JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF INDUSTRIAL DEVELOPMENT
THE DEMOCRATIC SOCIALIST REPUBLIC OF
SRI LANKA

MASTER PLAN STUDY

FOR

INDUSTRIALIZATION AND INVESTMENT PROMOTION

IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

(Phase II)

APPENDIX-III

F. Rubber Industry
G. Plastic Industry
H. Machinery Industry
I. Electric/Electronic Industry
J. Information Technology Service Industry

July 2000

KRI INTERNATIONAL CORP.

APPENDIX-F

RUBBER INDUSTRY

F. RUBBER INDUSTRY

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F. RUBBER INDUSTRY

1. OVERVIEW OF RUBBER INDUSTRY

1.1 Structures

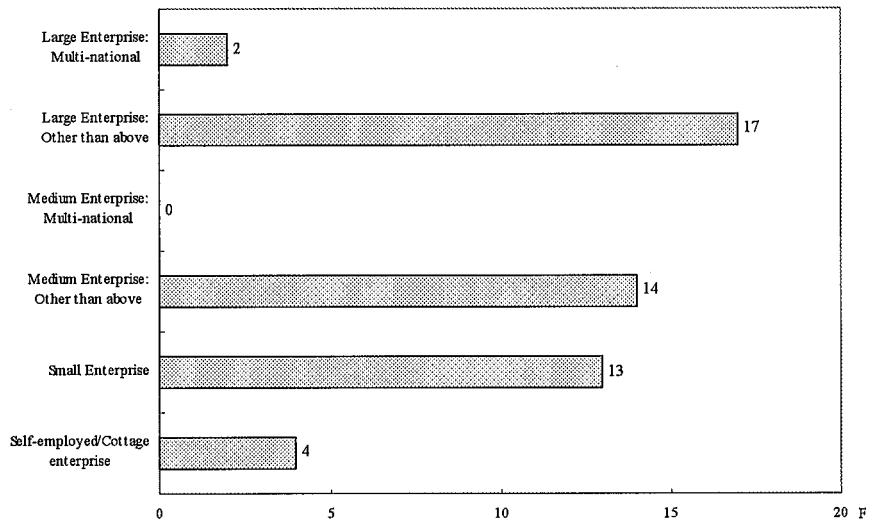
Statistics (Annual Survey of Industries 1996 Interim Report) which summarize the activities of the manufacture of rubber products (ISIC 355) are as tabulated below. It was reported that there were 213 enterprises with 25 employees or more.

Basic Indicators of Rubber Industry (1995)

No. of Establishment (1)	Employment (2)	Output (Rs. mill.) (3)	GVA (Rs. mill.) (4)	GVA ratio (4)/(3)	GVA per Worker (Rs.) (4)/(2)
213	31,041	15,075	6,654	44%	214,353

In the course of this Study, a questionnaire survey was conducted to 50 rubber enterprises, which represent about one-fourth of the existing rubber enterprises. From the survey, rubber enterprises were found to consist in the structure as shown below.

Character of Enterprises

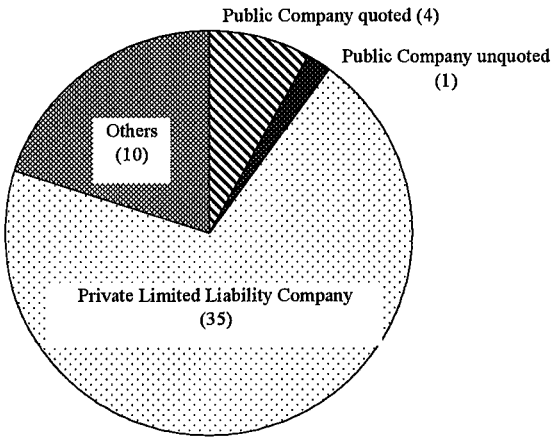


It is interesting that there is a clear division in cluster of organizations. While most enterprises (74%) are small and medium size industries (SMIs), a dozen enterprises are large ones. This

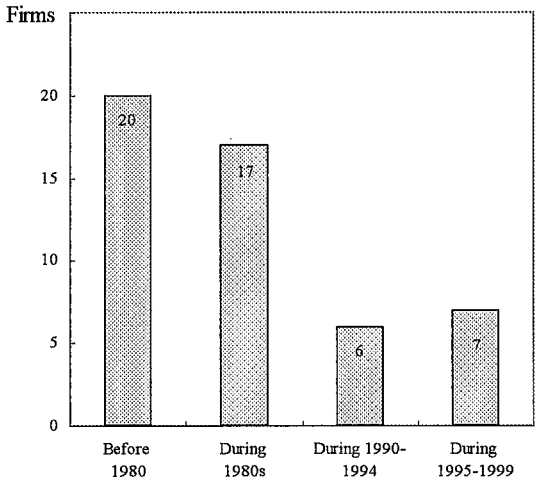
indicates the fact that the rubber industry in Sri Lanka is composed of two different types of enterprises in its structure.

Private limited liability companies occupy a major share of 70%. The years of establishment are fragmented, but 40% of respondents (20 enterprises) were established before 1980, which demonstrates the fact that the industry incorporates many traditional "resource-based" enterprises relying on natural rubber produced in the country. Public enterprises still account for 10%.

Type of Organization

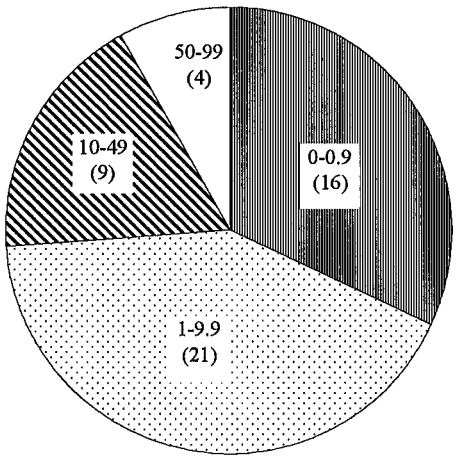


Year of Establishment

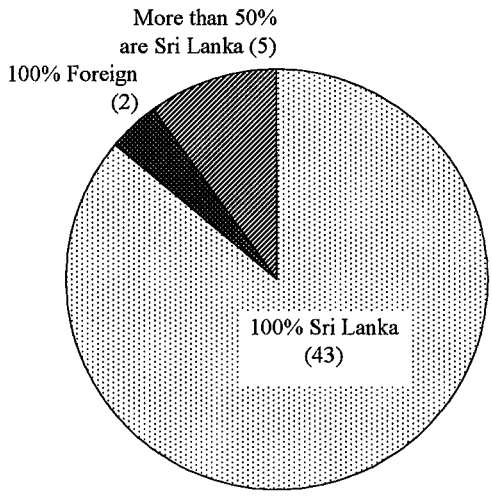


In terms of the capital scale, about three-fourths (3/4) of enterprises have paid up capital of less than Rs. 10 million. The majority (86%) are of 100% Sri Lanka capital, while foreign capital participation accounts for 14%.

Paid-up Capitals



Domestic & Foreign Capitals



1.2 Production and Input

1) Production and Sales

Natural rubber produced in Sri Lanka is a valuable resource for the rubber industry, as well as for foreign exchange earning through exports. As shown below, it is estimated that the country produces around 100,000 tons of natural rubber per year, of which domestic consumption and exports share almost in an equal manner. By using 50,000 tons of local natural rubber, the rubber industry in Sri Lanka manufactured 91,000 tons of rubber products in 1997. The difference between the volume of natural rubber used and the volume of manufactured rubber products is the volume of such other raw materials as synthetic rubber and additives, both of which are mainly imported.

Production and Consumption of Rubber Products (1997)

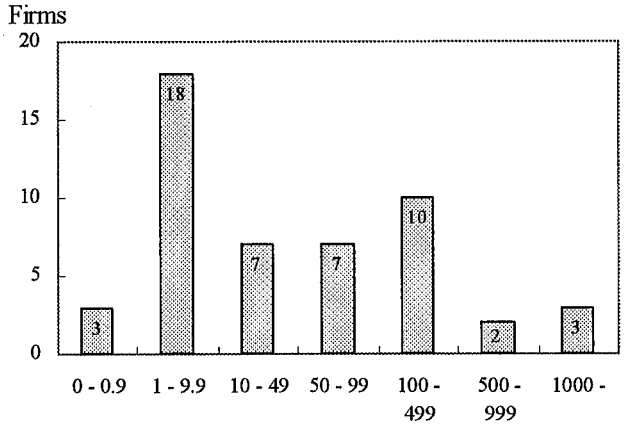
(1,000 ton)

Products	Production (a)	Export (b)	ratio (b/a)	Domestic consumption	Natural rubber (NR) used (c)	(c/a)
Natural rubber	100	50	50%	50	-	-
Rubber products	91	52	58%	39	50	55%
Tyre retreading	7	0.1	2%	7	5.3	75%
Industrial solid tyres	26	26.0	100%	0	11.2	43%
Pneumatic tyres and tubes	15	3.0	20%	12	6.0	40%
Latex dipped products	20	19.4	97%	1	18.2	91%
Latex foam rubber	2	0.1	6%	2	1.7	83%
Flooring	15	1.9	13%	13	5.0	33%
Other rubber products	5	1.5	31%	4	2.0	40%
Total	-	102	-	-	50	-

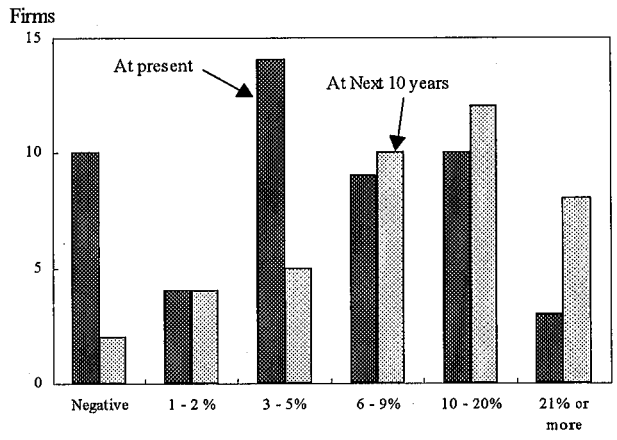
Source: JICA estimate based on "The role of rubber goods manufacturing sector in the Industrialization"

Results of the questionnaire survey indicate that the existing enterprises are small in scale of sales, with 70% of enterprises earning revenues of under Rs. 100 million. Most enterprises expect a steady growth in production in the future.

Sales Range



Growth Rate of Production

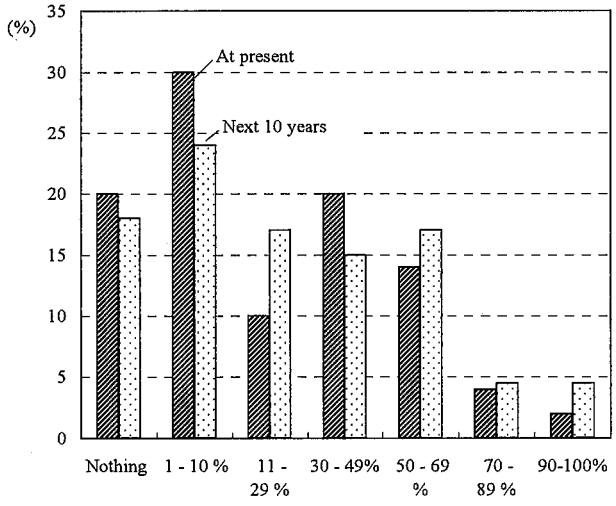


2) Raw Materials

The questionnaire survey shows that current import ratio of raw materials is quite low. 80% of enterprises rely majorities of raw materials on domestic supply. Only 9 enterprises out of 50 surveyed rely more than 50% of their raw materials on imports, with the implication that those companies have some special needs for imported raw materials. In general, rubber product manufacturers use natural rubber as their main raw materials, combining with 30 to 40 % of artificial synthetic rubber which does not exist in Sri Lanka; therefore, the level of reliance on imported synthetic rubber is estimated to be the source of such a difference.

The questionnaire survey also shows some tendencies to rely more on imported raw materials in the future. This indicates some potential for diversification of the existing business. The origin of raw material imports varies widely. This implies that the rubber industry in Sri Lanka can source raw materials, mainly synthetic rubber, from everywhere in the world, as long as the cost and quality conditions are satisfied.

Raw Material Imports



Origin of Raw Materials

Country	Firms
Sri Lanka	40
India	18
Korea	13
China /Hong Kong	13
Singapore	10
Other ASEAN	9
E U	9
USA	6
Japan	6
Others	2

1.3 Products and Market

1) Products-Market Matrix

A products-market matrix indicates current situation of domestic demands and export, as well as future capabilities of marketing. Utilizing this matrix analysis, one can find the current

manufacturing capabilities and potential markets. This is a rather qualitative approach, but it is useful to step into the selection of targeted products.

Two different categories of rubber products are defined, i.e., "molded & extruded products" and "latex products". In molded and extruded products, 15 products are listed (e.g., tyre, automobile parts, and products for industrial use) and in latex products, 13 products are listed. These products are listed in relation to potential markets (e.g., Domestic, India, SARRC except India, ASEAN, Europe, USA, Japan, Africa and Middle East). The products-market matrix table is shown and discussed further in Section 3.2.

2) Export/Imports

Sri Lanka exported 52,000 tons of rubber products in 1997, while 39,000 tons were consumed in the domestic market, which leads to the export ratio of 58%. Industrial solid tyres and latex dipped products are major export-oriented products (almost 100% are exported). One foreign capital enterprise produces around 20,000 tons of industrial solid tyres and exports all the manufactured volume.

Exports of Rubber Products

(Rs. million)

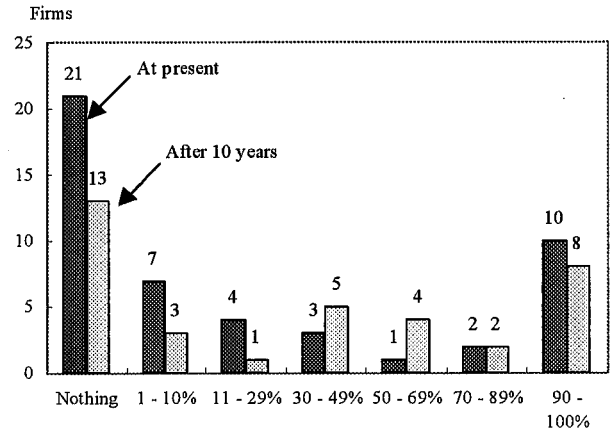
Products	1997	1998		
			share	growth
Natural rubber	**4,599**	**2,758**	**100%**	**-40%**
Crepe	2,284	1,943	70%	-15%
Sheet	2,006	640	23%	-68%
Block	294	173	6%	-41%
Others	15	2	0%	-87%
Rubber products	**10,554**	**11,578**	**100%**	**10%**
Rubber thread	39	50	0%	27%
Unhardened rubber	252	270	2%	7%
Rubber hose	0	0	–	–
Rubber belts	7	2	0%	-68%
Tyres and tubes	4,319	5,493	47%	27%
Apparel clothing accessories	4,630	4,284	37%	-7%
Atticles of unhardened rubber	1,154	1,325	11%	15%
Others	153	154	1%	1%
Total	**15,153**	**14,336**	**-**	**-5%**

Source: EDB, Central Bank

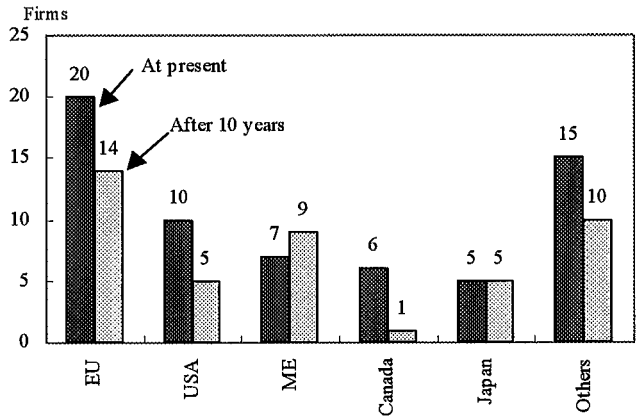
In terms of value, rubber products earned Rs. 10.6 billion in 1997, while natural rubber earned Rs. 4.6 billion, almost half the value, given the same export volume of around 50,000 tons. This is a simple reflection of the difference in value added.

The questionnaire survey revealed the existence of two different categories in the industry, i.e., "export-driven" enterprises and "domestic-oriented" ones. 45% (21 companies) are enterprises which have no export value, while 20% (10 enterprises) export 90-100% of their production. It is presumed that such export-driven companies are large scaled with foreign capital participation. There are some preferences to future export business, but 35% (14 enterprises) are still considering supplying their products only to the domestic market.

Ratio of Exports



Export Destination



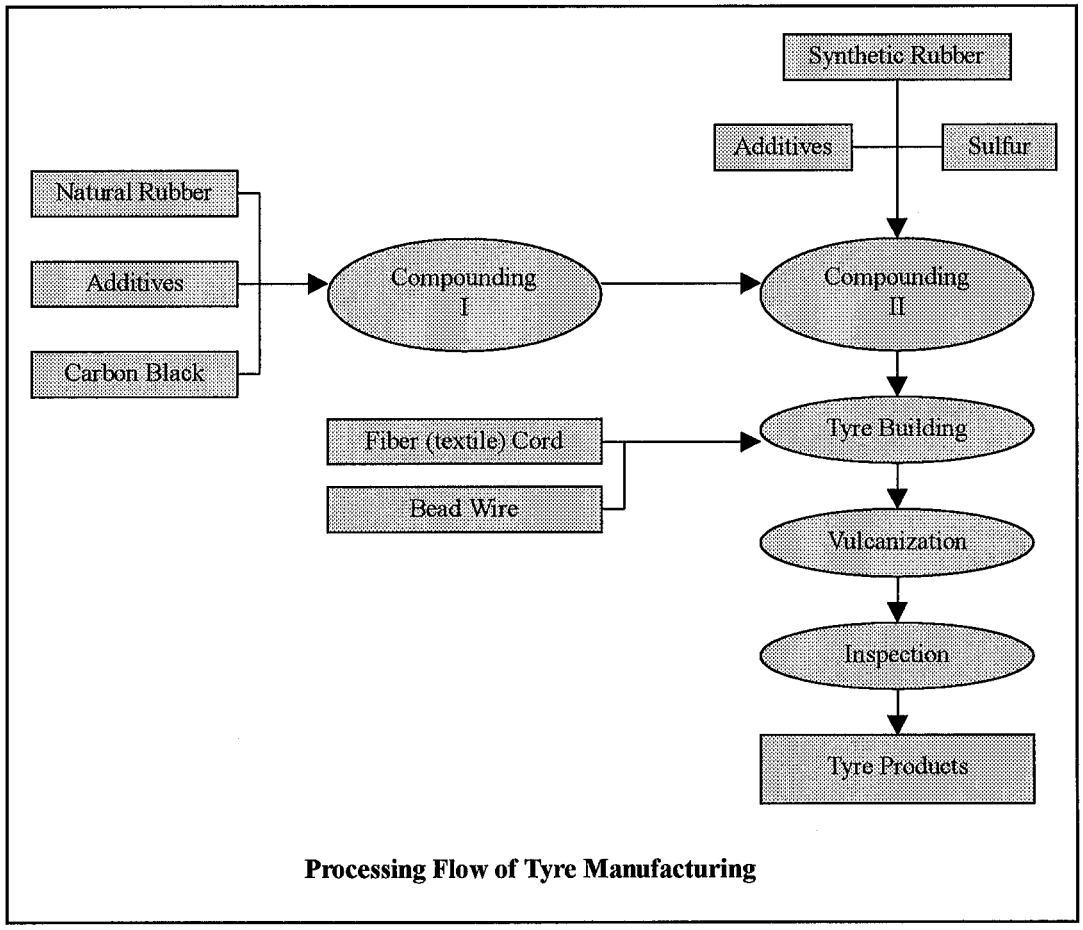
The destination of exports widely ranges from EU (20), USA (10), Middle East (7), Canada (6), to Japan (7), though they tend to be oriented to more advanced countries. There is no clear indication that major export destinations will change in the next ten years.

