standard technologies, used for standard quality and low cost production are slowly moving to other countries. The higher tech factories survive and still grow. This comes with increase in advancedness of machinery, higher SDM requirements and more R&D carried out.

Appendix D - Human Resources in the Indonesian textile industry

Table D-1 Educational attainment of the total industrial manufacturing workers, 1975-1995

	no schooling	*not yet completed primary school*	*primary school*	*junior high school*	*senior high school*	*diploma I/II*	*academy/ diploma III*	*university*	*total*
Avg.	0	3	6	9	12	13.5	15	16	
1975									
1976	1,138,665	1,495,252	617,999	143,905	143,102		14,440		3,553,363
1977	1,128,719	1,546,008	1,068,556	252,466	156,824		12,367	6,348	4,171,288
1978	1,186,052	1,504,795	813,391	196,654	142,756		11,912		3,855,560
1979									
1980									
1981									
1982	1,495,154	2,006,408	1,753,412	403,805	337,665		13,014	10,882	6,020,340
1983									
1984									
1985									
1986	814,819	1,487,078	2,012,136	653,781	593,068	4,419	24,341	16,329	5,605,971
1987	710,680	1,492,295	2,160,634	663,118	673,415	7,511	53,600	27,201	5,788,454
1988	669,643	1,456,848	2,305,320	798,693	700,498	10,994	35,727	18,744	5,996,467
1989	829,352	1,785,858	2,834,227	869,965	868,084	12,606	34,820	26,578	7,261,490
1990									
1991	726,351	1,512,875	3,098,734	1,218,412	1,266,644	13,252	57,451	52,631	7,946,350
1992	753,262	1,565,603	3,205,257	1,322,133	1,279,414	15,811	57,069	56,947	8,255,496
1993	826,951	1,674,214	3,411,526	1,278,859	1,397,807	27,274	67,257	87,368	8,771,256
1994	818,686	2,025,020	4,270,174	1,654,669	1,843,317	19,661	104,750	103,918	10,840,195
1995	823,105	1,895,456	3,602,256	1,451,434	2,011,626	21,925	99,318	121,927	10,027,047

Note: Data refer to *'population of 10 years and over who worked during the previous week'*.

Sources: All years BPS, Keadaan angkatan kerja di Indonesia, appropriate years; except 1993: BPS, Keadaan angkatan kerja di Indonesia, May 1993.

Table D-2.1 Eduational attainment and income of the Indonesian labour force, 1977

income category	*average*	*no schooling*	*not yet completed primary school*	*primary school*	*junior high school*	*senior high school*	*diploma I/II*	*academy/ diploma III*	*university*	*total*
<3000	3,000	1,035,287	701,471	248,945	15,930	10,991		283		2,012,907
3000 - 4999	4,000	1,218,596	1,089,254	525,680	37,318	16,116		1,648		2,888,612
5000 - 6999	6,000	683,721	850,465	562,141	49,354	33,063		995	283	2,180,022
7000 - 9999	8,000	570,880	1,028,237	812,788	84,951	42,679		122	42	2,539,699
10000 - 14999	12,500	358,603	773,260	759,266	174,427	107,372		2,924	3,133	2,178,985
15000 - 19999	17,500	236,814	527,396	599,378	216,001	174,047		9,443	972	1,764,051
20000 - 29999	25,000	51,934	306,008	527,581	251,597	339,648		24,514	2,406	1,503,688
30000 - 39999	35,000	21,475	99,174	245,043	214,313	302,978		23,224	5,959	912,166
40000 - 49999	45,000	7,020	19,659	72,125	125,724	107,164		29,181	11,111	371,984
50000 - 74999	62,500	3,447	11,384	58,235	86,734	141,320		40,327	25,563	367,010
75000 - 99999	87,500	2,062	5,602	13,032	12,317	32,464		18,764	15,034	99,275
100000 - 149999	125,000	587	1,271	2,018	3,969	13,867		6,075	10,583	38,370
150000 - 249999	200,000		42	806	929	5,198		822	7,418	15,215
250000 - 299999	275,000			226	241	898		522	1,602	3,489
300000+	300,000	7,392	3,430	2,822	1,062	4,770		730	2,604	22,810
Average income per educational attainment		7,225	9,801	14,406	26,785	33,820		52,663	89,589	14,358