ASEAN except Singapore (24 enterprises indicated), India (14) and China/Hong Kong (8) are listed as the major competitors for the domestic industry. For the next ten years, ASEAN except Singapore and India will continue to be the biggest rivals. India has a huge market and cost competitiveness utilizing cheap labor cost, while ASEAN is seen as the strong supplier of rubber materials and latex products.

1.4 Technology and R&D

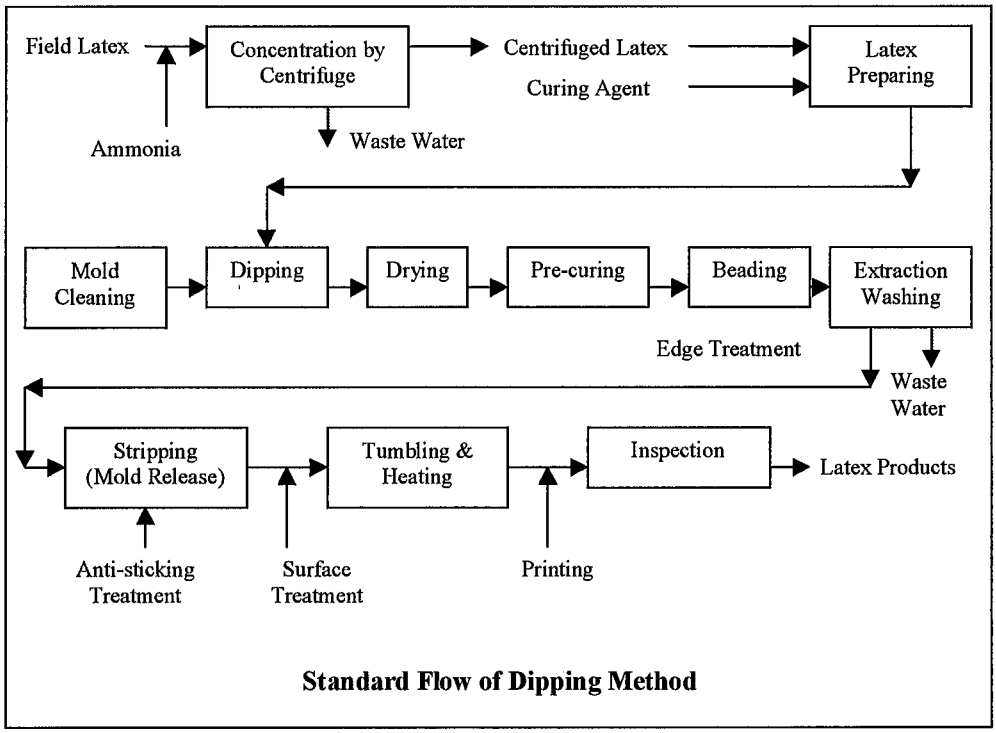
1) Technology Level and its Characteristics

As noted in Section 1.2, the processing of tyres and latex products is a major manufacturing activity in Sri Lanka. With respect to the processing of tyres, natural rubber and synthetic rubber are blended at the ratio of 50% to 50% in most countries. In Sri Lanka, however, the blending ratio of natural rubber is increased to 65%, due mainly to the low price of natural rubber. A simplified processing flow of pneumatic and bias tyres is illustrated below.



Processing Flow of Tyre Manufacturing

On the other hand, the dipping method for the processing of latex products is normally used by manufacturers of household and examination gloves in Sri Lanka. In most cases, field latex is concentrated by centrifuge, as shown in the standard processing flow diagram on the following page.

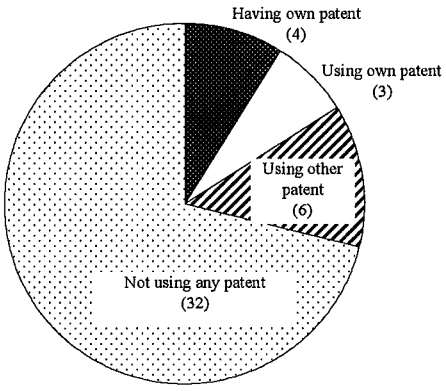


Standard Flow of Dipping Method

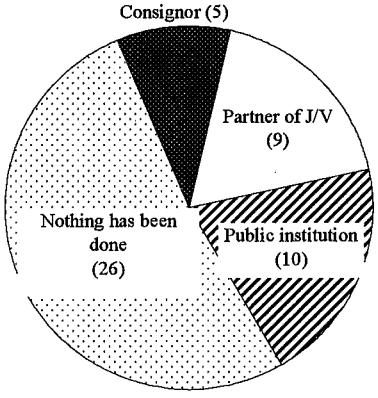
2) Technology and its Transfer

The questionnaire survey revealed that 70% (32 firms) of the surveyed enterprises do not use any patent, with the implication that they do not produce technologically advanced products. On the other hand, seven companies have or use their own patents, showing a certain level of their technology. Only nine companies have ISO 9000, three are in the process of application, and 24 are planning to apply, which indicates a high level of interest in quality assurance, but also a reality that most are not yet at a global standard level. It suggests again that technological bases are concentrated in a limited number of large enterprises, and others lag behind, as in the case of export capabilities. There is no enterprise which has registered under ISO 14000, but 18 companies have plans to apply.

Patent Use



Technology Transfer

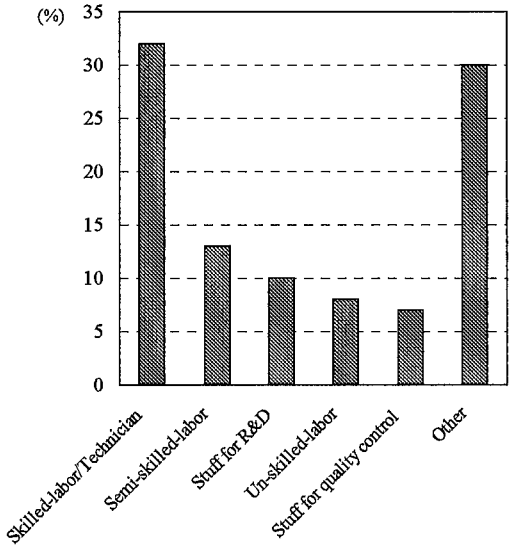


Most technology transfer is extended through public institutions (10 respondents), J/V partners (9) and consignors (5). On the other hand, there are 26 companies which have no experience in any technology transfer, indicating that they do not have any access nor strong needs to advanced technology. Major technologies and processes used for production are compression molding (39 respondents), mixing (39), bonding (19), machining (8), assembly (9), and sub-assembly (5). Major technologies transferred from others are compression molding (39 respondents) and bonding (19), where all technologies that they currently use are estimated as being transferred, because the number of respondents are the same for two questions. Computer uses (e.g., CAD, CAM, CIM, CAT, CASE) are reported by eight enterprises. Major origins of technology transfer are EU (6 respondents), USA (6), Singapore (3), Korea (4), India (3), and Japan (3).

3) Skilled Manpower and Training

Responses to the skilled manpower shortage varies widely. Around 30% of total respondents (29 enterprises) show that they have a shortage in "skilled-labor/technician", but there are also many different responses about the issue. This implies that each enterprise has a different situation or some enterprises do not have a clear insight about their human resource problems. Slight expectations for improved situations are seen for the next ten years, as 23 enterprises are concerned about shortages in "skilled-labor/technician", 9 about "staff for R&D", and 5 about "staff for quality control".

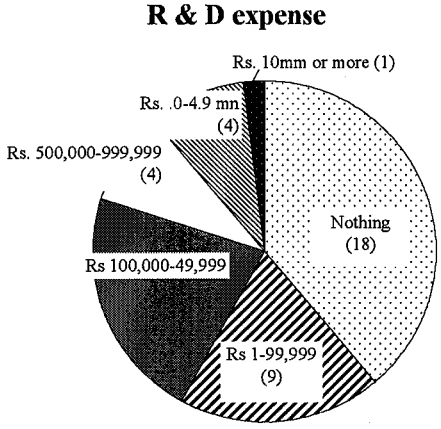
Skilled Manpower Shortage

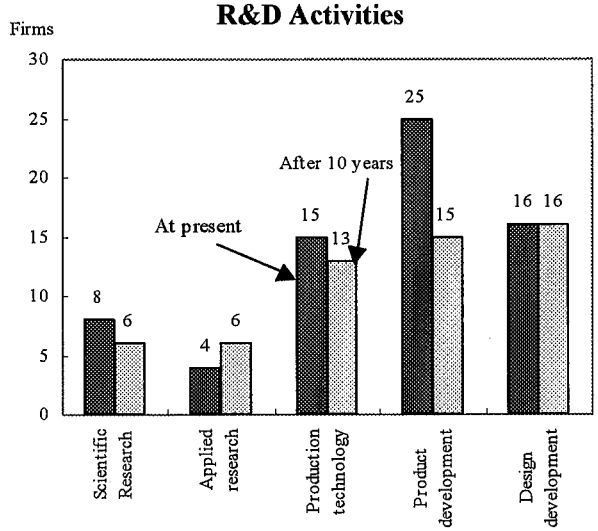


Most enterprises (50) have on-the-job training programs, while there are 15 enterprises conducting on-the-job training abroad. It was reported that 6 companies were dependent on public training.

4) R&D

R&D activities are production- and development-oriented. The questionnaire survey indicates that enterprises are conducting "product development" (25 enterprises), "design development" (16), and "production technology" (15). They have almost the same orientation for the next ten years. However, R&D expense is small; i.e., 18 companies have zero expense, 19 have less than Rs 500,000, and only 9 have more than Rs 500,000. It should be noted that there is one enterprise which consumes more than Rs. 10 million for its R&D. It is also noted that 22 enterprises have no joint R&D activities with others, with the implication that there is little collaboration in R&D activities.





1.5 Environmental Protection

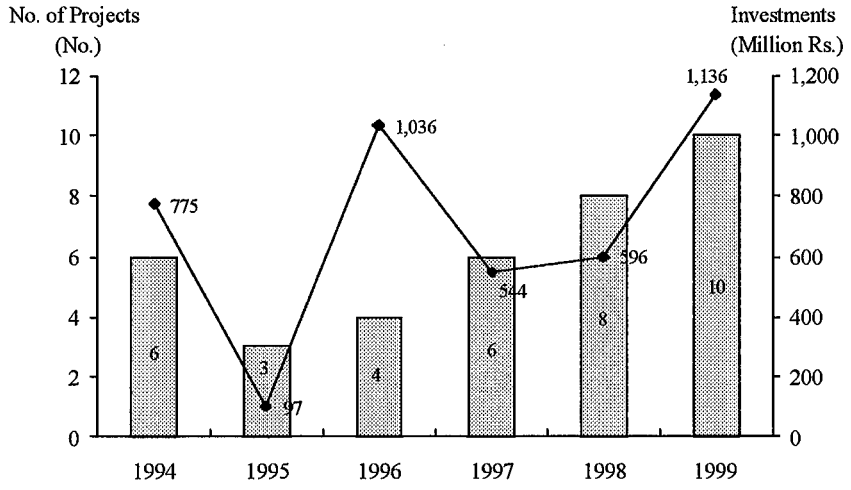
Most of the rubber processing factories in Sri Lanka have not taken appropriate measures in protection from bad odors. In latex product factories, on the other hand, large factories have facilities to collect gas emitted from the field latex storage tanks and wash it away by water in scrubbers. However, such facilities are not provided in most factories of SMIs, hence bad odors are emitted into the atmosphere.

For solid waste disposal, many factories including SMIs in Sri Lanka have already taken measures. Collection and recycling are being performed for off-specification products before vulcanization. In addition, wastes that cannot be recovered are incinerated by private small incinerators.

Waste water is discharged from the production process of centrifuged latex and washing of latex products. In large factories, waste water that contains weak ammonia and 3-6% of latex is caught by drained latex tanks and sent to separation basins to separate floating rubber. Water discharged from the separation basin flows into neutralization and settling basins, where acid is added to neutralize the water and settled. Separated water is discharged to a river, after the monitoring of COD and pH, while separated solid waste is incinerated. However, in most factories of SMIs in Sri Lanka, waste water is not treated.

1.6 Investment

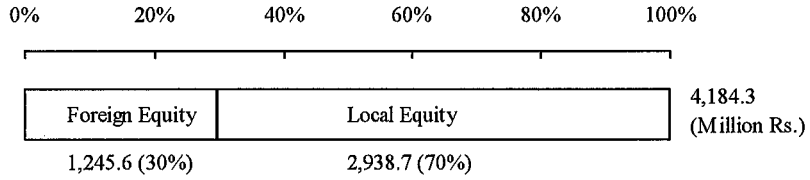
The investment in the rubber industry under Sections 16 and 17 of the BOI law has been increasing since 1995, as shown below.



Source: BOI

Numbers of Projects and Investments in Rubber Industry approved under Sec. 16 & 17 of the BOI Law

In terms of equity share on investment in the rubber industry, local equity accounts for 70% as shown below.



Source: BOI

Accumulative Investments in Rubber Industry approved under Sec. 16 & 17 of the BOI Law (1994-1999)

Since rubber products are appointed as a thrust industry, the incentives under Section 17 are provided subject to the qualifying criteria. The incentives provided to rubber products (new export-oriented industry) are tabulated below.

BOI Incentives on Rubber Based Industry (New Export-Oriented)

Description of Activity	Qualifying Criteria			Incentives				
	Minimum Investment in Rs.mn	Minimum Direct/ Indirect Export Requirement (% of output)	Minimum New Employ-ment Required	Full Tax Holiday	Concession-ary Tax at 15%	Import Duty Exemption		Exemption from Exchange Control
						On Capital Goods	On Raw Materials	
New export – oriented industry undertaking an investment in a "Thrust Industry"	50 – 1,499	90%	50	10	10 years after tax holiday	Yes	yes, if utilized for export	Yes
	1,500 – 2,499	90%	50	12 years	8 years after tax holiday	Yes	Yes, if utilized for export	Yes
	2,500 – 4,999	90%	50	15 years	5 years after tax holiday	Yes	Yes, if utilized for export	Yes
	Above 5,000	90%	50	20 years	as per IR Law after tax holiday	Yes	Yes, if utilized for export	Yes

Source: BOI

2. STRENGTH AND BOTTLENECK

2.1 Strength and Weakness

1) Strength

The rubber industry in Sri Lanka has the potential to be one of the world leading rubber product manufacture countries, because of the following strengths.

(i) Sri Lanka ranks sixth among countries of natural rubber production in the world, with an annual production volume of approximately 100,000 tons.

(ii) Top grade natural rubber is produced in Sri Lanka with a very low content level of proteins.

(iii) Sheet rubber produced in Sri Lanka has gained a good reputation in the world for its high quality.

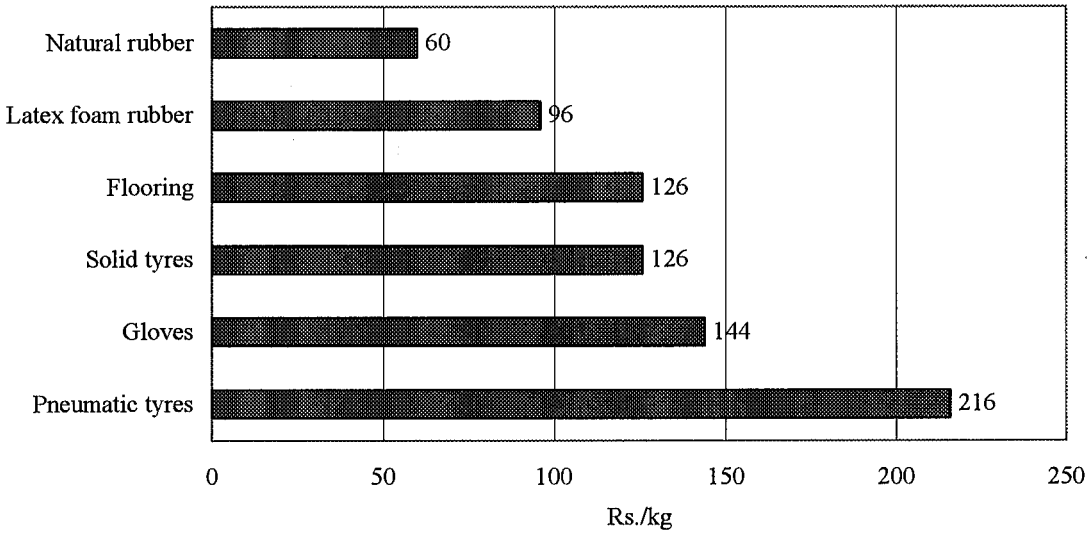
(iv) Rubber product processing cost is relatively low in Sri Lanka

According to the questionnaire survey, most enterprises indicated that their strength is "durability" and "price", though responses widely vary. Much smaller responses were made for design, management, production development, marketing, and production technology/skill. Paradoxically this diversion of responses imply that most producers admit that their technological and management capabilities are still limited, even though they can take advantages of relatively cheap labor and raw material costs.

2) Differences of Value Addition

One of the most notable characteristics of the rubber industry in Sri Lanka is the difference in value addition to natural rubber and various rubber products. As noted in the proceeding section, natural rubber produced in Sri Lanka is world top grade in quality and marketable with high competitiveness. However, the fact is that natural rubber export has less value added to the Sri Lankan economy, in addition to the fact that natural rubber production is limited to the level of 100,000 tons per annum. The next figure shows the difference in value addition of natural rubber and rubber products in Sri Lanka.

Difference in Value Added of Natural Rubber and Rubber Products



This characteristic of the rubber industry in Sri Lanka should be taken into account in formulating a strategic plan for development of the rubber industry in the future.

3) Strength/Weakness for Industrialization

A "product-industrialization matrix" describes a current situation of capabilities in different technology and engineering stages. For the rubber industry in Sri Lanka, this matrix has been prepared as shown below.

Products-Industrialization Matrix

[Dry rubber based products]

	Products	Key technology	Modernized facility	Production technology	QC technology	Human resources	Practical training	Financial affairs	Entrepre-neurship	R&D supporting
1)	Tyre : steel radial for motor vehicle	Road endurance, cost	X	○X	○	○△	○△	○X	○	X
2)	Tyre : bias tyre for motor vehicle	Road endurance, cost	○	○	○	○	○△	○	○	X
2	For bus & truck, light truck	Gen. quality, cost	○	○	○	○	○△	○	○	X
3	For agriculture: pneumatic	Endurance, cost	○	○	○	○	○△	○	○	X
4	For heavy duty: truck	Gen. quality, cost	○	○	○	○	○△	○	○	X
5	For motorcycle, bicycle	Gen. quality, cost	X	X	△	○	X	△	△	△X
6	of Re-tread for all kind	Gen. quality, cost	○	○	△	○	△	△	△	△X
3)	Automobile : Mud guard	Competitive cost	○	○	△	○	△	△	○	△
2	: Window profile	Quality, technology	X	△X	△	○△	△X	△	○△	X
4)	V-shaped belt: for industry	Quality, technology	△	△X	X	○△	△	△	○△	△X
5)	Rubber roller: for machine	Quality, technology	△	△X	△	○	△	△	○△	△X
6)	Mat: shoe soles, floor, can & bottle seal	Quality, cost	○△	△	△	△	X	△	○△	△
7)	Industry mat: bridge, rail pad, machine	Quality, cost	○	X	△X	△	X	△	○△	X
8)	Hose & pipe: oil resistive, mobile use	Quality, cost	○	△	△X	△	△	△	○	△
9)	Cable & wire extruded: oil resistive,	Quality, cost	○	△X	△X	△	X	△	△	X

Note: ○: Available, △ To be improved, X Unavailable

[Latex based products]

	Products	Key technology	Modernized facility	Production technology	QC technology	Human resources	Practical training	Financial affairs	Entrepre-neurship	R&D supporting
1)	Latex based products									
1	Surgical gloves	Thin & tough	○	△	△	△	○△	○	○	△
2	Examination gloves	GMP systems	○	△	△	△	○△	○	○	△
3	House hold gloves	Formulation for	○	△	△	△	○△	○	○	△
4	Catheters	Fine technology	X	△X	△	△	△	○	○	X
5	Teething rings /pacifiers	Hygiene formulations	△	△	△	△	△	○	○	△
6	Balloons: toy & meteorological	High technology	X	△X	△X	△	△	○	○	△X
7	Finger stalls	Low cost	△	△	△	△	○	○	○	△
8	Condoms	High tech. & invest.	△	△	△	△	△	○	○	X
2)	Rubber thread	High tech. & facility	X	△X	△	△	△	○	○	X
3)	Adhesive/ bonding agents	Formulations								
1	for Plywood, packaging	Formulations	△	○△	△	△	△	○	○	△
2	for Footwear bonding	Formulations	△	○△	△	△	△	○	○	△

○: Yes we have, △: Needs to improve, X: Needs

It is clear in the matrix table that there are limited "industrialization and development" capabilities in most rubber products except for some tyres and industrial products. It is observed that "high value added " products for industrial use do not have these capabilities, "rubber thread" and some kinds of "latex based products" have some, and "pneumatic tyre for heavy duty " has a certain level of capability. It is also noted that there are many areas that require foreign investments to attain these capabilities, particularly in high value added "latex based and dry rubber based products" for industrial use.

4) Constraints

Through factory inspections and discussions with rubber product manufacturers, a number of constraints are pointed out, including:

(i) Natural rubber production has been descending in production volume in recent years.

(ii) Quality of natural rubber sheets (e.g., RSS) which are produced by small holders is low due to their low level production skill and old production facilities.

(iii) Since small holders are scattered over wide areas, collection efficiency and consistency of natural rubber sheets (RSS) and field latex for the manufacture of centrifuged latex from such small holders is quite low.

(iv) Environmental pollution caused by emission of sulphar dioxide and ammonia odor from disposal of effluent from rubber processing factories into river and streams in the surrounding area of small holders.

These problems are mainly of the raw material suppliers. However, it is necessary that small holders make a cooperative society with new installation of facilities for production and pollution control to improve quality and collection efficiency as well as environmental protection.

The questionnaire survey indicates that critical constraints faced by rubber processing enterprises vary a lot. Among "raw materials related" problems, both "high cost of local raw materials" and "unstable supply of local raw materials", as well as "high cost of imported raw materials", were pointed out by many enterprises. This seems to be a reflection of their strong sensitivity against raw material issue, as discussed before. There are three kinds of raw materials for rubber industry in Sri Lanka, i.e., local natural rubber, imported artificial (synthetic) rubber, and carbon black and other additives. Materials locally supplied in Sri Lanka is only natural rubber, and therefore, purchasing policies and issues of imported raw materials become highly important. However, it is also interesting to know that many issues of local raw materials are addressed. This implies that there are some inefficiencies in distributing local natural rubber to the domestic rubber industry, and some measures for effective and maximum utilization of the country's valuable natural resource for its industrialization should be considered.

Concerning "government support", major concerns are "support to financing" (31 enterprises indicated.) and "weak investment promotion/incentives" (23). Concerning "market-related problem", while many responses were divided into different directions, 22 enterprises pointed out "flooding of imported goods" as a serious problem. This illustrates that there exist certain product ranges which have relatively low competitiveness and face a fragile situation under global competition, presumably in traditional, low value added commodity type products. Weak international competitiveness in terms of quality and price is one of the reasons of this situation.

5) Factors for Profitability

According to the questionnaire survey, 42 enterprises out of 50 pointed out that the most critical factor for profitability is raw material cost. The factory inspection also revealed that material cost accounts for 50-90% of total production cost (approximately 90% for latex products, 65% for re-treaded tyres, 50% for new pneumatic tyres). This may be attributable to the following two facts; one is that the rubber industry is an upstream manufacturing sector which relies its manufacturing cost heavily on raw materials, and the other is that lower value added products in the Sri Lankan rubber industry create this vulnerability of profits. As

previously discussed, even though most enterprises source their raw materials mainly from the domestic market, many rely on imported synthetic rubber; hence, the weakening of rupees will create a fragile situation for the industry. An effective use of valuable high quality natural rubber produced in Sri Lanka and a good balance of using both domestic natural rubber and imported synthetic rubber would become a central issue to be addressed, when designing an industrialization plan of the rubber industry.

The second most critical factor of profitability is electricity cost and supply condition. 31 enterprises pointed out that this was a big burden for them. In the case of a rubber compounding factory, the cost for electric power consumption is estimated at about 8% of its total production cost.

Rubber Industry in Malaysia

The Malaysian Rubber Research Board (RRB) takes leadership in all aspects in the rubber industry from rubber production to rubber processing. RRB is even in charge of improving rubber trees and collection vessels to attain better productivity of rubber production, since 1995.

Malaysia is the world third largest producer of natural rubber. Malaysia became the world leader of manufacturing latex based products in 1995. Latex based products account for 58.2% of natural rubber consumption, followed by tyres (17.7%) and other products (14.7%). This implies that Malaysia's rubber industry has already shifted to latex based products of high value added. Malaysia has attracted a growing number of foreign manufacturers and investors. Several examples of FDIs are listed below.

Dry rubber based products

- Goodyear Tyre and Rubber Company (USA, tyre manufacturer)
- Bata (Canada, shoe manufacturer)
- Virking Askim (Norway, shoe manufacturer)

Latex based products

- Ansell (Australia, glove manufacturer)
- Euro-Medical (UK and Germany, glove manufacturer)
- BDF Bejersdrof AG (Germany, catheter manufacturer)
- Sagami (Japan, condom manufacturer)
- Dongkuk Techno (South Korea, condom manufacturer)
- Skellerup Industries (New Zealand, balloon and swimming cap manufacturer)
- Huntchinson MAPA (France, glove manufacturer)
- Baxter Healthcare (USA, glove manufacturer)
- Pirelli (Italy, glove manufacturer)

2.2 Bottleneck on Management

1) Impact of New Environment

The questionnaire survey reveals that there are much more concerns than expectations for the "SAARC impacts on business" in the rubber industry. "Strong competitors" ranked first among responses, indicated by around 50% (23 companies). India is seen as the "best partner among SAARC countries", as responded by 26 enterprises. It is surprising to know that there is much concern about SAARC cooperation. However, this could be again understood that it is a reflection of the current structure of the rubber industry in Sri Lanka, which consists of some large, competitive companies and many, small less-competitive enterprises. It is necessary to design a plan to develop the rubber industry to readily benefit from SAARC cooperation in the medium and long term.

2) Supportive Measures

A "product-required supporting factor matrix" has been worked out through discussion with Sri Lankan industry people, as shown below.

Required Supporting Factor Matrix

[Dry rubber based products]

	Products	Key technology	Exist tech.	Raw materials	Formu· lations	Production Tech.	Modern facility	Exp.qual. guarant	Marketing force	Research labo.
1)	Tyre : steel radial for motor vehicle	Road endurance, cost	○△	○	○△	○△	×△	○△	○△	×
2.1	Tyre : bias tyre for motor vehicle	Road endurance, cost	○	○	○	○	○	○	○	×
0.2	For bus & truck, light truck	Gen. quality, cost	○	○	○	○	○△	○	△	×
0.3	For agriculture: pneumatic	Endurance, cost	○	○	○	○	○△	○	△	×
0.4	For heavy duty: truck	Gen. quality, cost	○△	○	○△	○△	○△	○	△	×
0.5	For motorcycle, bicycle	Gen. quality, cost	○△	○	○	△	×	△	△	×
0.6	of Re-tread for all kind	Gen. quality, cost	○	○	○	○	○	△	△	×
3.1	Automobile : Mud guard	Competitive cost	△	○	×	△	△	△	△	×
0.2	: Window profile	Quality, technology	△	○	×	×	×	△	×	×
4)	V-shaped belt: for industry	Quality, technology	△	○	×	△	×	△	×	×
5)	Rubber roller: for machine	Quality, technology	△	○	×	△	△	△	×	×
6)	Mat: shoe soles, floor, can & bottle seal	Quality, cost	△	○	△	△	△	△	×	×
7)	Industry mat: bridge, rail pad, machine	Quality, cost	△	○	×	△	△	△	×	×
8)	Hose & pipe: oil resistive, mobile use	Quality, cost	△	○	○△	△	△	△	×	×
9)	Cable & wire extruded: oil resistive,	Quality, cost	△	○	○△	△	△	△	×	×

[Latex based products]

	Products	Key technology	Exist tech.	Raw materials	Formu· lations	Dip Tech.	Equip· ment	Exp.qual. guarant	Marketing force	Research labo.
1)	Latex based products									
1	Surgical gloves	Thin & tough	×	○△	×	△	△	△	△	△
2	Examination gloves	GMP systems	△	○△	△	△	△	△	△	△
3	House hold gloves	Formulation for	○△	○△	○△	○△	○△	△	△	△
4	Catheters	Fine technology	△×	○△	×	△	△	△	△×	△
5	Teething rings /pacifiers	Hygiene formulations	○△	○△	△	△	△	△	△	△
6	Balloons: toy & meteorological	High technology	○△	○△	△×	△	△	△	△×	△
7	Finger stalls	Low cost	○△	○△	△	△	△	△	△	△
8	Condoms	High tech. & invest.	×	○△	△	△	△	△	△×	△
2)	Rubber thread	High tech. & facility	△×	△	△×	△	×	△×	△	△
3)	Adhesive/ bonding agents	Formulations								
1	for Plywood, packaging	Formulations	○△	○△	△	△	△	△	△	△
2	for Footwear bonding	Formulations	○△	○△	△	△	△	△	△	△

○: Yes we have, △: Needs to improve, or import ×: Needs foreign technology

It is noted through the matrix that supporting measures in "formulation", "marketing force", and "research laboratories" are required in general. In product areas, "modern facilities" for steel radial tyre is particularly required by means of introduction of foreign technology. Some high value added products for industrial use require overall technologies and effective business functions, which should be further "improved or imported".

Expansion Plan of Radial Tyre Production

Factory inspections revealed that one enterprise had an expansion plan for its radial tyre production capacity to increase up to 30,000 unit/month by the year 2010. The new facilities will require introduction of foreign technology. The expansion plan will be implemented stage-wise, i.e.,

- Phase I: Capacity to be increased to 10,000-15,000 unit/month
- Sales value to be increased to Rs 300 million
- Phase II: Capacity to be increased to 30,000 unit/month
- Sales value to be increased to Rs 500 million

Target markets of the radial tyre are: 10% for domestic market, 10% for export to India, and the remaining 80% for export to other foreign countries.

3) Required Public Support

As discussed before, the questionnaire survey reveals that the rubber industry mainly asks for government supports in "financing" and "investment promotion/incentives", as pointed out by 31 and 23 enterprises, respectively. This seems to be voices from small, fragmented enterprises which do not have a technological base nor competitiveness. Some measures should be taken to stimulate an integration of industrial structure and modernization of equipment. Without active introduction of technology, as well as investment in plant and equipment, enhancement in competitiveness in these small and medium size industries in the rubber industry will not be attainable.

For instance, two Sri Lankan rubber product manufacturing companies have plans to relocate their factories to industrial estates. They are planning to modernize facilities and layout for productivity improvement. They are looking for special financial support for factory relocation to improve productivity and prevent environmental complaints.

2.3 Industrial Clustering

1) Potential Linkages

The rubber industry is an important supplier of necessary materials and goods for machinery, chemical and food industries, working as one of the key supporting industries. Rubber products are required for such machinery parts as joint packaging sheets, vibration absorber, shock absorber, and lubricating oil hose. They are also used for joint seals of liquid transportation pipes in chemical factories, and for inside liner and sealing sheets for bottled foods.

If the rubber industry in Sri Lanka can supply those products with a competitive edge, the machinery, chemical and food industries will benefit at the same time. Further, the rubber industry itself requires an improvement in the machinery industry. Such machinery as mixing (wet and dry), blending, extruding, laminating, cutting, autoclave facilities, compression molding, automatic control regulator, and textile coating machine (for byas tyre) are some examples which the rubber sector needs to have. The analysis indicates that there are some ways for the Sri Lankan rubber industry to attain capabilities to supply competitive products to the closely-linked industries. It is also noted that technological upgrading of the local industry should be promoted further and some measures should be taken to integrate an industrial structure of the rubber industry in order to cope with this difficult task.

2) Constraints for Clustering

It is observed that rubber product manufacturers in Sri Lanka are in the midst of a fragmented industrial structure and there is no collaborative approach in the industry. Under such a situation, positive clustering effects with other industries are less expected. This is partly because they are not faced with a real global competition and also benefit from its valuable resources of local natural rubber. However, the only source of advantage, domestic natural rubber production, has more or less a limitation in the future. It is not realistic to expect that natural rubber production will continue to increase; therefore, the rubber industry cannot help increasing its dependence of raw materials on imported synthetic rubber.

As long as Sri Lanka keeps a certain level of high quality natural rubber production, the country should carefully think of the best use of its valuable resources, and design an effective clustering program to utilize its largest "competitive advantage of the nation". Before designing a clustering program, it is vital to share an understanding that both competition and cooperation is important to upgrade a playing field of the rubber industry as a whole. All the

industry, academia, and the government should recognize that they need to collaborate with each other to share scarce resources and realize an effective industrialization program.

Collaboration in R&D is particularly important for upgrading the rubber industry. Recommended items for such R&D activities to face the future challenges are as follows.

(i) Development of new and modified rubber compound having similar properties to IIR (Butyl Rubber) that is suitable for tyre-tube material because of its low air-permeable character,

(ii) R&D for sterilization of surgical gloves by irradiation of cobalt 60 gamma ray to latex gloves

(iii) R&D for industrial production process for rubber thread by cut-rubber thread manufacture or by extruded-latex thread production

(iv) R&D for development for environmentally friendly green tyres with high abrasion resistance

(v) R&D for new products of therapic and health related products such as magnetic shoe soles, health pillows, anti static and conductive rubber pads for the fast developing electronic industry.

(vi) R&D for recycling options of used and waste tyres (retreading, utilization of used tyres for its caloric values, devulcanization, reclaiming process reuse application etc)

3. MASTER PLAN FOR RUBBER INDUSTRY

3.1 Framework and Strategies

1) Vision

The rubber industry in Sri Lanka is one of the five largest GVA subsectors (i.e., food processing, tobacco, textiles, garments, and rubber products). This sub-sector contributed 6.5% of the total manufacturing GVA in 1995, being a typical resource-based industry backed by high quality natural rubber produced in the country.

Rubber is a basic material not only for commodity products, but also for higher value added manufacturing products. Quality of natural rubber produced in Sri Lanka and some rubber products are world top-level and well known in the global market. To heighten competitiveness of the rubber industry through further upgrading of technological bases and increasing value added is an important task for Sri Lanka to accelerate its industrialization. To promote an effective and coordinated way of development, the vision for the rubber industry toward 2010 should be stated as follows:

"By enhancing a higher technological base to manufacture higher value added products, the rubber industry in Sri Lanka should lead the industrialization of the country by maximum utilization of high quality natural rubber produced in the country and by heightening competitiveness in the global market ".

2) Targets

In line with the above-mentioned vision, it is proposed that development of the rubber industry in Sri Lanka be designed to achieve targets as enumerated below.

(i) Develop the rubber industry as a "resource-based" and "global-linked" target industry and double its production.

(ii) Establish technological bases of producing high value added rubber products for both industrial and commercial use.

(iii) Supply sufficient volumes of raw materials to the increasing rubber products manufacturing, and expand production volume of natural rubber to the level of 130,000 tons by the year 2010 (a 30% increase from the current level).

(iv) Attain higher value added to products, shift to manufacture of high value added rubber products, and gradually decrease export volume of raw natural rubber.

(v) Promote an increase in FDI (foreign direct investment) to the rubber industry to accelerate technological transfer and to increase production capabilities, particularly in focal products of high value added rubber products both for industrial and commercial use.

(vi) Promote "exports" of focal products at the latter stage, keeping an export ratio to production at no less than 50%.

(viii) Achieve an increase in GVA up to around Rs. 33 billion by 2010 (from Rs. 14 billion in 1998).

3) Basic Strategies

It is proposed that basic strategies and approaches to accelerate development of the rubber industry be defined as follows:

(i) Promote the rubber industry focusing on tyre, industrial use, and latex products

(ii) Promote an introduction of technological transfer and FDI to develop technological capabilities in product marketing, product design, production control and quality control

(iii) Establish a mechanism of improvement in relationships and responsibility sharing in "research", "development" and "design" among academia, institutes, and the private sector.

(iv) Establish an official testing organization to increase capabilities in quality control and quality assurance by restructuring institutional framework.

(v) Integrate less competitive SMIs to form joint venture companies to attain higher economy of scale and higher competitiveness by mergers.

(vi) Promote "clustering" with major rubber-using industries through joint research and development programs.

3.2 Production and Marketing

1) Maximum Use of Natural Rubber

As reviewed in Sections 1.2 and 2.1, natural rubber produced in Sri Lanka is characterized as summarized below.

(i) Natural rubber produced in Sri Lanka is top-grade in the world because of a low level of protein contents.

(ii) Production areas of rubber plantation have been decreasing in the past decade, and the current production is limited to around 100,000 tons per annum.

(iii) There remains room to heighten productivity of natural rubber, though increase in production areas is less expectable.

(iv) Export of raw natural rubber accounts for about 50% of rubber production, or about 50,000 tons per annum at present, and the export price is vulnerable to the international rubber price, as experienced in 1998.

(v) Value added natural rubber export to the national economy is less than half of rubber products manufactured in Sri Lanka.

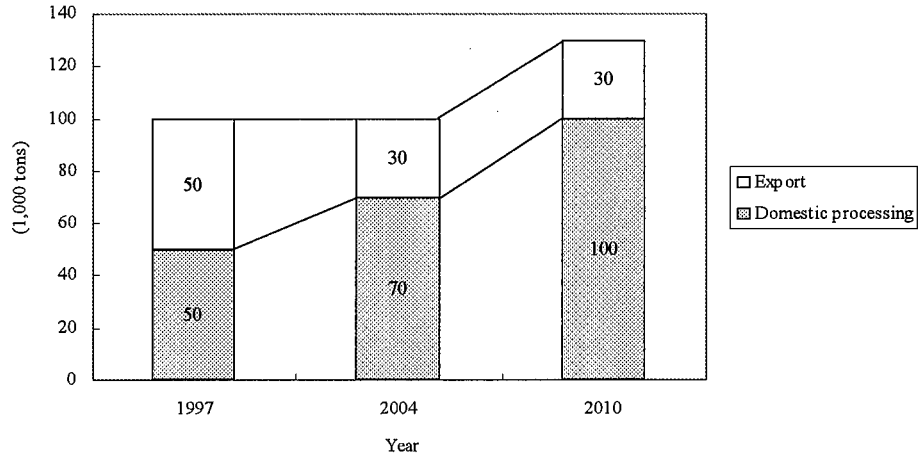
Through discussions with the Rubber Research Institute (RRI), it is found reasonable to expect that natural rubber production will increase or recover to the level of 130,000 tons per annum through improvement of rubber productivity.

Now, it is an important and strategic question of how the country will make a plan for consumption of its valuable natural rubber, even though "market" decides it in principle. Sri Lanka should utilize its local natural rubber mainly for manufacturing high value added rubber products which require chemical components and characteristics of high quality natural rubber produced in the country. This is of high importance to be considered, because production volume of rubber products are expected to increase along with the country's overall economic growth, while production volume of natural rubber will be limited in the long term.

If Sri Lanka intends to develop the country's rubber industry as a competitive industry, it should have a clear plan for utilization of limited resources of natural rubber. It is planned that the country will increase domestic consumption of natural rubber to supply enough volume of

raw materials to the growing rubber industry, while it reduces volume of exports. A future plan of natural rubber utilization is presented in the figure below.

Future Plan of Natural Rubber Utilization



In the event that the above plan is implemented, the production and value of the rubber industry in 2004 and 2010 are estimated as tabulated below.