Source:
BPS, Keadaan angkatan kerja di Indonesia, 1977

Table D-2.2 Eduational attainment and income of the Indonesian labour force, 1990

income category	*average*	*no schooling*	*not yet completed primary school*	*primary school*	*junior high school*	*senior high school*	*diploma I/II*	*academy/ diploma III*	*university*	*total*
< 10000	10,000	103,415	131,185	76,676	7,830	17,305	45	459	0	336,915
10000 - 14999	12,500	160,274	179,361	131,443	17,818	32,062	46	0	282	521,286
15000 - 19999	17,500	217,455	277,319	291,405	36,357	54,155	1,957	3,516	855	883,019
20000 - 24999	22,500	215,214	321,613	363,255	58,346	53,205	850	4,503	639	1,017,625
25000 - 29999	27,500	126,253	274,417	347,414	62,632	52,470	1,309	1,416	898	866,809
30000 - 39999	35,000	315,703	641,409	924,435	202,090	149,910	4,009	4,475	1,751	2,243,782
40000 - 49999	45,000	195,641	445,905	747,775	178,702	194,736	2,874	4,381	1,956	1,771,970
50000 - 74999	62,500	210,651	718,383	1,433,672	544,088	711,938	18,280	16,716	11,464	3,665,192
75000 - 99999	87,500	118,966	440,371	1,050,654	531,265	1,033,845	39,831	39,932	32,649	3,287,513
100000 - 149999	125,000	69,948	250,891	738,283	490,185	1,398,737	88,343	99,016	91,901	3,227,304
150000 - 199999	175,000	24,131	62,971	252,477	251,292	875,398	39,923	94,276	114,235	1,714,703
200000 - 249999	225,000	11,223	16,206	68,884	85,150	333,751	22,890	63,248	68,773	670,125
250000 - 299999	275,000	3,273	11,533	25,906	31,032	167,549	8,015	46,465	51,775	345,548
300000+	300,000	8,966	7,269	28,339	39,501	199,537	12,629	97,392	129,974	523,607
Average income per educational attainment		43,606	53,063	67,952	96,350	125,545	141,743	189,579	204,994	87,944

Source: BPS, Keadaan pekerja/karyawan Indonesia, 1990

Table D-3 Completed questionnaires by Indonesian textile firms

I - GENERAL INFORMATION

Coding number:	1	2	3	4	5
1. Name:	xxxx	xxxx	xxxx	xxxx	xxxx
2. Address:	xxxx	xxxx	xxxx	xxxx	xxxx
3. Year of establishment:	1965	1974	1973	1989	1977
4. Ownership:	private	private	private	private	private
5. Activities:	weaving	weaving	spinning, weaving	spinning, weaving	weaving
6. Range of products:		kain jadi gorden			25% exported, 75% local; 100% polyester, 80% printing-20% dyeing
7a.Total number of employees:	2560	220	2179	885	2518
7b.Female employees:	1270		1060	330	832
7c.Male employees:	1290		1119	555	1686
7d.Average age:	25		24	23	24
7e.Average education:	SMU		SMP/SMU	SMP/SMA	SMA/SMP
9. Estimated assets (Rp.):		20 billion		80 billion	80 billion

8a.Annual production (yard):	60 million	5.5 million	10,621,806 (kain jadi) 12,865,508 (kain grey)	45,000,000 spinnning: 9,600 ton	30 million
8b.Annual sales (Rp.):	25.5 billion	23.375 billion		80% of prodution	78.7541501 billion
Remarks:	annual sales based on unit price for cloth (Rp. 4,250 per yard)	personnel data forthcoming			

II - TECHNOLOGY

Coding number:	1	2	3	4	5
1a.Types of machines:		a - shuttlelooms b - rapier	a - ring spindle b - shuttleloom c - air jet loom d - water jet loom	a - ring spindle b - OE rotor	
1b.Total number of machines:		a - 110 b - 10			520
1c.Number of operators:		a - 200 b - 20			
1d.Year of purchase:		a - 1974-1990 b - 1995			
1e.Expected lifetime (years):		a - 20 b - 20			
1f.Price of machines (Rp.):					

1g.Capacity (yard per year):		a - 2.574 million b - 2.926 million			
2. History of technology used:	expansion has been accomplished in phases; in every phase modern technology was acquired	shuttlelooms have been gradually acquired; in 1995 more modern technology was bought		in 1989, waterjet looms were introduced; in the period 1993-1996 various replacements were made	
3a.Investment plans:	not yet available	in 1997 a restructuring is planned in which old shuttlelooms are replaced by newer ones	not yet available, since there has been investment in 1995	depending on the market and consumers (extern); computerisation of production efficiency counting/weaving (intern)	
3b.Expectations for textile industry:	yes	developments will be fast; following world market	yes	management problems will keep being straightened out	with new technology the sector will grow, on condition that the quality of the human resources will follow
4. Technology differentiation for products:	Not certain; mostly it is not strived for	technologies can be used interchangeably	various machines are used in one process	WJL - filament OMNI - dobby DELTA - filament/plan TOYODA - plan	different cloth requires different machines
5. Productivity/ efficiency differences;	Yes; New technology is a lot faster	yes, big differences; the rapiers are a lot faster, better and efficient	no	yes, because the result of the production is partly determined by the market/consumers	yes, the more modern the machine the better the efficiency.
Remarks:		the high costs for importing and exporting, bot official and hidden, are a			