Estimated Production and Value

		2004	2010
Raw Natural Rubber Export			
Volume	(tons)	30,000	30,000
Value	(billion)	2.4	2.4
Processed Rubber Products			
Natural Rubber Volume	(tons)	70,000	100,000
Rubber Product Volume	(tons)	140,000	240,000
Value	(billion)	32.2	67.2
Total			
Production Value	(billion)	34.6	69.6
QVA	(billion)	14.2	33.6

2) Analysis of "Products-Market" Matrix

A products-market matrix table shown on the following page describes the current manufacturing situation and potential markets of the rubber industry. Products evaluated as having "big/medium potentials" in the table would be selected as targeted or focal products which should be accounted with priority in promoting further development.

Projects-Market Matrix

[Dry rubber based products]

	Products	Key technology	Domestic	India	SAARC*	ASEAN	Europe	USA	Marketing	Research Mild.east
1)	Tyre : steel radial for motor vehicle	Road endurance, cost	O×	O	O	O	△	△	△	O
2.1	Tyre : bias tyre for motor vehicle	Road endurance, cost	O	O	O	O				
0.2	For bus & truck, light truck	Gen. quality, cost	O△	O	O	O		△	×	O
0.3	For agriculture: pneumatic	Endurance, cost	×△	O	O	O	O	×O	×	O
0.4	For heavy duty: truck	Gen. quality, cost	×△	O	O	O	O	O	×	O
0.5	For motorcycle, bicycle	Gen. quality, cost	×O	–	O△	–	+	+	+	O
0.6	of Re-tread for all kind	Gen. quality, cost	O	–	–	–	–	–	–	–
3.1	Automobile : Mud guard	Competitive cost	△	+	+	+	+	+	+	△
0.2	: Window profile	Quality, technology	△	×	×	×	+	+	+	×
4)	V-shaped belt: for industry	Quality, technology	△	△+	△+	△+	△+	△+	△+	△
5)	Rubber roller: for machine	Quality, technology	×	△+	△+	△+	O+	O+	△+	△+
6)	Mat: shoe soles, floor, can & bottle seal	Quality, cost	×△	–	–	–	O	O	O	×
7)	Industry mat: bridge, rail pad, machine	Quality, cost	×	×	×	×	+	O+	O+	△
8)	Hose & pipe: oil resistive, mobile use	Quality, cost	△	O+	O+	△	O+	O+	O+	△
9)	Cable & wire extruded: oil resistive,	Quality, cost	△	△	+	+	+	+	+	+

[Latex based products]

	Products	Key technology	Domestic	India	SAARC*	ASEAN	Europe	USA	Marketing	Research Mild.east
1)	Latex based products									
1	Surgical gloves	Thin & tough	×	×	×	×	O	O	O	△
2	Examination gloves	GMP systems	×	△×	△	△	O	O	△	△
3	House hold gloves	Formulation for	×	△×	O	O△	O	O	△	△
4	Catheters	Fine technology	×	××	△×	△	△	△	△×	△
5	Teething rings /pacifiers	Hygiene formulations	×	××	△×	△	△	△	△	△
6	Balloons: toy & meteorological	High technology	×	×	×	△	△	△	△×	△
7	Finger stalls	Low cost	×	△	×	△	△	△	△	△
8	Condoms	High tech. & invest.	O	O+	O+	△	O+	O+	△×	O+
2)	Rubber thread	High tech. & facility	O	O+	O△	△	O△	O+	O+	O+
3)	Adhesive/ bonding agents	Formulations	O	O△	O△	–	–	–	–	–
1	for Plywood, packaging	Formulations	O	–	–	–	–	–	–	–
2	for Footwear bonding	Formulations	O	–	–	–	–	–	–	–

O: Big Potential, △: Medium X: Small, –: Out of target, *: except India, +: Attractive

*: SAARC is SAARC countries except India.

Through analysis of the "products-market" matrix, some observations are presented on major rubber products as follows:

(i) Tyres:

In the domestic market, steel radial tyres and bias tyres for passenger car use, bias tyres for buses and trucks, and tyres for motorcycles and bicycles appear to have big potential. New registration of motor vehicles in Sri Lanka, particularly of cars and trucks, has gradually increased in recent years, as shown below. Usually, replacement of tyres is required every 3-5 years, and new car registration itself will increase gradually, given a steady economic growth. When the road infrastructure develops, demands in tyres will be further increased. In Sri Lanka, there are still demands in old types of bias tyres, mainly for buses and trucks, and this will remain unchanged in the near future.

New Registration of Motor Vehicles

(units)

Type	1994	1995	1996	1997
Cars and trucks	26,340	31,746	33,400	33,397
Bus and coaches	3,823	1,700	1,479	2,059
Cars (include dual purpose)	22,517	30,046	31,921	31,338
Motor cycles	36,791	34,207	31,955	36,755
Goods transport vehicles	5,213	7,293	5,600	5,561
Land vehicles	7,160	9,294	8,340	7,652
Others	34	30	65	16
Total	101,878	114,316	112,760	116,778

Source: Central Bank of Sri Lanka

Export markets in India, other SAARC countries, ASEAN, Africa and the Middle East seem to be promising. Because different technological and quality features of products are required for those markets, efforts for marketing and technological upgrading will be required to gain shares. Heavy duty tyres for truck and pneumatic tyres for agriculture also have potential for market expansion in Europe and USA.

(ii) Industrial products:

In general, current domestic markets of industrial dry rubber products are relatively small because of the infant stage of industrialization. Even so, there exist some markets and production capabilities of such industrial dry rubber products as automobile parts, V-shaped belts, oil resistive pipe, and cable & wire extruded covering. In line with the progress of industrialization, markets for industrial dry rubber products will grow, particularly for the electric/electronic industry and general machinery industry.

(iii) Latex based products:

Latex products have higher value addition than dry rubber based products such as tyres. In the fields of latex bassed products, domestic markets for condoms, rubber thread, adhesive/bonding agent would be promising, though markets for gloves for surgical, examination, and household use are small. Export of gloves for household use to the SAARC countries, all gloves to USA, and gloves for surgical use to Japan will have bigger opportunities. Condoms also have a big potential for export. Sri Lanka will continue to produce raw natural rubber of top grade such as sole crepe and pale crepe in more acceptable forms of manufacturing and packaging to the end user. They are the only grade of rubber produced anywhere in the world with a low level of proteins and hence the safest for making medical and infant products. This is one of the strongest features of latex based products in Sri Lanka, and an industrialization plan should make an effective use of such characters.

(iv) Rubber thread

Rubber thread and adhesive/bonding agents seem to have a big potential in the domestic markets. Market expansion is expected in line with further development of packaging, plywood, and footwear industries. For exports, rubber thread has a big potential in all destinations except ASEAN which will be a competitor for the Sri Lankan products. In spite of big potentials of market, all of several plants for rubber thread production in Sri Lanka are out of operation because of no technology for marketable products. It is required to start R&D over for production. Development of highly competitive rubber thread manufacturing based on high quality natural rubber would become one of key issues in the overall development strategy of the rubber industry.

3) Selection of "Focal" Products

Basically, promising products which appear on the products-market matrix table are candidates of focal products. In addition to that, limitation of high quality natural rubber in terms of volume should also be considered. If Sri Lanka succeeds in inviting or developing appropriate technologies to process high quality natural rubber to higher value added products, the country would benefit more by increasing GVA in the rubber industry. In this respect, high quality products which require and can utilize characteristics of Sri Lankan natural rubber in the most effective manner should also be included in focal products. These technologies would be introduced by FDIs. It is appropriate to include products whose technologies can be brought by FDIs to complement the current technological base in Sri Lanka and to bring about technological upgrading of the domestic rubber industry. As a result of these considerations, the following have been selected as "focal products" of the rubber industry in Sri Lanka:

Focal Products in Rubber Industry

Category	Products	Key technology
Dry rubber based products	Steel radial tyre	Road endurance, cost
	Bias tyre	Road endurance, cost
	Rubber roller for machine	Quality, technology
	Mat: shoes soles, floor, can & bottle seal	Quality, cost
	Industry mat: bridge, rail pad, machine	Quality, cost
	Hose & pipe: oil resistive, mobile use	Quality, cost
Latex based products	Surgical gloves	Thin & tough
	Examination gloves	GMP systems
	Household gloves	Formulation for dermatitis
	Condoms	High tech. & investment
	Rubber thread	High tech. facility
	Adhesive/bonding agents	Formulations

4) Strategies for Marketing

As the first step of effective marketing efforts, it is vital to understand the country's current rubber processing capabilities in terms of product range, quality, and cost competitiveness in a systematic manner. It is afraid that the current situation is not really understood by people in both industrial and public sectors. By organizing and restructuring collaborative groups and institutions inside the industry, understanding of the current situation and clear targets for products and technology should be shared. Internal development of collecting and sharing information should be promoted as a basis for upgraded marketing.

The second step is to take a proactive approach to cultivate export markets. The strength of rubber products made in Sri Lanka is their high quality derived from a world class quality of natural rubber produced in the country. It is important to let worldwide customers know much about Sri Lankan rubber products and their quality, and also to understand the needs and requirements for rubber products by customers in a global market. One of the ideas is to organize a "marketing promotion mission" of the rubber industry, for visits to major potential customers in export markets and have discussions on users' needs for product performance, quality, price, and so forth. The mission should be organized by a private initiative and collaboration by the industry, but possibly with some assistance by the public sector. If the mission brings samples of focal rubber products and listen to customers' responses, discussion would be fruitful. When customers are at least interested in Sri Lankan rubber products as a whole, direct sale efforts by individual companies become much easier. The rubber industry in Sri Lanka should start with sincere efforts of following and understanding changing customers' needs and requirements for the focal products, and promoting its high quality products in a global market.

The third step is to draw a clear map for development of targeted focal products. Detailed analysis of current advantages and disadvantage of each targeted products should be performed in consideration of future needs of customers. Categorization of products with references of "export-competitive" and "export-competitive with some improvements (i.e., quality, cost, property)" will be required. If modification for improvements is economically feasible, start with upgrading of technologies for those products, possibly given advice and assistance from experts in the advanced countries. Organization of a trade fair is also effective to promote export of targeted products and to stimulate competition among domestic manufacturers through advanced information sharing.

With a growth of information technology in Sri Lanka, the Internet will be a useful tool for sales development. Enterprises will be able to advertise own products through an Internet homepage and to make sales promotions by the Internet.

3.3 Technological Upgrading and Quality Control

1) Technological Upgrading

Analysis on strengths and bottlenecks of the rubber industry in Sri Lanka reveals that the industry requires a lot of efforts for technological upgrading to play a leading role in the country's industrialization. To take an effective approach, there should be a clear policy statement on "mission" of the industry, as well as of a "corporate mission" of each enterprise. The mission for technological upgrading of the rubber industry is proposed to set as follows:

(i) Become the No.1 rubber processing country, manufacturing products of high competitiveness backed by strong technological capabilities.

(ii) Make maximum and effective use of world-top class high quality natural rubber based produced in the country.

In line with this, a strategic plan for product development, process improvement, quality control, and R&D issues should be worked out to foster development and improvement in focal products.

The first step to promote technological upgrading is to make a clear recognition about strengths and weaknesses of the current technological bases. Successive factory inspection and diagnosis by experts, sometimes from the advanced countries, would be a practical and effective approach. This should not be a one way teaching by experts, but be an interactive approach through successive discussions between experts and factory engineers to encourage their own efforts for problem-solving and improvements. Problems or "seeds" for improvements are to be clearly found and defined, and various approaches for problem-solving such as production control method, quality control method, and value engineering are to be considered.

In some product areas, technological transfer from foreign countries should be considered. The industry as a whole had better select some specific areas and products as in the case of "focal products" to which efforts are concentrated in introducing product development and production technology through technical transfer from abroad. Such focused areas should be

of high value added products which are manufactured in light and small shapes, but require high quality of raw natural rubber which can be procured in the country. The public sector also should extend support to promote technological transfer in these selected areas.

R&D efforts should also focus on the selected areas and products such as sterilizing technology for surgical glove, rubber thread, and low air permeability rubber. An integrated approach by academia, institutes and enterprises is required, and some organizational restructuring might be considered to accelerate technological upgrading. Frequent, effective information sharing and joint activities of research and development is strongly recommended.

2) Quality Control

Factory visits reveal several issues to be addressed in relation to quality control programs. In many factories, 5S activities are performed, but the results are not reflected to improve the situation due to lack of a proper QC cycle. Quality control on product design, market-in production, and cost analysis (value engineering) has not yet been introduced in many factories. Each individual is not always conscious of quality control methods. Quality control in the rubber industry in Sri Lanka, therefore, has room for improvement.

It is important to understand that there are four different aspects of quality control, i.e., management quality, production quality, quality assurance, and environmental quality. Two issues, production quality and environmental control, should be considered with priority at the first stage of improvement until 2004. By learning concepts and techniques of QC, each factory is expected to draft its original QC plan. A quality control method should not be taught as a tool on the book, but a practical operational tool on the job. Quality control on product design, process operation, process maintenance should be enhanced at each shop and individual worker. 5S and small group activities are practical and effective methods for an introduction. Leadership of middle managers to QC on the job is of vital significance. 5S activities should be gradually integrated to "small group activities", "zero defect in each shop", and overall quality improvement program in the factory as a whole. Activities to apply for ISO 9000 and ISO 14000 would be a good way to set a clear target to improve the level of QC.

Addressing environmental issues often upgrades quality control of products, because process improvement for environmental control is associated with issues of product quality itself. Improvement of environmental control in a latex treatment factory, industrial waste control at

a rubber processing factory, and process improvement in raw rubber processing (rubber compound mixing) would become central issues.

At the latter stage of development after the year 2005, management quality control and quality assurance should be emphasized to promote technological upgrading. Quality control on overall business activities (e.g., product design, marketing, shipment, and customer service) should be enhanced and improved to make better business performances. At this stage, the concept of "Total Quality Control (TQC)" would better be introduced. The rubber industry and the public sector in Sri Lanka are advised to cooperate with each other to establish a "quality assurance system" to support above mentioned efforts by each enterprise. When an official quality assurance system backed by a formal testing service is enhanced, rubber products in Sri Lanka could establish a better "brand name" and competitiveness in a global market.

3) Environmental Control

Environmental control is required mainly for protection from odor, waste water and solid waste disposal in the rubber industry. Major environmental issues are bad odors for rubber processing factories, and bad odor, waste water and solid waste disposal for latex product factories.

Most rubber processing factories in Sri Lanka have not taken appropriate measures to prevent bad odors. It is therefore recommended to take following measures:

Emission Source and Prevention Measures of Bad Odor

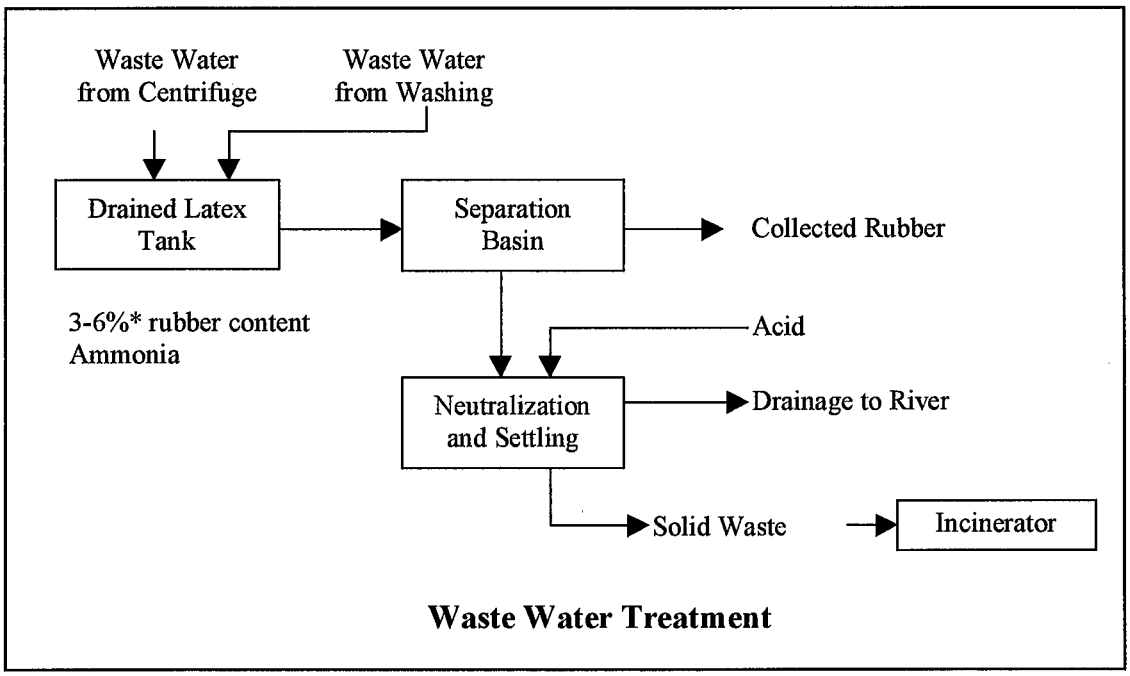
Emission Source	Preventive Measures
Rubber mixing process	• Catalytic incineration • Adsorption by activated carbon • Chemical absorption • Masking • Change in rubber grade
Vulcanization	• Chemical absorption • Catalytic incineration
Whole factory building	• Ventilation • Absorption

Some latex product factories are purchasing field latex from small holders and concentrating it into centrifuged latex in Sri Lanka, while others are purchasing centrifuged latex for manufacturing latex products. The latex product factories that are purchasing field latex as

raw material have storage tanks of field latex, where ammonia is added. The bad odor of ammonia is emitted from these tanks, unless no measures are taken. In large factories, gas emitted from the tanks are collected and washed by water in scrubbers. However, such facilities are not provided in most factories of SMIs; hence a bad odor is emitted to into the atmosphere and the inhabitants near the factories are making complaints. It is strongly recommended for SMIs to take measures for environmental control of bad odors.

Most rubber factories, including SMIs, have set up a system for collection and recycling of off-specification products before vulcanization, and wastes that cannot be recovered are incinerated by small incinerators.

As noted in Sector 1.5, however, waste water discharged from the production process of centrifuged latex and washing of latex based products is not treated in most of the SMI factories in Sri Lanka, though waste water is treated in some large factories. It is therefore recommended that waste water treatment facilities be installed in such SMI factories, or alternatively small rubber processing factories be collectively located to have common facilities for waste water treatment. A standard waste water treatment system is applicable as shown below.



Waste Water Treatment

4) Testing Authority

Although there is positive evaluation for "Made in Sri Lanka" rubber products to some extent, this image has not been well managed to proliferate in a worldwide market. In Sri Lanka there are two organizations, the Rubber Research Institute of Sri Lanka (RRISL) and the Industrial Technology Institute (ITI), which research and test rubber products. Strengthening official testing and export inspection for quality assurance are important issues to improve overall quality level and increase credibility of Sri Lankan rubber products. In this respect, it is proposed that the analytical function be installed in RRI or ITI so that they can issue certificates in exporting rubber products. Effective collaboration with the Rubber Research Board (RRB) in Malaysia would also be beneficial to improve quality level of rubber products in both countries.

3.4 Manpower Development and R&D

1) Current Situation

Human resource development through higher education and vocational training is an integral part to develop the technological bases of the rubber industry in Sri Lanka. It is observed that education and training courses for the rubber industry is currently fragmented, though there are lots of courses and curricula in various institutions, academia, and organizations, including training courses at the Vocational Training Bureau, ITI, and Rubber Products Development Service Center in RRI. For instance, in academia, basic courses and curricula are evaluated as being well prepared in rubber chemistry, rubber processing, and property analysis. However, there are no professors nor teaching staff who have experiences in the industry, which makes it difficult to give practical courses. Moreover, facilities and equipment at universities are quite limited and little opportunity is offered to students to experience an operational training. Many managers in the industry cite that an effective training system to introduce practical training for their young workers is necessary, particularly for SMIs which do not have an integrated in-house training center.

2) Measures to be Taken

Several measures should be taken to overcome the weakness of the current situation and to develop competitive human resources for the rubber industry in Sri Lanka. It is important to encourage more cooperation and collaborative approach among universities, institutions and the industry. It is proposed that RRI should continue to provide practical training of rubber product manufacturing technology more effectively for an intermediate class such as foremen

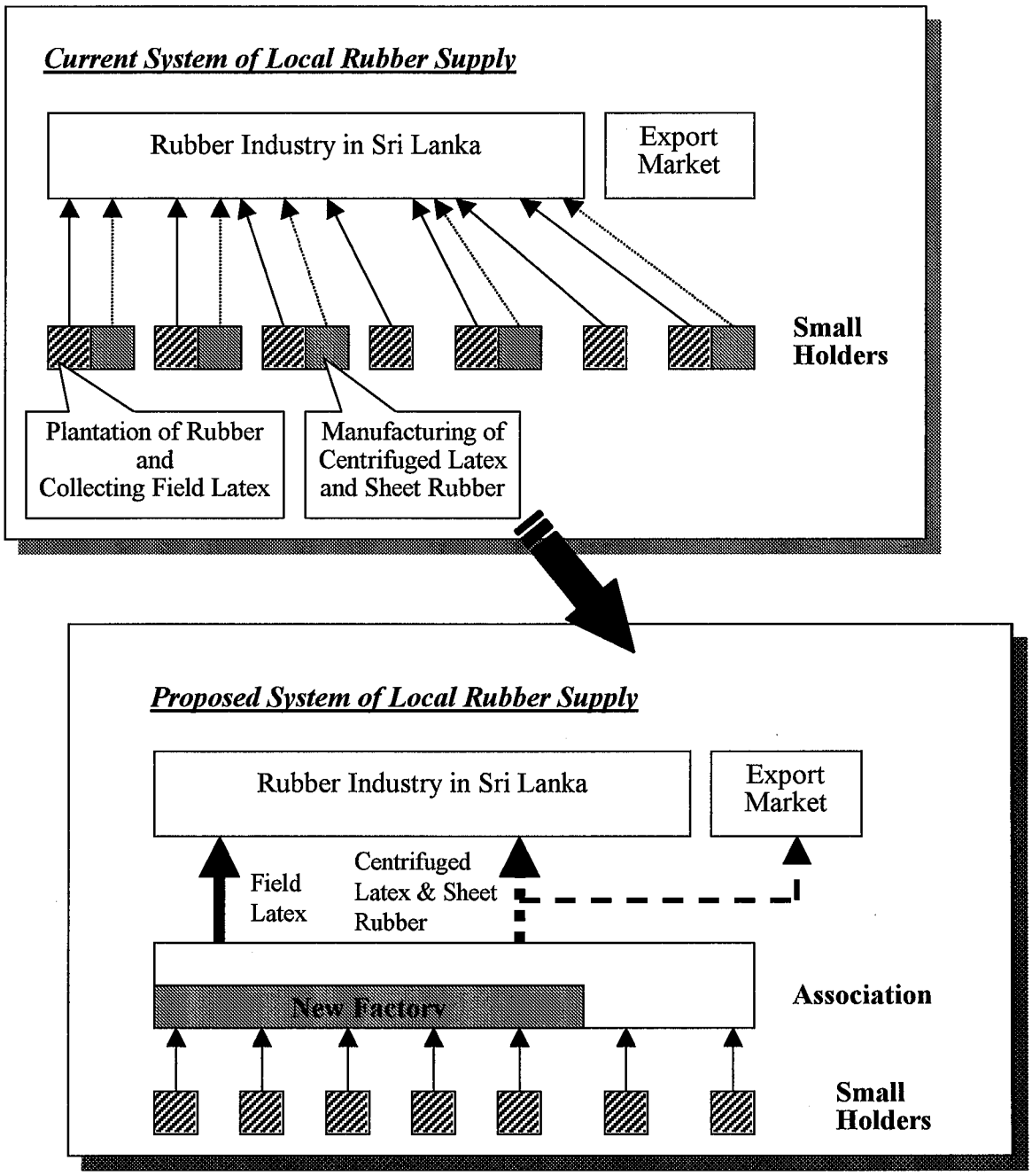
and supervisors. This would be more supportive and productive with the support from PRI (Plastic and Rubber Institute) and ITI. Such intermediate class trainees are expected to be instructors for workers' training in factories to enhance the technical skills of the factories. It is necessary that RRI be equipped with laboratory scale production facilities for its own R&D work and for practical training. A detailed plan of practical training is proposed further in Section 3.7.

3.5 Restructuring and Enterprise Development

1) Improvements in Local Rubber Supply

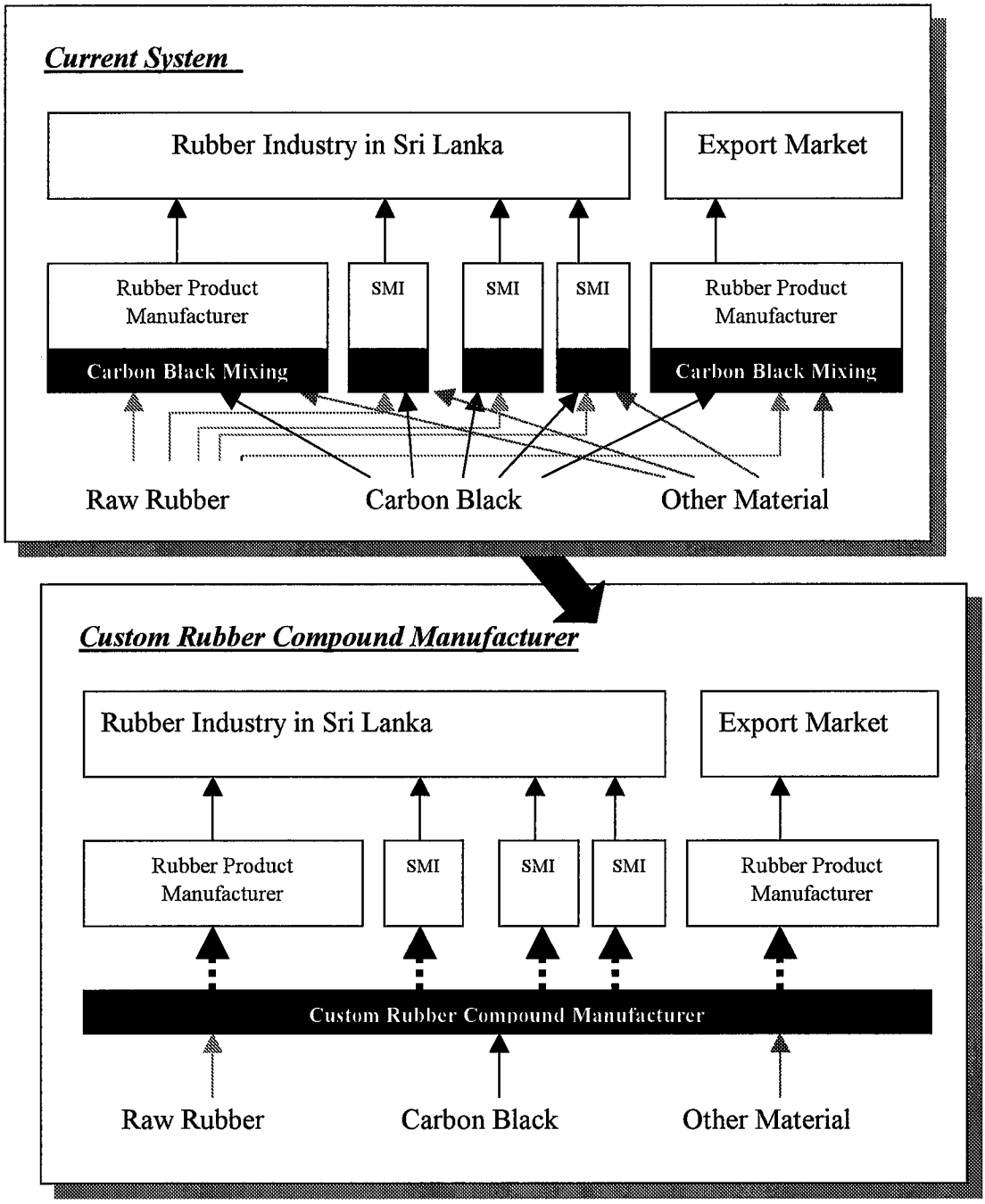
Raw material supply is an essential issue for the rubber industry in Sri Lanka. Improvements in raw material supply is therefore proposed not only for development of the rubber industry but also for improving rubber products in Sri Lanka as a whole. In Sri Lanka, large public plantations produce 20% of field latex, and a great number of small holders produce the remaining 80%. These small holders supply not only field latex to the rubber industry for manufacturing centrifuged latex but also sheet rubber (RSS) manufactured by themselves as a household industry. Consequently, manufacturing of sheet rubber by the small holders creates problems in (i) poor quality and consistency of sheet rubber, (ii) low productivity, (iii) low efficiency of collection, and (iv) bad odor emission and waste water discharge due to lack of environmental protection facilities.

Under such circumstances, it is recommended that associations be organized by small holders and new factories be set up for manufacturing of sheet rubber and centrifuged latex. Eventually, cooperative delivery of sheet rubber, centrifuged latex and field latex could be realized. The new factories should be equipped with facilities for environmental protection. To implement this restructuring, both financial and technical support are necessary from the Rubber Development Department (RDD) and RRI.



2) Creation of Custom Rubber Compound Manufacturer

In Sri Lanka, mixing of raw rubber and carbon black is executed in a rubber product factory. This operation is quite dirty and working conditions are hard. Due to this hard working condition, skilled labors are unwilling to work in this operation. It is also noted that most factories need replacement of facilities in this operation, since those facilities are quite old, causing poor quality of products.



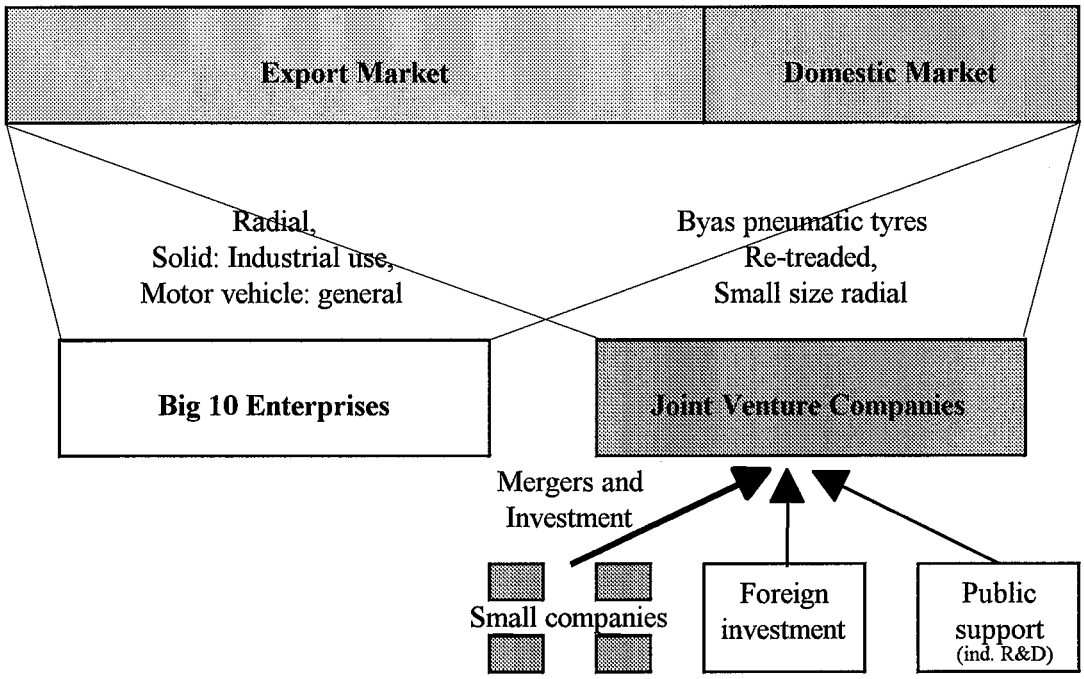
It is therefore recommended that a new company be set up to produce a custom rubber compound by mixing raw rubber with carbon black on a larger scale. The new factory should be equipped with environmental control facilities to maintain good working conditions and new mixing facilities, as well. The new company sells the custom rubber compound to the rubber products companies. Each rubber product processing company should adjust composition to the purchased custom rubber compound in order to meet specific requirements respectively.

By establishing a new company for custom rubber compound, benefits will accrue from the effects that (i) no replacement cost is required for individual companies of rubber products, (ii) large-scale production reduces production costs, (iii) both raw material and transportation costs reduction is possible by purchasing a large volume of raw materials, and (iv) good working conditions can be secured for labor force.

3) Restructuring of SMIs

To promote an effective development of the rubber industry in Sri Lanka, integration and reorganization should be considered. For instance, the tyre manufacturing is composed of a dual structure of FDI companies who have solid foundations of business and SMI companies who have fragile business foundations. There is one Sri Lankan rubber product company having a large share (20%) of industrial use solid tyres in the global market, while 30 enterprises out of total 40 tyre manufactures are SMIs with a weak management infrastructure. It is estimated that only 24% of tyre production is of new tyres, and the rest is of rebuild/retread tyres.

To enhance competitiveness in the industry, establishment of several joint venture companies through mergers of existing SMIs will be one option to be considered. This approach is appropriate for such focal products as bias pneumatic tyres, re-treaded tyres, and small-scale radial tyres, where a structure of fragmentation exists at the moment. If joint venture companies are established, they could accumulate all the resources for business and focus their efforts on specialized products to upgrade their technologies and products. Some measures and assistance by the public sector should also be considered to encourage these initiatives.



An idea of Restructuring Tyre Industry

The segment of rubber products for industrial use has a small production scale in terms of both volume and value at the moment. However, value added is relatively high in these products (around 5 to 7 times the price of raw rubber). This is a promising area for increase in demand in line with an advancement of overall industrial structure in Sri Lanka. Because technological and management resources in this field are still scarce in the country, some measures should be carefully designed to invite technical transfer and FDIs. Concentration of technology, human resources, and capital into an integrated entity will be desirable in calling for FDIs to establish a globally competitive basis in the sector.

To realize those restructuring, the role of "association of industry" is important. It is observed that there is no effective function or "forum" which discusses common tasks and issues to be addressed in the industry. If top managers in the industry move effectively to cooperate under the association, it could initiate any restructuring moves as proposed herein.

3.6 Clustering Program

Because the rubber industry is a basic material supplier to other manufacturing sectors, there exists a close relationship between the rubber industry and the others. An effective

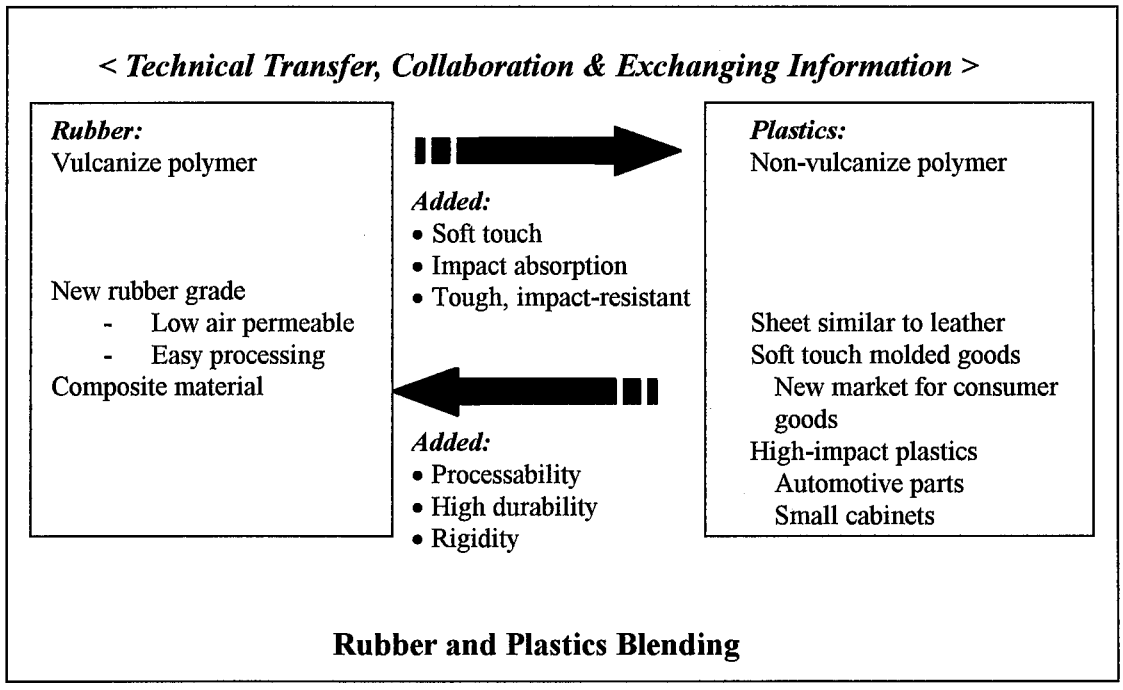
cooperation and coordination of development programs among related industries are expected to realize a maximum effect of "clustering".

1) Clustering with Plastic Industry

While plastics are non-vulcanize polymers, rubber is a vulcanize one, showing different types of property of high quality. Though these two are competitive products each other in terms of basic materials for downstream manufacturing industries, there are some areas in which the two sectors should take a collaborative approach.

One is R&D, where some polymer engineers are pioneering to develop a "blended composite" of rubber with low level vulcanization and polyethylene plastics. By making a joint research and development, both plastics and rubber industries can make an effective interaction to increase their technological bases and to develop new products. This collaborative approach for research and development, as well as a fair competition between the two, would also stimulate and create new demands in these material-using sectors.

As an initial step to make collaboration, information exchange in market development, technical transfer between the two sectors, and cooperation in some specialized theme and topics would be recommended.



Rubber and Plastics Blending

2) Clustering with Electric/Electronic Industry

The electric/electronic industry is another subsector with which the rubber industry should build a close relationship. If the rubber industry in Sri Lanka takes responsibility for supplying competitive and advanced materials to the electric/electronic industry, industrialization of the country will be further upgraded. It is important for the rubber industry to function as a competitive "supporting" industry for the electric/electronic industry.

One example is a new type of "blended composite with high-impact plastics" material mentioned above, which could be used for small cabinet and small key blocks of electric/electronic products. Another example is flexible "soft-touch" plastic materials for portable electronic goods. Cost effective material with high performance is a major source of product differentiation in material-using industries; therefore, a positive clustering effect is expected between the two sectors.

3) Clustering with Other Industries

As industrialization progresses in Sri Lanka, various environmental issues will occur. In many factories, requirements for noise reduction will become acute and this would call for a demand for new machinery which have a feature of reduction in noise. Rubber is an appropriate material for parts and components of those machinery and equipment; therefore, collaborative approach with the machinery industry is important.

Blending processing of rubber with a massive filter, which creates high performance of reduction in both noise and vibration, is one example of materials which could be supplied to the machinery industry as advanced parts and components.

3.7 Financial and Institutional Arrangement

1) Financial Arrangement

The majority of rubber enterprises (54% of 50 surveyed enterprises) are SMIs, and they lack in financial resources. Most SMIs, as well as large enterprises, expect that public support will be extended in financing at concessional terms. Assuming that 50 sample enterprises selected for the questionnaire survey represent the opinions of all the rubber enterprises in Sri Lanka, the demand for future borrowing is estimated to exceed Rs. 2 billion, respectively for public loan and commercial loan. This demand is estimated on the basis of the operation contemplated by rubber enterprises at the moment. When the rubber processing industries are

developer as proposed in this Master Plan, the demand for financial borrowing will be further increased. It is recommended that efforts be further made by the government to secure enough funds to meet the demand for borrowing in the rubber industry.