		main problem for the developments of the textile industry			

III - HUMAN RESOURCES

Coding number:	1	2	3	4	5
1. Training new employees:	yes	yes	yes	yes	yes
1a.Trainees:	all new employees	new employees	new employees	new operators	new employees
1b.Training contents:	general orientation for everyone; on-the-job training for operators. Objects: rules of the company, work safety, working standards, operation of machines	technical introduction, operation of machines, problem handling	discipline, working rules	discipline, motivation, skills, work safety	standard orientation of new employees
1c.Training time:	average 2-3 weeks	3 months, during working - 2 hours before entering, 1 hour after finishing	2 days	2 weeks	3 months
2. Training for new technology:	yes	yes	yes	yes	yes
2a.Trainees:	employees that will be operating the new technology	operators and technicians	operators and supervisors	old and new workers	operators, technicians and supervisors
2b.Training contents:	working standards, features of new	operating and maintenance of the	operating and maintenance of the	introducing the new technology, way of	control of the new technology

	machines	new machines	new machines	working, problems solving	
2c.Training time:	2-3 weeks	first 2 weeks with foreign experts, after that 6 months of on-the-job training (carried out by head of maintenance	on-the-job	dependent on what is needed to understand the basics of the new technology	1-3 months
3. Other training:	yes	yes	yes	yes	yes
3a.Subject of training:	leadership, planning and control, problem-solving and decision-making	management, administration, discipline, motivation	supervisory training, leadership skill building, motivation and discipline	leadership	increasing productivity, leadership, problem-solving, organisation of work
3b.Trainees	middle and higher management	head of divisions	supervisors	middle-level management	middle- and high level management
3c.Training contents:	ways of leadership, planning and taking decisions well and effectively	management, adminstration, discipline and motivation	methods of supervising, communication methods, problem-solving and decision-taking	motivation, leadership, problem-solving, safety	practical but conceptual material, e.g. HRM, leadership, supervisory management, problem-solving, decision-making, communication etc.
3d. Training time:	1 week (about 20 hours)	continually, normally one week at the time	48 hours	4-8 meetings	1 week-2 months
4a.Start training programs (year):	1991	1994	1990	1994	1995
4b.HRM department - establishment:	yes; for a long time	yes; effective since 1994	no	yes; since 1996	yes

4c.Expansion training activities in the past:	yes; most importantly by using more scienti-fic/professional ways in supplying and expanding HRD	yes; general improvement since the start	yes; TQC and sending employees to seminars or workshops	yes; the working discipline has started to improve, efficiency and effectivity are doing well	
5a.Labour Turnover Ratio (per year):	12%	10%	2.22%	10%	12.7%
5b.Role of LTR in HRD:	not yet felt, because the labourers are replaced a lot, usually the operators	yes; more training is needed because of the high number of new employees		yes; we try to use the workforce optimally and not replace workers that have left	if the LTR is high, training focusses on loyalty, sense of belonging
6. Importance of training: 6a.New employees: 6b.New technology: 6c.General productivity:	2 2 1	2 2 1	1 2 1	2 2 2	0 2 1
7. Annual expenditures on training activities (Rp.)	20,000,000	10,000,000	40,000,000	50,000,000	100,000,000
8. Estimate of benefits of training compared with costs: 8a.New employees: 8b.New technology: 8c.General productivity:	1 1 1	2 1 -1	1 1 1	1 1 1	1 1 1
9a.Cultural factors in HRD:	there is not yet a culture of continuous learning in the	there are about 60% Javanese employers in the firm, since they are generally		yes	training programs take the cultural roots of the workers into their contents,

	workforce	more motivated and industrious			so that workers can adapt to and understand the company culture
9b.Environmental factors in HRD:	training programs are not yet popular with every industry in the area	no		yes, society	training in changing the orgininal way of thinking of the workers - from agricultural to industrial
9c.Industrial relations in HRD:	no problems	there is a need for good industrial relations for training programs		yes	
9d.Other factors:	the costs are rather high	education	education	government	government policies
Remarks:		Since the start of training programs with the coming of a new manager (1994), the company has seen its productivity improve substantially			

IV - LINKAGES

Coding number:	1	2	3	4	5
1. Change in education over last 25 years:		about 60% in the last 3 years			used to be dominated by SD, in the last 5 years

					changed to SLTA
2a.Education - capabilities: 2b.Education - need for training for new technology: 2c.Education - time of training:	0 -1 1	1 -2 0	0 1 -1	0 -2 1	0 -2 0
3. Necessity of training for new technology:	1	2	2	2	1
4a.Main factors in decisions on new technology:		money, HR, future challenge		costs, readiness of the HR	HR, budget, efectivity and efficiency
4b.Role of HR in decisions on new technology:	1	2	2	1	2
5.Effectiveness training programs 5a.Reliability machines: 5b.Availability machines: 5c.Utilisation machines:	0 0 0	-1 0 0	0 1 0	0 0 0	
6. Effectiveness training programs 6a.Total productivity: 6b.Management productivity: 6c.Administration productivity: 6d.Workfloor	0 0 0 0	0 1 1 0	0 0 1 1	0 0 0 0	0 0 0 0

productivity:					
7a.Influence government in decisions new technology:	not	high costs for imports, bureaucracy		External factors when introducing new technologies	-
7b.Influence government in decisions training programs:	very little, mainly SDP and WALATRA	little motivation, little backup for training efforts	cooperation with SDP unit Jawa Barat	little help in carrying out training	-
7c.Influence government in decisions new investments:	regulations for new investments	high costs for imports, high level of political stability		ease of finance/credit facilities	-
7d.Influence government in other ways:	not	not		Regional Minimum Wage	-
Remarks:					

Table D-4 HRD index for the Indonesian textile industry, 1975-1995

	Expenditures per worker *(1996 Rp)*	***HRD returns*** *(accrued)*	***HRD index***	***P0*** *(current prices)*	***Wholesale price index*** *incl. petr.*	*excl. petr.*	*consumer prices*	***Interest rates*** *money market*	*deposit rate*	*lending rate*	*adjusted for inflation*
1975	0	0	100.0	385000							
1976	0	0	100.0								
1977	0	0	100.0								
1978	0	0	100.0								
1979	0	0	100.0								
1980	0	0	100.0								
1981	2,098	0	100.0								
1982	4,196	321	100.0								
1983	6,294	931	100.1								
1984	8,392	1,802	100.1								
1985	10,490	2,907	100.2								
1986	12,588	4,223	100.3								
1987	14,686	5,730	100.3								
1988	16,784	7,409	100.4								
1989	18,881	9,242	100.6		90.9	93.6	92.8	12.57	18.63	21.70	11.43
1990	20,979	11,215	100.7		100.0	100.0	100.0	14.37	17.30	20.61	7.90
1991	23,077	13,313	100.8		105.1	107.4	109.4	15.12	23.27		14.97
1992	25,175	15,524	100.9		110.6	113.9	117.7	12.14	20.37	24.03	9.07
1993	27,273	17,836	101.1		114.7	121.9	129.0			20.24	
1994	29,371	20,149	101.2		120.9	134.6	140.0				
1995	31,469	22,462	101.4		137.0	153.7	153.2				
1996	33,567	24,775	101.5	1,655,000							

Sources:
Wholesale price indices and interest rates: IMF, International Financial Statistics, May 1996.
Expenditures per worker: questionnaires
Base year productivity: appendix table A-1 (GVA per employee)

Appendix E - Growth accounting for the Indonesian textile industry

Table E-1 Total working hours on main job of the total industrial manufacturing labourforce, 1975-1995

Interval	*0*	*1*	*5*	*1*	*10*	*15*	*20*	*10*	*25*	*35*
(hours)	*0*	*4*	*9*	*9*	*14*	*19*	*24*	*24*	*34*	*44*
Avg.	*0.0*	*2.5*	*7.0*	*5.0*	*12.0*	*17.0*	*22.0*	*17.0*	*29.5*	*39.5*
1975										
1976	51,888			72,242				508,942	454,691	
1977										
1978										
1979										
1980										
1981										
1982	54,174			171,207				1,219,739	804,090	1,228,228
1983										
1984										
1985										
1986	42,004			148,970				844,542	621,186	1,486,432
1987	55,520			115,415				795,222	701,485	1,559,942
1988	64,594			105,825				782,356	639,750	1,804,211
1989	130,963			155,629				994,768	796,787	1,999,322
1990										
1991	65,172	19,870	100,469		254,099	205,163	405,799		837,158	2,039,449
1992	78,729	18,864	130,553		277,815	259,338	511,883		879,395	2,050,816
1993	124,094	32,461	149,447		300,524	320,508	492,018		888,378	2,138,093
1994	109,185	36,175	149,891		354,603	381,700	664,397		1,378,977	2,896,862
1995	95,494			165,105				1,162,598	1,009,226	2,688,436

Note: data refer to *'population of 10 years and over who worked during the previous week'.*

Sources: All years BPS, Keadaan angkatan kerja di Indonesia, apprpriate years, except 1993: BPS, Keadaan angkatan kerja di Indonesia, May 1993

Table E-1 (continued)

Interval *(hours)* **Avg.**	*45* *54* *49.5*	*55* *59* *57.0*	*45* *59* *52.0*	*60* *74* *67.0*	*75* *+* *75.0*	*60* *+* *60.0*	*total*	*Average hours worked*	*Annual average hours worked*	*Average hours worked index*
1975									42.70	100.0
1976	1,905,185					512,854	3,505,802	42.07	42.07	98.5
1977									41.45	97.1
1978									40.83	95.6
1979									40.21	94.2
1980									39.59	92.7
1981									38.96	91.3
1982			1,904,969			622,474	6,004,881	38.34	38.34	89.8
1983									38.71	90.7
1984									39.09	91.5
1985									39.46	92.4
1986			2,075,780			387,057	5,605,971	39.83	39.83	93.3
1987			2,188,703			361,442	5,777,729	40.14	40.14	94.0
1988			2,158,934			440,797	5,996,467	40.47	40.47	94.8
1989			2,716,997			467,024	7,261,490	39.86	39.86	93.4
1990									40.90	95.8
1991	2,796,990	926,599		213,336	82,246		7,946,350	41.93	41.93	98.2
1992	2,838,192	627,473		501,280	81,158		8,255,496	41.53	41.53	97.3
1993	3,098,828	625,257		526,460	75,188		8,771,256	41.23	41.23	96.6
1994	3,391,757	1,046,920		281,811	147,917		10,840,195	40.51	40.51	94.9
1995			4,177,765			828,423	10,127,047	41.82	41.82	97.9