2) Promotion of FDI

Foreign direct investment (FDI) is expected to share a substantial contribution to double domestic rubber processing (from 50,000 tons to 100,000 tons per annum). Proactive promotion efforts for inviting FDIs are expected to encourage further technological upgrading of the rubber industry in Sri Lanka, particularly for manufacturing of tyres, industrial products, latex products, and rubber thread.

The following measures are proposed to promote further FDI to achieve production/processing targets of the rubber industry in Sri Lanka:

(i) Promote ideas of promising products for which the country has seeds, but does not produce a lot at present, and have a potential to enhance competitiveness through utilization of the country's high quality natural rubber. Such promising products will include steel radial and bias tyre, rubber roller for machine, industry mat, hose & pipe, surgical gloves, examination gloves, rubber thread, condoms, and adhesive/bonding agents.

(ii) Establish a fully equipped technology based laboratory at RRI for new technological developments to serve the industrial needs in R&D effort, to handle industrial trouble shooting, development of new value added grades of rubber for specific applications, etc.

(iii) Extend information about the high quality and competitiveness of natural rubber products in Sri Lanka, as well as incentives and promotion policies for FDIs particularly for the rubber industry.

(iv) Establish an official testing system in RRI that technological upgrading of the rubber industry in Sri Lanka has been elevated.

(v) Organize missions by the industry association to promote further collaboration with other countries (e.g., Malaysia) and to invite FDI and joint venture partners.

(vi) Develop human resources through practical training by the cooperative organization with leadership of RRI so that they can provide foreign companies of FDIs with competent human resources.

3) Reinforcement of Rubber Research Institute (RRI)

To enhance technical competitiveness of the rubber industry in Sri Lanka, four major functions are to be strengthened; i.e., technology development, testing, marketing, and training. These functions could be strengthened through reinforcement of the Rubber Research Institute of Sri Lanka (RRI). The function of technology department is needed to be competitive in the field R&D activities and serving the rubber industry in trouble shooting will also be part of these functions.

The function of official testing of product performance and quality is required to enhance competitiveness in the global market. While major FDI rubber processing companies take their own inspection and quality assurance procedures, the quality assurance by an official testing system for both FDIs and SMIs would bring about more reliance on products made in Sri Lanka. The function of proactive marketing and product development is also important to make best use of high quality natural rubber produced in the country. It is required to design a strategic use of valuable raw material resources by analyzing customers' needs and making an effective product development. The function of training and human resource development is required to sustain competitiveness. The training function could be effectively combined with the product development function. The three functions can be strengthened by expanding the existing RRI.

The current organization of RRI comprises five biological researches departments and four technological and chemical departments, all of which are focusing on researches. The technological and chemical departments are composed of the Rubber Technology Department, Raw Rubber Process Department, Polymer Chemistry Department, and Raw Rubber and Chemical Analysis Department. These departments are more oriented towards industrial development by carrying out such activities as; (i) adapting and developing new technologies, (ii) providing technical services for trouble shooting, (iii) training of technical persons, university students, and manufacturers, (iv) monitoring of environmental pollution, (v) implementation of quality assurance systems (analysis, issue certificates and quality controlling), (vi) energy management, and (vii) developing new grades of modified rubber for value addition to the raw market.

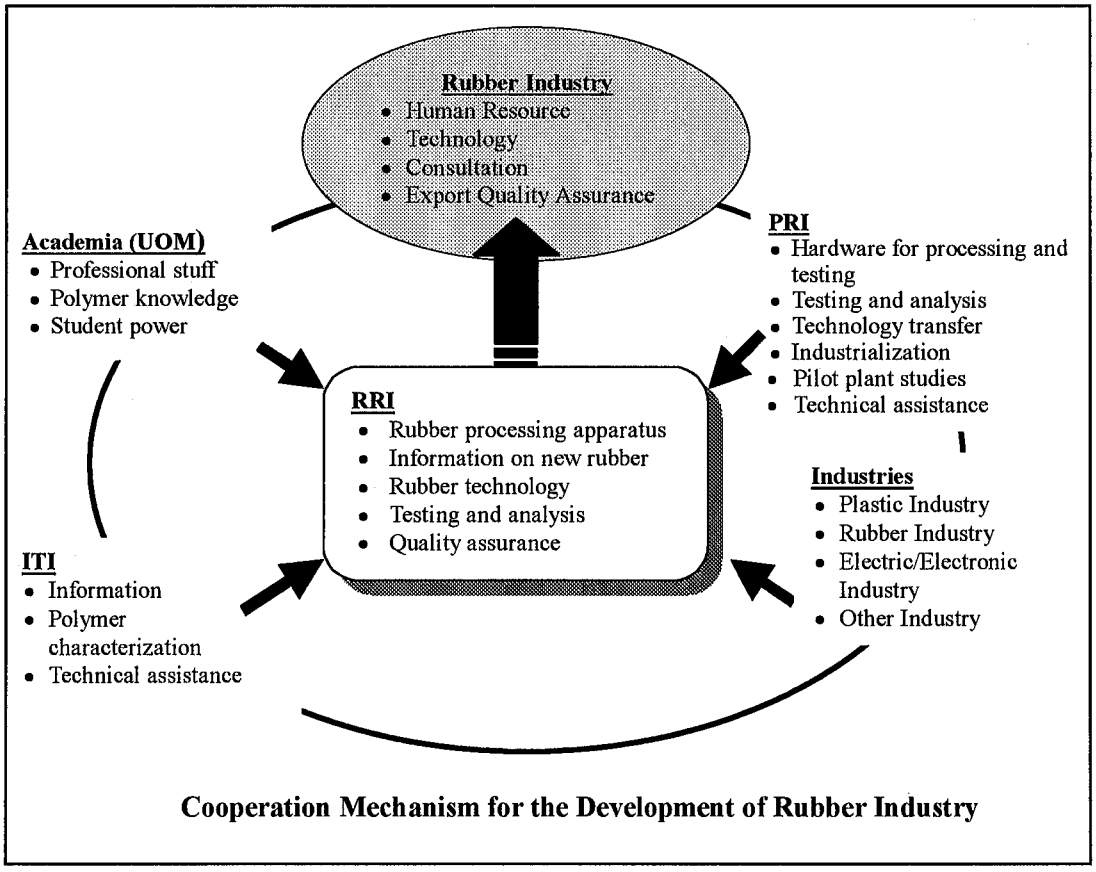
For reinforcement of RRI, it is proposed that an "Rubber Products Inspection and Testing Department" be newly established in RRI, or rename "Polymer Chemistry Department" which has no relevant meaning to the rubber industry, with the objectives to (i) conduct

quality inspection of natural rubber, centrifuged latex, and rubber based products, (ii) promote export of rubber and rubber products through quality inspection, and (iii) support export by SMIs through issuing certificates of product quality. To attain these objectives, RRI should be equiped with a tensile testing machine, ozone resistance tester, abrasion tester, Rhometer, DMA (differential thermal mass-spectro analysis) mooney viscometer, and other analytical apparatus such as total sulfur analyzer, ball mill, stress relaxometer, particle size analyzer (total 15 sets).

The reinforcement of RRI will make it possible to extend consultation to SMIs based on the technologies accumulated by R&D and practical training. Such consultations will cover; (i) troubleshooting for product quality and machinery, (ii) productivity improvement, (iii) cost analysis, (iv) diagnosis of factory, process, and management, and guidance for obtaining ISO 9000 and ISO14000.

4) Cooperation for R&D and Training

It is important to establish a mechanism of cooperation among academia (e.g., UOM), institutes (e.g., RRI, PRI, ITI), and the private sector for "research", "development", and "design"



Cooperation Mechanism for the Development of Rubber Industry

For R&D, it is suggested to include practical research on latex based products such as surgical gloves, tyre technology, rubber thread, new rubber materials with low air-permeability, racycling options, etc. At the same time, cooperation should be promoted for practical training of raw rubber processing technology, rubber products manufacturing technology, properties, and inspections (e.g., rubber chemicals, market-in, and product design).

4. ACTION PROGRAM (2000-2004)

Action programs to be implemented in the short term (2000-2004) are proposed to the private sector, academia, and the public sector, as follows:

1) Programs for the private sector

(i) Analyse the products-market situation, and study on market expansion through product development in the field of tyres, industrial products, latex products and rubber thread (refer to discussion in Section 3.2.2(2) and (3)).

(ii) Select focal products in molded/extruded products or latex products and concentrate on technology upgrading and quality control (refer to discussion in Sector 3.2 (3) and 3.3 (1)).

(iii) Study and implement some new factories by forming association of small holders in rubber plantations, for processing of field latex, centrifuged latex, and sheet rubber (refer to discussion in Section 3.5.(1)).

(iv) Study and implement restructuring of SMIs in formulating some custom rubber compound manufacturers (refer to discussion in Section 3.5.(2)).

(v) Study and implement restructuring of SMIs by establishing joint venture companies for processing of byas pneumatic tyres, re-treaded, small size radial tyres (refer to discussion in Section 3.5.(3)).

(vi) Promote clustering with the plastic industry, studying the possibility of collaboration in rubber and plastic blending (refer to discussion in Section 3.6.(1)).

(vii) Promote FDI and J/V with foreign investors in rubber based products, particularly for the focal products in dry rubber based and latex based products.

(viii) Control the environment at factories, particularly for protection of odor and waste water treatment (refer to discussion in Section 3.3.(3), and encourage recycling technology for used Tyres.

2) Programs for academia

(i) Support RRI by extending basic information and R&D activities, particularly for rubber and rubber technology and polymer composite.

(ii) Introduce curricula of more practical technologies for rubber processing.

(iii) Prepare textbook/handbook for practical rubber processing engineering, in collaboration with RRI.

3) Programs for the public sector

(i) Reinforce RRI through establishing the Rubber Products Inspection and Testing Department with adequate testing equipment (refer to discussion in Section 3.7.(3)).

(ii) Secure funds for financing to SMIs in their restructuring, product development, and environmental protection.

(iii) Cooperate in promoting FDIs and J/V, particularly for promotion of higher value added products.

(iv) Prepare promotional brochures for different rubber grades and rubber based products with specifications web pages etc in collaboration with RRI.

(v) To establish a Rubber Propaganda Unit to promote raw rubbers, specialty or value added grades and rubber products from Sri Lanka.

APPENDIX-G

PLASTIC INDUSTRY

G. PLASTIC INDUSTRY

Table of Contents

G. PLASTIC INDUSTRY

1. OVERVIEW OF PLASTIC INDUSTRY

1.1 Structures

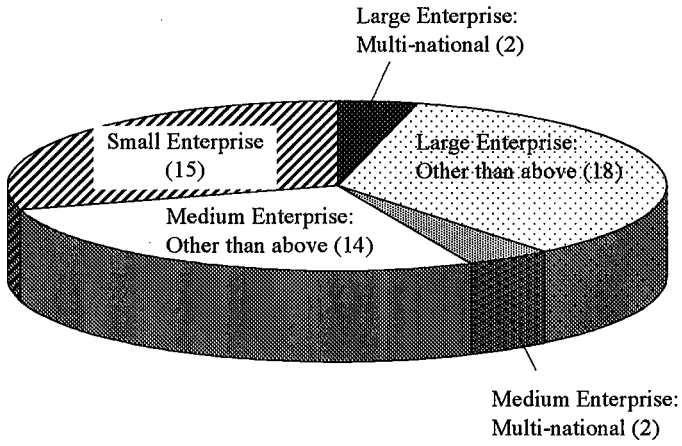
Statistics (Annual Survey of Industries 1996 Interim Report) which summarize the activities of manufacture of plastic products (ISIC 356), are as tabulated below. There were 57 enterprises with 25 employees or more.

Basic Indicators of Plastic Industry (1995)

No. of Establishment (1)	Employment (2)	Output (Rs. mill.) (3)	GVA (Rs. mill.) (4)	GVA ratio (4)/(3)	GVA per Worker (Rs.) (4)/(2)
57	7,164	3,375	1,326	39%	185,108

In the course of this Study, a questionnaire survey was conducted to 53 plastic enterprises, which included most of companies referred to above. The surveyed enterprises are characterized by organizational background as shown below.

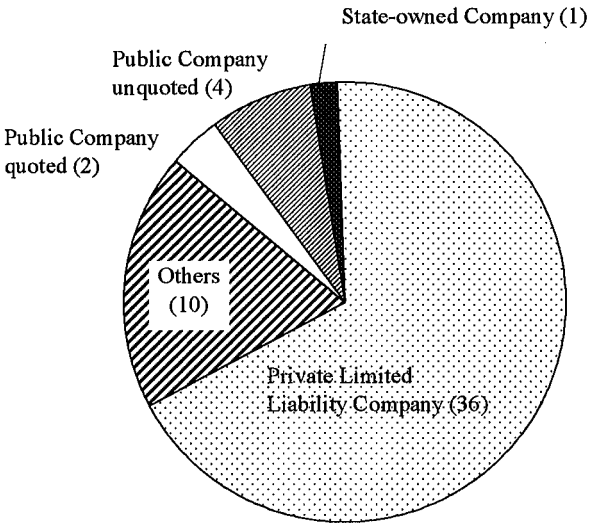
Character of Enterprises



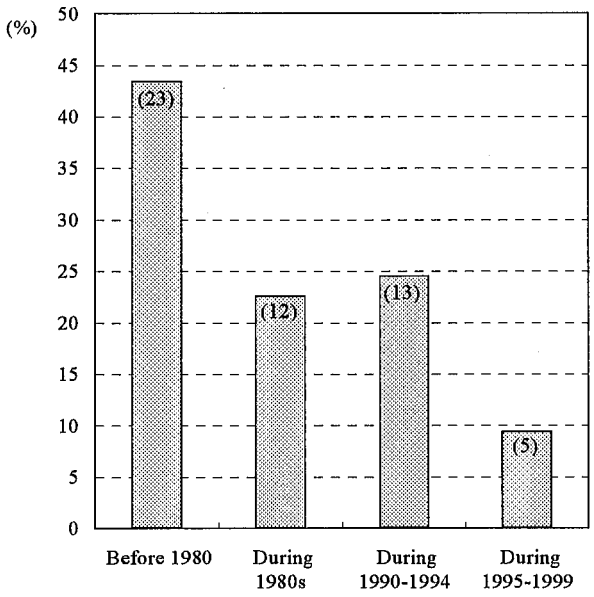
As shown above, nearly 60% of the plastic industry in Sri Lanka are small and medium industries (SMIs). Four large and medium enterprises are multi-nationals. Private limited liability companies account for 68%. The years of establishment are fragmented. While 34%

of enterprises have been established since 1990, about 43% were established before 1980.

Type of Organization

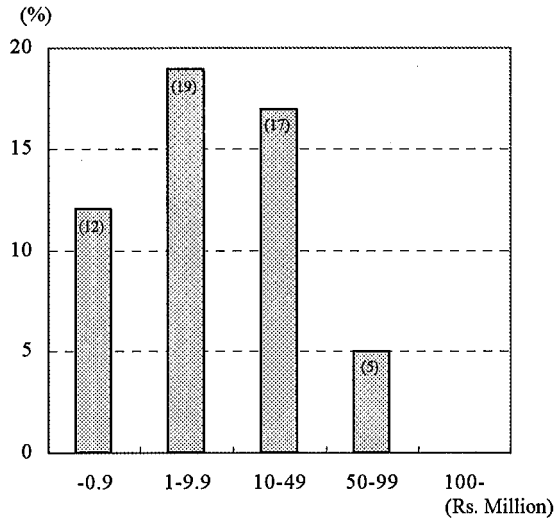


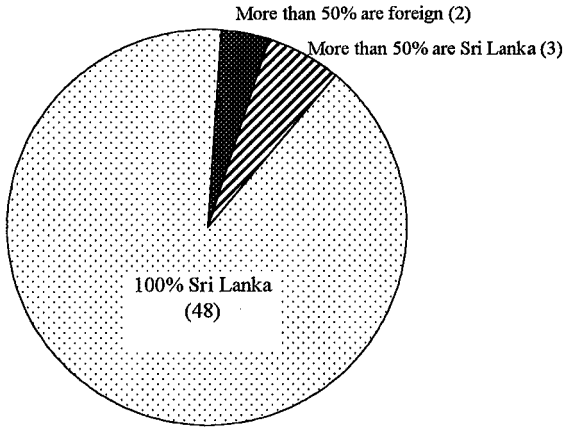
Year of Establishment



In terms of capital scale, 90% are small enterprises of less than Rs. 50 million. Most of them are of 100% Sri Lanka capital, while foreign capital participation accounts for 10%.

Paid up Capital and its Character





Note: Figures in parenthesis show number of enterprises.

1.2 Production and Input

1) Production and Sales

Plastic products are generally divided into two categories. One is commodity plastics for all-purpose applications on consumption, which are mainly composed of low density polyethylene (LDPE), liner low density polyethylene (LLDPE), polypropylene (PP), high density polyethylene (HDPE), and polyvinyl chloride (PVC). The other is for industrial use, where products are called "specialty" plastics or "engineering" plastics. Plastic products manufactured in Sri Lanka are dominated at present by end-use consumer goods such as buckets or containers. The country is still at the preliminary production stage of precision plastics such as parts or components of electronic products. However, the table below shows that engineering plastics for industrial use in Sri Lanka recorded a more remarkable increase than commodity plastics in recent years.

Production of Major Plastic Products

(1,000 tons)

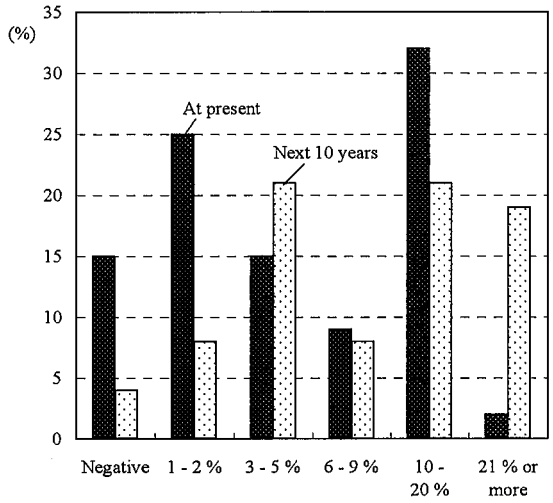
Raw Materials	Major Applications	1992	1996	1998	AAGR (92-98)
PVC	Pipes, Shoes, Hoses	14.0	18.0	24.0	9.4%
LDPE	Bags, Films, Tanks	9.5	12.0	15.0	7.9%
PP	Crates & containers	7.5	10.0	13.5	10.3%
HDPE	Consumer goods	7.2	9.0	12.0	8.9%
Others	Industrial uses	12.5	26.5	34.0	18.1%
Total		50.7	75.5	98.5	11.7%

Source: PRI and partly estimated by JICA Study Team

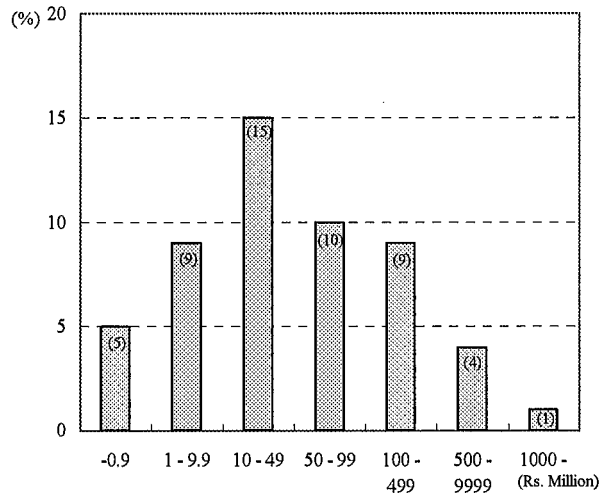
Based on several statistics, it is estimated that GVA of the plastic industry in 1998 amounted to about Rs 3,800 million.

Results of the questionnaire survey indicated that the existing enterprises were small in sales scale, and only 43% of enterprises had experienced growth of more than 6% in production, while 15% recorded a negative growth, as shown in the next figure. However, half of the surveyed plastic enterprises expect that their production will grow at more than 10% per annum in the next 10 years.