Table E-2 Number of core-machines in the Indonesian textile industry, 1975-1994

	Spinning				***Weaving***					***Textiles***
	Ring spindles	*OE rotors*	*Total*		*ATBM*	*Shuttle-looms*	*Shuttle-less looms*	*Total*		*Total (1990 weights, constant million Rp)*
Investment costs	125.70	1,911.00			100	2,500	41,250			
1990 weights (for subsectors)			136.89					7,064.21		
1975	869,660	7,868	877,528	0.10	78,500	67,924	0	146,424	0.90	1,154,487
1976	1,238,500	10,216	1,248,716	0.15	66,000	72,579	351	138,930	0.85	1,152,361
1977	1,394,268	12,564	1,406,832	0.18	49,500	74,794	807	125,101	0.82	1,076,316
1978	1,573,224	14,912	1,588,136	0.22	33,000	77,009	1,263	111,273	0.78	1,003,445
1979	1,724,072	17,260	1,741,332	0.26	16,500	79,224	1,719	97,444	0.74	926,726
1980	1,776,046	19,608	1,795,654	0.29	0	81,440	2,176	83,615	0.71	836,473
1981	1,923,044	21,956	1,945,000	0.30		83,655	2,632	86,286	0.70	875,786
1982	2,227,910	24,304	2,252,214	0.33		85,870	3,088	88,958	0.67	936,710
1983	2,404,522	26,652	2,431,174	0.34		88,085	3,544	91,629	0.66	980,077
1984	2,545,770	29,000	2,574,770	0.35		90,300	4,000	94,300	0.65	1,018,604
1985	2,545,770	28,118	2,573,888	0.34		90,498	4,579	95,077	0.66	1,023,972
1986	2,571,080	27,235	2,598,315	0.35		90,993	4,541	95,533	0.65	1,030,537
1987	2,600,000	26,353	2,626,353	0.35		91,487	4,502	95,989	0.65	1,037,596
1988	3,480,000	25,470	3,505,470	0.41		91,576	7,085	98,661	0.59	1,176,812
1989	4,903,513	24,588	4,928,101	0.49		91,666	9,668	101,333	0.51	1,390,426
1990	5,108,000	32,206	5,140,206	0.49		91,755	12,250	104,006	0.51	1,438,337
1991	5,500,000	39,823	5,539,823	0.50		91,845	14,833	106,678	0.50	1,511,916
1992	5,729,545	47,441	5,776,986	0.51		91,934	17,416	109,350	0.49	1,563,257
1993	6,500,000	55,058	6,555,058	0.54		90,103	18,829	108,931	0.46	1,666,807
1994	7,000,000	60,766	7,060,766	0.56		88,271	20,241	108,513	0.44	1,733,073
1995						86,440	21,654	108,094		

Sources: Appendix table B-1 and chapter III

Table E-3.1 Contribution of labour inputs to growth in gross value added, 1975-1994