Growth Rate of Production



Sales Range



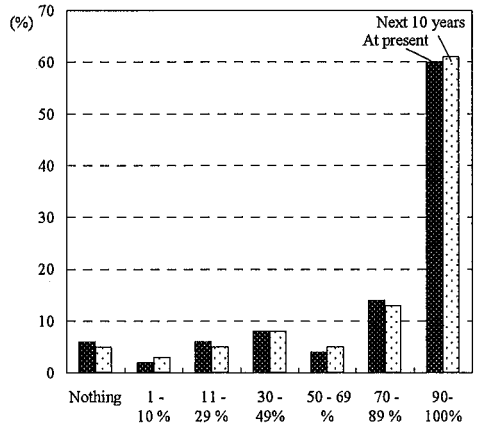
2) Raw Materials

The questionnaire survey revealed that the current import ratio of raw materials is quite high. 38 enterprises out of total 49 replies rely more than 50% of their raw materials on imports; i.e., 29 enterprises rely 90-100 % of their raw material on imports, and 7 enterprises for 70-90%.

Most raw materials for the plastic industry are produced by petrochemical industries which Sri Lanka does not have in any form. While some enterprises manifest their interests in reducing the import ratio, most of them foresee an unchanging situation of relying raw materials on imports in the future.

The origin of raw material imports varies widely. Major origin countries are Singapore (31companies), Korea (25), Middle East (22), Japan (18), India (17), and EU (10). It is noted that 12 enterprises are importing 100% directly from raw material suppliers, while 22 enterprises are mainly dependent on sourcing through a middleman.

Dependency on Imported Raw Materials



Origin of Raw Material Imports

Origin	Answered
Sri Lanka	6
Singapore	31
Korea	25
Middle East	22
Japan	18
India	17
EU	10
Others	28

1.3 Products and Market

1) Products-Market Matrix

A products-market matrix indicates the current situation of market potentials for domestic consumption and exports , as well as future capabilities of exports to major destinations. Utilizing this matrix analysis, one can find the current manufacturing and potential markets. This is a rather qualitative approach, but it is useful to step into the selection of targeted products. A matrix and its analysis are presented in Section 3.2.

2) Export/Imports

Sri Lanka imported raw materials for plastics (approximately 84,000 tons) in 1997, as well as plastics products (about 13,200 tons). On the other hand, Sri Lanka exported plastic products, mainly polyethylene and polypropylene products, of approximately 20,000 tons in 1997. The average value was Rs. 56/kg for imported raw materials, Rs. 218/kg for imported plastic products, and Rs. 125/kg for exported products.

Imports/Exports of Plastics (1997)

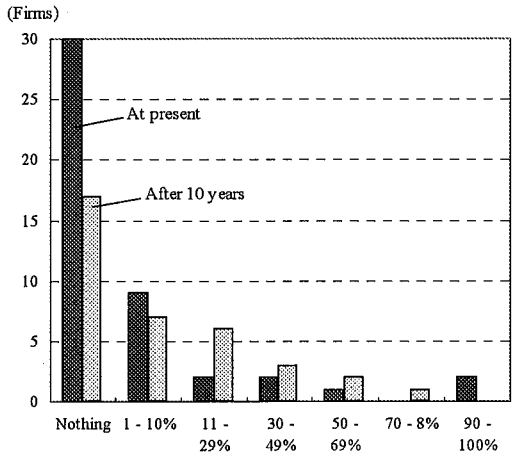
Imports		
Products	Quantity (tons)	Amount (Rs. Million)
Raw Materials		
Polyethylene	39,000	2,007
Polypropylene	15,000	682
Polystylene	2,000	150
Polyvynilchroride	18,000	920
Engineering plastics	10,000	919
(Sub-Total)	(84,000)	(4,678)
Plastic Products		
Polyvinylchloride product	1,540	225
Adhesive sheet	1,200	290
Film certified	2,500	500
PVC sheet	1,410	200
Packaging	2,100	480
Engineering plastics	1,650	580
Consumer goods	2,800	610
(Sub-total)	(13,200)	(2,885)
Total	97,200	7,563

Exports		
Products	Quantity (tons)	Amount (Rs. Million)
Polyethylene/polypropylene products	17,300	1,700
Article for conveyance	1,500	150
Statuettes/ornamental	200	398
Builders ware	354	171
Carboys, bottles	150	38
Bobbins, spools	70	28
Table wares	50	10
Shatters, blinds	8	7
Gloves	4	0.2
Total	19,636	2,502

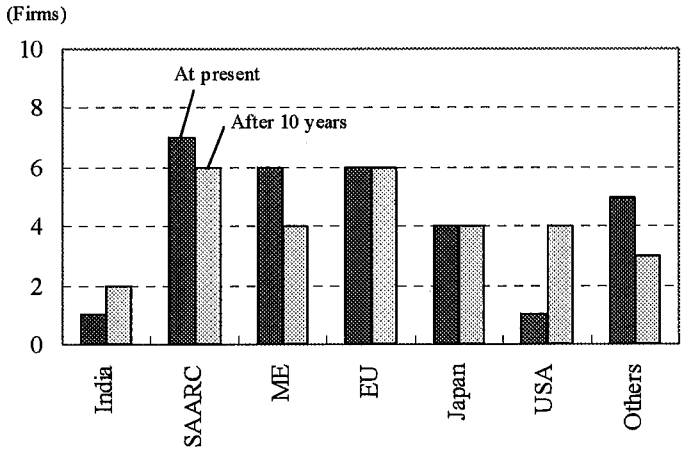
According to the questionnaire survey, there are 30 enterprises having no experience in exports, while 2 companies export 90-100% of their production. It is presumed that such export-driven companies are those with foreign capital investment. There is a clear preference to future export business, as the number of companies having no intention to export has

declined to 17. Destination of exports also widely ranges from the SAARC countries except India (7 companies), Middle East (6), EU (6), and Japan (4).

Ratio of Exports



Export Destination



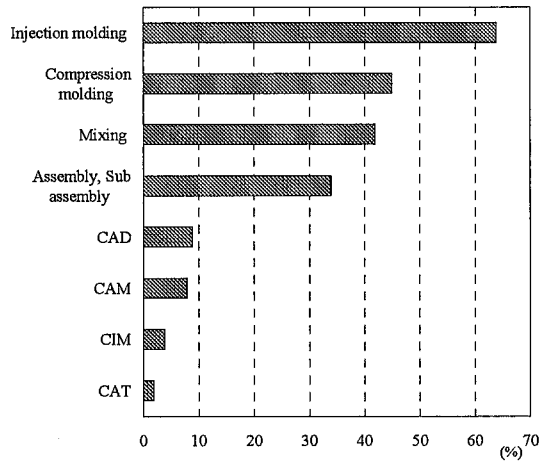
India (17 companies), China (8) and ASEAN (7) are listed as the major competitors for the domestic industry. For the next ten years, they will continue to be the biggest rivals.

1.4 Technology and R&D

1) Technology Level

Major technologies and processes used for production are injection molding (34 respondents), compression molding (24), mixing (22), assembly and sub-assembly (18). 13 enterprises are reported to use computer facilities (e.g., CAD, CAM, CAT, CIM). Major origins of technology transfer are Japan (9 respondents), India (8), EU (6), Singapore (5), and China /Hong Kong (5).

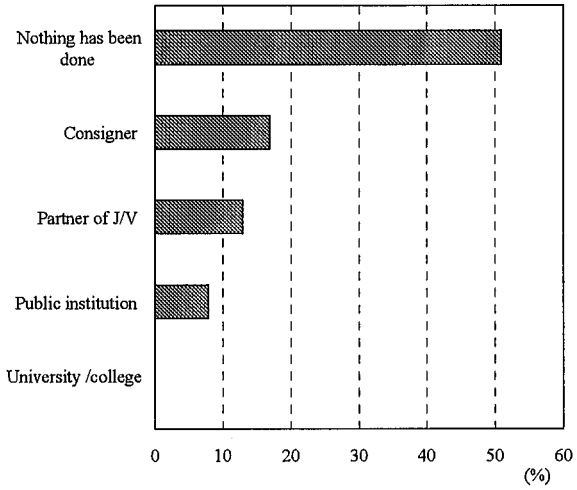
Technology & Process Used



2) Technology and its Transfer

The questionnaire survey revealed that 66% of the answered enterprises do not use any patent, with the implication that they do not produce technologically advanced goods. On the other hand, seven enterprises claim that they have their own patents, showing a certain level of their technology. Most technology transfer is performed through a partner of J/V companies (7 respondents) and consignors (9). On the other hand, there are 27 enterprises which have no experience in any technology transfer, indicating that they do not have any access to advanced technology.

Technology Transfer Source



Eight companies already have ISO 9000, eight are in the process of application, and 18 are planning to apply, which indicate a high level of interest in quality assurance. There is no enterprise who has registered under ISO 14000, but 20 companies have plans to apply.

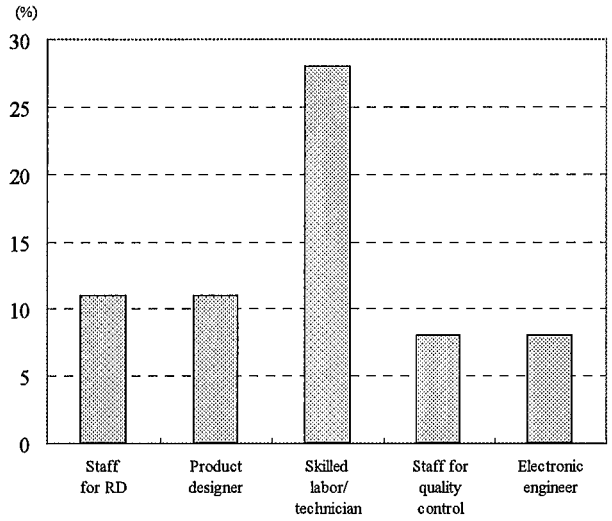
ISO 9000, 14000 Introduction

Total	answered	%	answered	%
Already have	8	15	0	0
Under application	8	14	0	0
Have a plan to apply	18	34	20	38
No plan to apply	18	34	31	59

3) Skill Level

Many enterprises claim that they have a shortage in "skilled-labor/technician" (15 respondents), "staff for R&D" (6), and "products designer" (6). Strong concerns for the next ten years were expressed by the industry, as 22 enterprises are concerned about "skilled-labor/technician", 9 about "staff for R&D", and 6 about "staff for quality control".

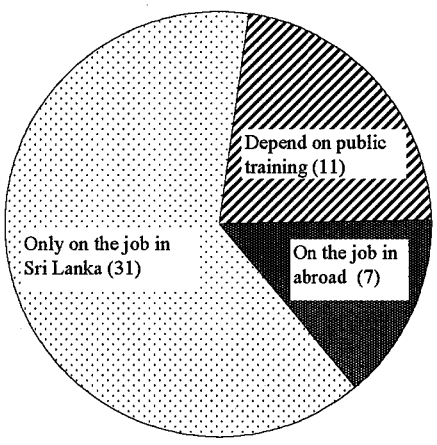
Shortage of Manpower



4) Training

Most enterprises (31) have on-the-job training programs, while there are 7 enterprises which are conducting on-the-job training abroad. It was reported that 11 companies were dependent on public training.

Training of Workforce

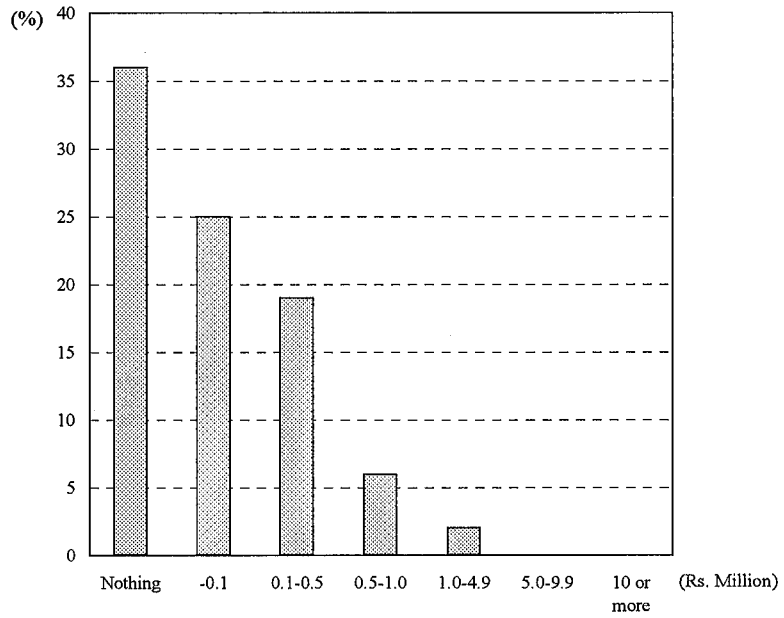


5) R&D

R&D activities are product development- and development design-oriented. The questionnaire survey indicated that enterprises were conducting "product development" (23 enterprises), "design development" (15), and "production technology" (8). They have the same orientation for the next ten years.

R&D expense is small; i.e., 19 enterprises of respondents have zero expense, 23 have less than Rs. 500,000, and only 4 have more than Rs. 500,000. It is also noted that 64% of respondents have no joint R&D activities with others, with the implication that there is little collaboration in R&D activities.

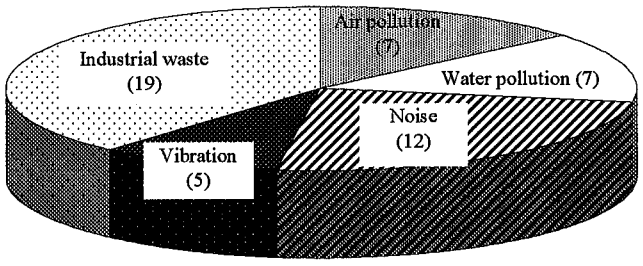
R & D Expense



1.5 Environmental Protection

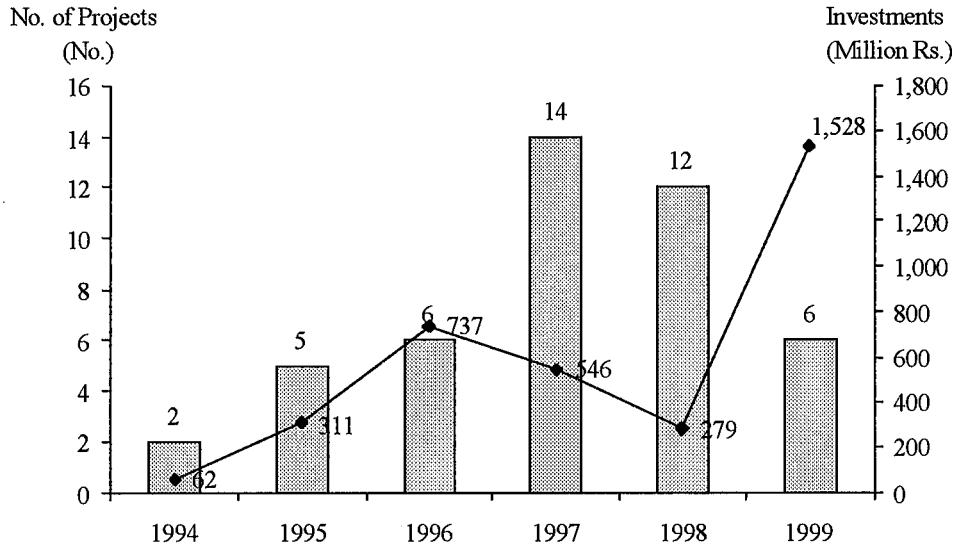
It is generally understood that the plastic industry in Sri Lanka has little possibility to create serious environmental problems at the factory sites, because its major activities are processing such as mixing, extruding and injection molding. Major environmental problems at the factories are seen as "industrial wastes" (19), "noise" (12 respondents), "air pollution" (7), and "water pollution" (7). Ten out of 32 environmental problems were treated by the enterprises themselves. "Industrial wastes" of plastic industries are composed of combustible materials.

Extent of Environmental Concern



1.6 Investment

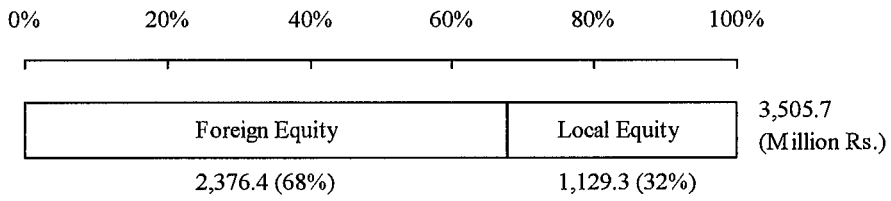
Investment in the plastic industry under Section 16 and 17 of the BOI law increased in the number of approved projects up to 1997, and it has been decreased thereafter, as shown below.



Source: BOI

Numbers of Projects and Investments in Plastic Industry approved under Sec. 16 & 17 of the BOI Law

In terms of equity share on investment in the plastic industry, local equity accounted for 32%, as shown below.



Source: BOI

Accumulative Investments in Plastic Industry approved under Sec. 16 & 17 of the BOI Law (1994-1999)

Since the plastic industry is not designated as a thrust industry, it is categorized as a general export oriented project when investors want to be approved by BOI and to enjoy the incentives. The incentives provided to general export oriented projects are tabulated as follows.

BOI Incentives for General Export Oriented Projects

Description of Activity	Qualifying Criteria			Incentives				
	Minimum Investment in Rs.mn	Minimum Direct/ Indirect Export Requirement (% of output)	Minimum New Employ-ment Required	Full Tax Holiday	Concession-ary Tax at 15%	Import Duty Exemption		Exemption from Exchange Control
						On Capital Goods	On Raw Materials	
New export oriented enterprise located outside a designated industrial estate and not qualifying for incentives specified elsewhere								
• Manufacturing (plastic, general machinery and so on)	12.5	90%	None	None	20 years	Yes	Yes, if utilized for export	Yes

Source: BOI

2. STRENGTH AND BOTTLENECK

2.1 Strengths and Weaknesses

1) Technology Level

Almost all basic technologies required for plastic processing are already applied to actual manufacturing in Sri Lanka, e.g., vacuum/pressure formed processing, woven fabrics made of stretched filament, blow molding, rotational molding, extruded flat film, extrusion pipe/tube, etc. Most of the molds used by plastic injection molding factories are imported mainly from India, Australia, Taiwan, and Hong Kong. The majority of the imported are "reengineering products" looking after technologies in such advanced countries as Japan. Technologies applied to their daily operation are good enough to manufacture products for the domestic market, because the market is still at a less advanced level and customers' needs for product quality is not so high. However, they are far behind the global technology standard and less competitive in international markets.

2) Strengths

According to the questionnaire survey, most enterprises claimed that their strength was "quality", as pointed out by 87% of respondents out of the selected 53 enterprises. 50-60% of the respondents noted price, durability and production technology/skill as their strength. This strength of quality is true, in a sense, because most enterprises are making serious efforts in quality control. However, enhancement of quality control is still limited at the production line level, and TQC (Total Quality Control) is not followed in most cases; thus, quality level is to be improved much more.

The second point which enterprises consider as a source of strength is "price". However, in view of the high interest rate and short depreciation period, one cannot help feeling that understandings of price-competitiveness is somewhat strange. Further, 25 enterprises pointed out "production technology/skill" as their strength, which indicates that they are unaware of the level of their technology. Understandings by manufacturers do not reflect a real situation of their products in a correct manner.