	Gross VA (constant thousand Rp)	Employment (#)	Employment contribution	Average hours worked	Average hours worked effect	Average hours worked contribution	Labour inputs: educational attainment	educational attainment effect	educational attainment contribution	HR index	HRD effect	HRD contribution	Average (1-a)	Total inputs	Total inputs contribution
1975	238,181,946	186,350		100.0	0		100.0	0		100.0				186,350	0
1976	315,151,545	211,716	12,649,650	98.5	-3,082	-1,537,113	100.0	0	0	100.0	0	0	0.39	208,634	11,112,536
1977	287,084,833	219,248	4,209,122	97.1	-6,387	-1,846,798	105.8	12,370	6,912,752	105.8	0	0	0.37	225,231	9,275,076
1978	362,995,537	214,305	-2,350,297	95.6	-9,366	-1,416,482	101.8	3,661	-4,140,724	101.8	0	0	0.37	208,600	-7,907,503
1979	385,158,720	211,064	-1,897,372	94.2	-12,300	-1,717,750	104.1	8,167	2,637,726	104.1	0	0	0.34	206,931	-977,395
1980	480,631,612	228,036	9,660,502	92.7	-16,613	-2,454,540	106.4	13,597	3,090,855	106.4	0	0	0.31	225,021	10,296,817
1981	492,500,552	234,799	4,589,353	91.3	-20,527	-2,656,303	108.8	18,757	3,501,103	108.8	0	0	0.32	233,029	5,434,153
1982	538,603,918	233,139	-1,170,755	89.8	-23,779	-2,293,833	111.1	23,189	3,125,793	111.1	41	28,633	0.33	232,589	-310,163
1983	520,096,583	226,454	-5,297,195	90.7	-21,119	2,108,229	115.9	32,572	7,435,286	115.9	116	59,358	0.34	238,023	4,305,678
1984	786,426,799	240,393	9,368,532	91.5	-20,318	538,076	120.6	45,445	8,651,832	120.8	240	83,376	0.31	265,759	18,641,816
1985	1,012,617,463	298,652	45,430,011	92.4	-22,633	-1,804,859	125.4	70,209	19,311,438	125.6	485	191,221	0.26	346,713	63,127,812
1986	1,331,506,485	310,247	8,408,289	93.3	-20,801	1,328,632	130.2	87,480	12,524,051	130.5	739	184,080	0.25	377,665	22,445,051
1987	1,265,358,154	326,202	13,022,651	94.0	-19,543	1,026,079	135.0	107,347	16,215,876	135.4	1,062	263,774	0.23	415,068	30,528,380
1988	1,346,245,772	355,209	22,444,829	94.8	-18,514	796,311	136.0	121,201	10,719,991	136.4	1,507	344,718	0.25	459,403	34,305,848
1989	2,205,926,148	397,691	29,090,831	93.4	-26,377	-5,384,527	135.0	130,002	6,026,419	135.6	2,074	387,776	0.23	503,389	30,120,499
1990	2,323,020,352	416,400	16,864,534	95.8	-17,538	7,968,024	141.5	165,370	31,881,012	142.1	2,703	567,185	0.21	566,935	57,280,757
1991	2,794,333,333	479,025	61,287,277	98.2	-8,579	8,767,424	147.9	225,388	58,736,062	148.7	3,784	1,058,324	0.24	699,618	129,849,087
1992	3,784,245,125	544,984	74,124,931	97.3	-14,894	-7,097,107	147.9	254,018	32,174,834	148.9	4,972	1,335,000	0.28	789,080	100,537,658
1993	3,946,108,696	582,192	50,736,306	96.6	-20,032	-7,005,258	148.7	274,052	27,318,421	149.8	6,059	1,481,415	0.28	842,271	72,530,883
1994	7,056,094,987	611,291	29,935,966	94.9	-31,282	-11,573,980	152.2	302,687	29,458,290	153.4	7,061	1,031,742	0.22	889,757	48,852,019
Sum of contributions (75-94)			381,107,166			-24,255,773			275,581,017			7,016,601			639,449,011

Source:
Gross Value Added: appendix table A-1
Average hours worked: appendix table E-1
Human Resources-index: chapter IV

Table E-3.2 Contribution of capital inputs to growth in value added

	Gross VA (constant thousand Rp)	*Total machines (#)*	*contribution*	*Technology-index: shift effect*	*effect*	*contribution*	*advance effect*	*effect*	*contribution*	*Avg. (a)*	*Total inputs*	*contribution*
1975	238,181,946	1,154,487		100.0	0		100.0	0			1,154,487	0
1976	315,151,545	1,152,361	-267,398	110.3	118,317	14,886,093	111.8	17,751	2,233,289	0.61	1,288,429	16,851,984
1977	287,084,833	1,076,316	-11,719,380	123.3	251,237	20,484,311	126.9	37,928	3,109,602	0.63	1,365,481	11,874,533
1978	362,995,537	1,003,445	-9,605,583	138.3	384,062	17,508,474	144.3	60,898	3,027,707	0.63	1,448,404	10,930,598
1979	385,158,720	926,726	-12,758,625	155.8	517,002	22,108,372	165.1	86,187	4,205,815	0.66	1,529,915	13,555,563
1980	480,631,612	836,473	-15,772,963	177.7	650,344	23,303,371	191.1	112,016	4,513,961	0.69	1,598,834	12,044,368
1981	492,500,552	875,786	8,063,521	179.6	697,019	9,573,309	196.1	144,236	6,608,559	0.68	1,717,042	24,245,390
1982	538,603,918	936,710	11,643,353	179.3	743,050	8,797,306	199.1	184,768	7,746,236	0.67	1,864,529	28,186,895
1983	520,096,583	980,077	8,240,721	180.6	789,604	8,846,246	203.6	225,896	7,815,140	0.66	1,995,577	24,902,108
1984	786,426,799	1,018,604	6,952,442	182.1	836,302	8,427,053	208.6	269,611	7,888,701	0.69	2,124,517	23,268,196
1985	1,012,617,463	1,023,972	1,463,462	185.8	878,775	11,578,973	215.9	307,983	10,461,262	0.74	2,210,730	23,503,696
1986	1,331,506,485	1,030,537	2,260,467	185.2	878,492	-97,392	218.6	343,471	12,218,987	0.75	2,252,500	14,382,062
1987	1,265,358,154	1,037,596	3,206,821	184.6	878,194	-135,172	221.3	380,112	16,645,192	0.77	2,295,903	19,716,841
1988	1,346,245,772	1,176,812	57,252,400	190.1	1,060,650	75,034,663	232.9	502,750	50,434,547	0.75	2,740,211	182,721,611
1989	2,205,926,148	1,390,426	80,423,284	189.2	1,240,891	67,858,729	238.1	678,672	66,232,795	0.77	3,309,990	214,514,807
1990	2,323,020,352	1,438,337	25,362,018	199.4	1,429,924	100,065,531	254.4	790,436	59,162,872	0.79	3,658,697	184,590,422
1991	2,794,333,333	1,511,916	35,559,617	207.0	1,618,192	90,987,586	268.3	926,857	65,930,424	0.76	4,056,966	192,477,626
1992	3,784,245,125	1,563,257	25,412,617	215.6	1,807,123	93,515,977	283.5	1,061,433	66,611,798	0.72	4,431,813	185,540,392
1993	3,946,108,696	1,666,807	63,278,713	213.9	1,898,022	55,548,625	287.7	1,230,426	103,270,831	0.72	4,795,255	222,098,168
1994	7,056,094,987	1,733,073	42,557,787	214.8	1,989,164	58,533,121	294.8	1,386,350	100,137,545	0.78	5,108,587	201,228,453
Sum of contributions ('75-'94):			321,553,274			686,825,177			598,255,264			1,606,633,716

Sources:
Gross value added: appendix A; (a): table E-3.1; core-machines: table E-2; technology-index: see chapter III.

Table E-4.1 Growth accounting for the Indonesian spinning sector, 1975-1994

	Labour inputs					*Capital inputs*							*Value Added*		
	Employment (#)	*Labour inputs A*	*Labour inputs B*	*(1-a)*	*avg. (1-a)*	*machines (#)*	*Technology index A*	*Technology index B*	*Capital inputs A*	*Capital inputs B*	*(a)*	*avg. (a)*	*current prices (thousand Rp)*	*index*	*constant prices (thousand Rp)*
1975	20,559	20,559	20,559	0.31		877,528	100.0	100.0	877,528	877,528	0.69		10,914,310	30.1	36,260,166
1976	33,024	32,543	32,543	0.39	0.35	1,248,716	99.7	102.7	1,245,464	1,282,828	0.61	0.65	13,531,154	31.0	43,648,884
1977	30,805	31,646	31,646	0.21	0.30	1,406,832	100.0	106.1	1,406,667	1,492,333	0.79	0.70	24,581,598	33.4	73,597,599
1978	38,781	37,749	37,749	0.23	0.22	1,588,136	100.1	109.4	1,590,368	1,737,838	0.77	0.78	35,980,374	35.2	102,216,972
1979	39,026	38,262	38,262	0.19	0.21	1,741,332	100.3	112.9	1,746,797	1,966,036	0.81	0.79	54,138,958	46.1	117,438,087
1980	43,309	42,736	42,736	0.15	0.17	1,795,654	100.6	116.7	1,807,294	2,095,150	0.85	0.83	97,350,339	54.8	177,646,604
1981	44,080	43,748	43,748	0.21	0.18	1,945,000	100.8	120.3	1,959,988	2,340,329	0.79	0.82	86,149,987	58.4	147,517,101
1982	47,373	47,253	47,261	0.24	0.23	2,252,214	100.6	123.7	2,265,853	2,786,714	0.76	0.77	92,369,554	63.0	146,618,340
1983	43,567	45,770	45,793	0.22	0.23	2,431,174	100.7	127.5	2,447,280	3,100,141	0.78	0.77	108,129,026	67.2	160,906,289
1984	52,083	57,527	57,579	0.19	0.21	2,574,770	100.8	131.5	2,594,395	3,385,097	0.81	0.79	164,334,895	72.0	228,242,910
1985	65,625	76,079	76,186	0.16	0.18	2,573,888	100.6	135.3	2,590,611	3,481,565	0.84	0.82	285,170,167	75.3	378,712,041
1986	67,247	81,700	81,860	0.14	0.15	2,598,315	100.5	139.1	2,611,384	3,614,766	0.86	0.85	365,057,975	78.6	464,450,350
1987	69,449	88,143	88,369	0.13	0.14	2,626,353	100.4	143.1	2,635,659	3,757,820	0.87	0.86	418,394,597	88.0	475,448,406
1988	77,558	99,979	100,308	0.17	0.15	3,505,470	99.4	146.0	3,485,694	5,118,859	0.83	0.85	429,185,287	92.2	465,493,804
1989	83,437	105,178	105,613	0.12	0.14	4,928,101	98.7	149.3	4,863,071	7,355,831	0.88	0.86	759,306,456	96.1	790,121,182
1990	101,478	137,505	138,164	0.15	0.13	5,140,206	99.1	154.4	5,094,141	7,936,506	0.85	0.87	827,606,597	100.0	827,606,597
1991	127,058	184,565	185,569	0.19	0.17	5,539,823	99.4	159.5	5,507,146	8,837,353	0.81	0.83	1,070,206,384	104.8	1,021,189,298
1992	136,674	196,643	197,890	0.31	0.25	5,776,986	99.7	164.9	5,762,530	9,524,583	0.69	0.75	1,006,088,598	108.1	930,701,756
1993	141,888	203,796	205,273	0.22	0.26	6,555,058	99.8	169.9	6,542,730	11,138,559	0.78	0.74	1,279,642,177	110.8	1,154,911,712
1994	136,827	197,576	199,157	0.13	0.18	7,060,766	99.9	175.1	7,052,333	12,366,308	0.87	0.82	2,288,337,074	114.2	2,003,797,788
1995															1,967,537,622

Source: Employment, Value added and textile index: appendix table A-1; Average hours worked and HR-index assumed to equal data for textile sector; Employment costs calculated by multiplying employment with average wages in the textile sector - in this manner (1-a) has been derived.
Number of machines: appendix B; Technology-index: chapter III

Table E-4.2 Growth accounting for the Indonesian weaving sector, 1975-1994

	Labour inputs					***Capital inputs***							***Value Added***		
	Employ-ment (#)	*Labour inputs A*	*Labour inputs B*	*(1-a)*	*avg. (1-a)*	*machines (#)*	*Technology index A*	*Technology index B*	*Capital inputs A*	*Capital inputs B*	*(a)*	*average (a)*	*current prices (thousand Rp)*	*index*	*constant pric (thousand R*
1975	149,021	149,021	149,021	0.57		146,424	100.0	100.0	146,424	146,424	0.43		43,647,472	30.1	145,008,2
1976	120,332	118,580	118,580	0.31	0.44	138,930	112.1	113.4	155,742	157,531	0.69	0.56	62,750,226	31.0	202,420,0
1977	114,975	118,112	118,112	0.38	0.34	125,101	128.4	131.4	160,669	164,378	0.62	0.66	51,741,266	33.4	154,913,9
1978	117,386	114,261	114,261	0.36	0.37	111,273	148.8	154.0	165,597	171,360	0.64	0.63	68,041,339	35.2	193,299,2
1979	115,053	112,800	112,800	0.34	0.35	97,444	175.0	183.2	170,524	178,476	0.66	0.65	91,262,762	46.1	197,966,9
1980	129,779	128,063	128,063	0.37	0.35	83,615	209.8	222.1	175,451	185,730	0.63	0.65	120,150,623	54.8	219,252,9
1981	130,192	129,210	129,210	0.37	0.37	86,286	214.0	229.1	184,665	197,713	0.63	0.63	147,392,561	58.4	252,384,5
1982	128,277	127,952	127,974	0.31	0.34	88,958	217.9	236.0	193,878	209,941	0.69	0.66	195,784,507	63.0	310,769,0
1983	126,869	133,285	133,350	0.39	0.35	91,629	221.6	242.7	203,092	222,419	0.61	0.65	180,244,344	67.2	268,220,7
1984	131,728	145,496	145,628	0.25	0.32	94,300	225.1	249.4	212,306	235,150	0.75	0.68	317,283,866	72.0	440,672,0
1985	156,302	181,202	181,455	0.32	0.29	95,077	230.5	258.2	219,151	245,485	0.68	0.71	336,663,835	75.3	447,096,7
1986	164,891	200,330	200,723	0.26	0.29	95,533	229.9	260.5	219,638	248,816	0.74	0.71	482,570,319	78.6	613,957,1
1987	173,992	220,825	221,392	0.29	0.28	95,989	229.3	262.7	220,125	252,188	0.71	0.72	477,943,603	88.0	543,117,7
1988	179,296	231,129	231,889	0.30	0.30	98,661	252.6	292.6	249,189	288,711	0.70	0.70	559,896,890	92.2	607,263,4
1989	198,189	249,830	250,864	0.22	0.26	101,333	274.6	321.7	278,252	326,021	0.78	0.74	961,334,300	96.1	1,000,347,8
1990	184,562	250,086	251,284	0.23	0.23	104,006	295.5	350.1	307,316	364,132	0.77	0.77	943,050,412	100.0	943,050,4
1991	205,968	299,190	300,817	0.31	0.27	106,678	315.3	377.8	336,380	403,054	0.69	0.73	1,072,168,552	104.8	1,023,061,5
1992	234,522	337,424	339,563	0.31	0.31	109,350	334.2	404.9	365,444	442,801	0.69	0.69	1,724,729,791	108.1	1,595,494,7
1993	243,785	350,153	352,690	0.28	0.29	108,931	346.9	425.0	377,852	462,974	0.72	0.71	1,739,955,786	110.8	1,570,357,2
1994	276,831	399,740	402,938	0.15	0.21	108,513	359.6	445.6	390,260	483,539	0.85	0.79	4,259,488,264	114.2	3,729,849,6
1995						108,094	372.5	466.7	402,667	504,499					

Sources:
Employment, Value Added and textile index: appendix A; Average hours worked and HR-index assumed to equal textile data
Employment costs calculated by multiplying employment with average wages; in this way (1-a) has been derived
Number of machines: appendix B; Technology-index: chapter III

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