3) Weaknesses

A "products-industrialization matrix" describes the current situation of capabilities in different technology and engineering stages. For the plastic industry in Sri Lanka, this matrix has been prepared as follows:

Products-Industrialization Matrix

[Electric & Electronic products]

	Products	Key technology	Modernized facility	Production technology	QC technology	Human resources	Training school	Financial affairs	Entrepre-neurship	R&D supporting
1	Electric: large size cabinet	Mold, appearance, cost	X	△X	X	△	X	X	△	△X
2	: small size cabinet	Mold, appearance, cost	X	△X	X	△	X	X	△	△X
3	Electronic: small size cabinet	Precise, Productivity	X	△X	X	△	X	X	△	△X
4	: small key block	Precise, Productivity	X	△X	X	△	X	X	△	△X
5	Electric & Electronic	Cost, productivity	△	△	△	△	△	X	△	△
6	: Wire Insulation	Technical quality data	△	△	△	△	△	X	△	△
8	: Power cable coating	Technical quality data	△	△	△	△	△	△	△	△
9	Switch, Connector, others	Precise, mold, cost	△X	△X	X	△	△	△	△	△

[Industrial products]

	Products	Key technology	Modernized facility	Production technology	QC technology	Human resources	Training school	Financial affairs	Entrepre-neurship	R&D supporting
1	Automotive : inside Parts *1	Surface appearance, cost	△X	△X	X	△	X	X	△	△
2	: Outside parts *2	Surface strength, cost	△X	△X	X	△	X	X	△	△
3	: Others *3	Gen. quality, cost	△X	△X	X	△	X	X	△	△
4	Architecture : Housing goods	Competitive cost	△X	△X	X	△	X	X	△	△
5	: Thermal Insulation	Quality,tech. support	○△X	△X	X	△	X	X	△	△
6	: Flooring sheet	Technology, cost	△X	△X	X	△	X	X	△	△
7	Rail Way :car inside	Low cost	X	X	X	△	X	X	△	△
8	Agricultural : heavy duty bag	High tech. & investment	△X	△X	△X	○△	○△	X	○	○△
9	: Greenhouse Film	UV endurance, cost	△X	△X	△X	○△	○△	X	○	○△
10	: seed bed film	Cost UV control tech.	△X	△X	△X	○△	○△	X	○	○△
11	Packaging: thin wall bag	Formulations, cost	○△	△X	△	○	○△	X	○	○△
12	: heavy gauge bag	Printability, cost	○△	△X	△	○	○△	X	○	○△

*1 : Instrument panel, roof inside, sheet & inside floor, *2 : Bumper bar, side mole, lump housing, *3 : Grip. handle wheel

○: Yes we have, △: needs to improve, X: Needs foreign investment

From this table, it is observed that all "electric/electronic products" are evaluated under the category of "needs to improve" or "needs foreign investment". Even though there exists a potential market in front of the plastic producers in Sri Lanka, it is a reality that they cannot supply products which meet demands by their own technologies. However, it was also observed by a factory inspection that many factories were capable of improving their technological level to the level that OEM (Original Equipment Manufacturer) production of advanced countries was possible, given technical assistance of foreign experts for a couple of years.

In the industrial products, weakness of marketing is typical in architectural and industrial products (e.g., preventive sheet of water leakage, rain drain sheet and reinforce net/sheet), due to lack of foreign technology/market information. The industrial product manufacturers of the

plastic industry in Sri Lanka require much more improvement in production technology and quality control, as well as in marketing technologies.

In the packaging products, no technology nor facility is currently available for high quality flat film production in the country, which makes it difficult to establish a solid foundation of manufacturing plastic packaging products. Technical transfer through FDIs should be sought in this area. Though there are some blown film production technologies, the industry has weakness in marketing due to a lack of advanced technical information. If certain technical transfer and investment are provided, it will not be difficult to enhance technological capabilities in this area.

4) Constraints

The questionnaire survey indicated that the most critical constraint which enterprises find was "external problem/marketing-related " (25 enterprises pointed out), and the second one was "raw material-related problem".

57% of the respondents pointed out "flooding of imported goods" as the most serious problem in the marketing-related problem. This demonstrates a relatively low competitiveness of domestic products in terms of cost and quality, while domestic manufacturers claim that they have confidence in their quality and price. 53% of respondents indicate that they have a limited domestic market, however, most of them are expected to understand that they can create a market by introduction of competitive and differentiated products which match with customers' needs.

"High cost of imported raw materials" is the most serious concern among "raw materials-related problems", which 72% of the respondents pointed out. It is understood that they rely heavily on imported raw materials and a small scale of procurement makes its cost expensive. "High import duties" is also considered as a serious constraint for assemble industries, which 49% of the respondents pointed out.

Among "infrastructure-related problems", the high cost of electricity is the most serious concern, as 79% of the respondents pointed out. This is actually a serious cost factor for the plastic industry; therefore, some incentives or supporting measures should be considered.

In factory operation-related problems, many indicate that they lack production scale merit, storage and warehouse space. Concerning the public services/supports, "support to financing"

and "custom clearance" are the central issues for the plastic industry in Sri Lanka. Concerning "financing" issues, a serious problem is the "access to loan at low interest rate", as pointed out by 64% of the respondents. "Depreciation of Sri Lankan Rupees" is another concern, which 55% of the respondents indicated. Because most manufacturers rely their parts and components on imports, weak rupees make their cost expensive.

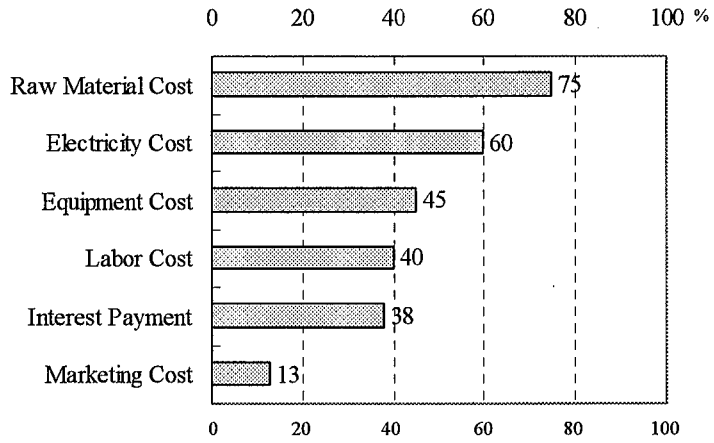
5) Factors for Productivity

According to the questionnaire survey, 76% of respondents of the selected 53 enterprises pointed out that the most critical factor for profitability is raw material cost. The factory inspection also revealed that material cost accounts for 60-75% of total production cost. This seems to be a result of the small economy of scale of the enterprises, because most enterprises cannot make their purchasing lot of raw materials large. The size of enterprises and their procurement practices lead to lower competitiveness of the industry.

The second most critical factor of profitability is high electricity cost. Plastic industries consume bulks of electric power for heating and melting. 60% of respondents pointed out high electricity cost as a serious constraint.

The third critical factor is machine and equipment, which 22 enterprises pointed out. Terms for depreciation for equipment are usually five years in Sri Lanka. Unless the depreciation cost is properly accumulated, renewal of machine and equipment is found difficult. This is one of the reasons why production equipment has not been renewed to enhance productivity.

The fourth and fifth critical factor of profitability are interest payment for loans, and wage cost, which 20 enterprises pointed out as heavy burdens to them.



Critical Factors for Profitability

2.2 Bottleneck on Management

1) Impact of New Environment

The questionnaire survey revealed that there was a concern about the "SAARC impacts on business" in the plastic industry. While 33% voted for positive impacts (including "strongly positive"), 40% voted for negative impacts (including "strongly negative"), and 25% for no-impact. "Strong competition" ranked first among responses, as indicated by 30% of the respondents. "Good place for raw material sourcing" and "good technical partner" were pointed out by 25% and 15% of the respondents, respectively. India is considered as "best partner among SAARC countries", as indicated by 62% of the respondents.

There seems to be a mixed feeling about the effects of SAARC, because most producers in the plastic industry in Sri Lanka do not always understand their position in a global and regional market. It would be the first step for the industry to find out its relative competitive position in a global market in terms of technology and product development, to draft a map for its further industrialization.

2) Required Improvement

A "product-required improvement matrix" has been worked out through discussion with Sri Lankan industrialists, as shown on the following page:

It is observed through the matrix that measures should be taken for "modernized facilities" and "existing technologies" by all "electric and electronic products". In "agricultural" and "packaging products", improvement is particularly required for the "existing technologies" and "equipment", even though it was observed through factory inspections that they had some level of production capabilities.

Products-Required Improvement Matrix

[Electric & Electronic products]

	Products	Key technology	Exist tech.	Raw materials	Formu-lations	Production Tech.	Modern facility	Exp.qual. guarantee	Marketing force	Research labo.
1	Electric: large size cabinet	Mold, appearance, cost	△	△	△	△	X	△	△	△
2	: small size cabinet	Mold, appearance, cost	△	△	△	△	X	△	△	△
3	Electronic: small size cabinet	Precise, productivity	X	△	△	△	X	△	△	△
4	: small key block	Precise, productivity	X	△	△	△	X	△	△	△
5	Electric & Electronic	Cost, productivity	△	△	△	△	X	△	△	△
6	: Wire Insulation	Technical quality data	X△	△	△	△	X	△	△	△
8	: Power cable coating	Technical quality data	X△	△	△	△	X	△	△	△
9	Switch, Connector, others	Precise, mold, cost	X	△	△	△	X	△	△	△

[Industrial products]

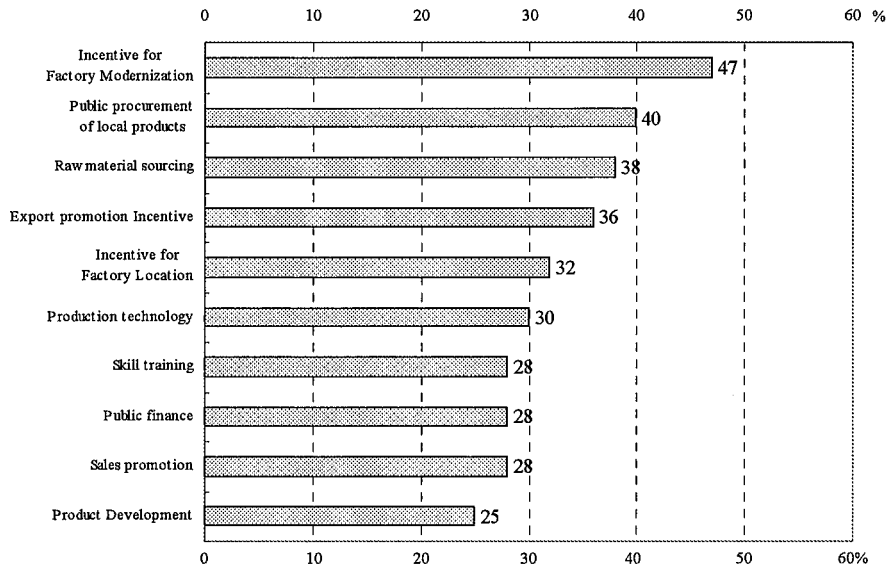
	Products	Key technology	Exist tech.	Raw materials	Formu-lations	Production Tech.	Modern facility	Exp.qual. guarantee	Marketing force	Research labo.
1	Automotive : inside Parts *1	Surface appearance, cost	△	△	X	△	X	△	△	○
2	: Outside parts *2	Surface strength, cost	△	△	X	△	X	△	△	○
3	: Others *3	Gen. quality, cost	△	△	X	△	X	△	△	○
4	Architecture: Housing goods	Competitive cost	△	△	X	△	X	△	△	○
5	: Thermal Insulation	Quality,tech. support	△	△	X	△	X	△	△	○
6	: Flooring sheet	Technology, cost	△	△	X	△	X	△	△	○
7	Rail Way :car inside	Low cost	△	△	X	△	X	△	△	○
8	Agricultural: heavy duty bag	High tech. & investment	△X	○△	X	△X	△X	△	△	△X
9	: Greenhouse Film	UV endurance, cost	△X	△	X	△X	△X	△	△	△X
10	: seed bed film	Cost UV control tech.	△	○△	○△	△X	△X	△	○△	△X
11	Packaging: thin wall bag	Formulations, cost	○△	○△	○△	○△	○△	○△	○△	△X
12	: heavy gauge bag	Printability, cost	○X	○△	△X	△X	△	○△	○△	△X

*1 : Instrument panel, roof inside, sheet & inside floor, *2 : Bumper bar, side mole, lump housing, *3 : Grip. handle wheel

○: Yes we have, △: Needs to improve, X: Needs foreign technology

3) Required Public Support

The questionnaire survey also revealed that the plastic industry calls for public support in "incentives for modernization of factory", as pointed out by 47% of the respondents. 32% of the respondents also asked for "incentives for new factory location". This will lead to the implication that the plastic industry has a fragmented structure and some measures are called for integration of the industry to make its solid business foundations. "Promotion of local-made products consumption (buy Sri Lanka)" and "export incentives/promotion" were also pointed out by 40% and 36% of the respondents, respectively.



Source: JICA questionnaire survey

Required Public Support

It is a fact that not only private consumers but also the public sector prefer imported products to domestic ones. It will be necessary for both the government and the industry to cooperate to improve a "Made in Sri Lanka" brand and to increase the preference of domestic products by consumers. There are also calls for public finance as well as training for factory modernization. Some measures to encourage effective training and R&D activities would be required as support by the government.

2.3 Industrial Clustering

1) Potential Linkages

The analysis indicates some directions for industrial clustering of the plastic industry with other industries. Injection molding in the plastic industry has a close relationship with the other sectors such as the processing mold industry and electric/electronic industry. Development of the plastic industry requires an advanced plastic processing mold industry. The plastic industry also serves as a supporting industry for the electric/electronic industry through supplying high value added plastic materials. If the plastic industry improves its technological level, the electric/electronic industry of Sri Lanka would also benefit.

Packaging of the plastic industry has impacts on sales and marketing issues in consumer product manufacturing sectors such as food processing and textile/garment industry, as packaging itself accounts for around 10-15% of total cost of manufacturing for those consumer products. Plastic processing also requires a high level of measurement and control equipment for size, weight, temperature, rotation speed, and so forth, while it needs technologies for chemical component analysis for additives. The plastic industry can be a driving force to encourage development of those industrial bases in Sri Lanka.

2) Constraints for Clustering

It is observed that the current plastic industry in Sri Lanka still has a weak structure both within the industry and with other industries, which creates a fragile situation against advanced imported goods. Even though Sri Lanka has a potential to see growth in plastic demands, the plastic industry has the possibility of being faded out by floods of imports without an integrated industrialization policy. This would invite serious constraints for other promising industries. In this respect, active government direction and support to develop "policy-driven industries" is expected.

The plastic industry relies heavily on imported raw materials, which causes constraints on the industry and other industries that have close relations with plastics. However, it also means that the plastic industry has a free choice to procure the world's best competitive raw materials for plastic production. The important thing is that the industry has a clear vision and targets for its development to change weakness and constraints to strengths.

3. MASTER PLAN FOR PLASTIC INDUSTRY

3.1 Framework and Strategies

The plastic industry has been classified as a policy driven industry, and its industrialization is to be promoted in a "selective and strategic" manner through promotion of focal products.

1) Vision

Plastic is a basic material of many manufacturing goods ranging from commodity goods to high value added products. To develop a competitive plastic industry is an important task for Sri Lanka to establish a solid foundation for the country's manufacturing industry. The analysis on strengths and bottlenecks for the plastic industry in Sri Lanka revealed that the industry is still in an infant stage and in a fragile situation with a fragmented industrial structure. However, the macroeconomic scenario of the country, which expects a growth rate of 6.5-7.5% in the next 10 years, would encourage further development of the plastic industry in Sri Lanka. To define an effective and coordinated way of development, the vision for the plastic industry toward 2010 should be stated as follows:

"By supplying high value added materials and by establishing stronger linkages with major plastic-using industries, Sri Lanka's plastic industry should support an upgrading and consolidation of industrialization of the country."

With this vision, as well as in line with a basic strategy of the manufacturing sector as a whole, focal products should be identified and efforts should be "concentrated" on these focal products in accordance with their respective development strategies.

2) Targets

It is proposed that development of the plastic industry be designed to achieve targets as enumerated below.

(i) By catching up with an increasing domestic demand which is expected to triplicate by 2010, expand production capacity of plastics. Target volume of plastic production in 2010 is set at 300,000 tons (270,000 tons for domestic consumption, 60,000 tons for exports and 30,000 tons for imports).

(ii) Establish a technological base of producing plastic "film" which is an intermediate goods to manufacture important packaging products. Expected production volume of

plastic film is 100,000 tons in 2010.

(iii) Keep a domestic production ratio of plastics to share at 80% and to meet an increasing domestic demand, diversifying product range and increasing competitiveness.

(iv) Promote "exports" of targeted products at the latter stage, keeping an export ratio to production at 20%. Target of exports in 2010 is 60,000 tons, an increase by 40,000 tons from 1998.

(v) Promote an increase in FDI (foreign direct investment) to Sri Lanka, particularly in focal products of plastic film for packaging products and new engineering plastics.

(vi) Increase GVA in the plastic industry up to the level of Rs. 15,000 million in 2010.

3) Basic Strategies

Basic strategies to achieve the above targets should be designed stage-wise for the next 10 years. It is proposed that basic strategies and approaches to accelerate development of the plastic industry be defined as follows:

(i) Increase production of plastics for packaging products and industrial uses, which can be identified as "focal products". The industrial use plastics play an important role of supporting goods for the electric/electronic industry and other industries.

(ii) Enhance basic technological capabilities of SMIs, which account for nearly 60% of establishments in Sri Lanka's plastic industry, in product marketing, product design, production control and quality control. With public support, promote technology transfer from abroad and increase collaborative programs among the industry, institutes, and academia.

(iii) Establish R&D bases of new products of high value added engineering plastic products to meet an increasing demand in the major plastic-using sectors.

(iv) Establish manufacturing bases of plastic film for packaging products through promotion of FDIs to Sri Lanka.

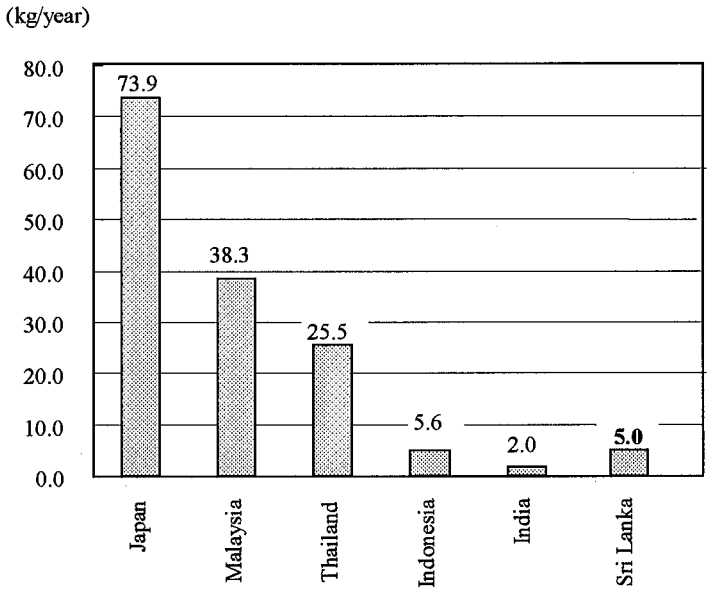
(v) Promote "clustering" with major plastic-using industries though joint research and development programs.

3.2 Promising Products and Marketing

1) Growth of Plastic Consumption and Production

Consumption of plastics in Sri Lanka is still relatively low among Asian countries. Apparent consumption per capita of plastics is compared to other countries, as shown below. The consumption in Sri Lanka is estimated to be 5.0kg per capita, which is far below the average in Malaysia and Thailand, while it is slightly lower than consumption in Indonesia and higher than that in India. It is also estimated that 98,000 tons of plastic products were manufactured in 1998, using all imported raw materials. About 20,000 tons of manufactured plastic products were exported, while the country imported 10,000 tons of plastic products. Therefore, apparent consumption of plastic products in Sri Lanka is estimated to be around 90,000 tons, which leads to the consumption per capita of 5.0 kg, as cited above.

This figure simply indicates a high potential that plastic consumption in Sri Lanka would increase in the future, given a stable economic growth and further advancement of the industrial structure. If the country succeeds in developing a competitive plastic industry which can source materials matching the changing customers' needs, it would enjoy an expansion of its domestic market.



Consumption per Capita of Plastic Products (1998)

As reviewed in Section 1.2, total production of plastics in Sri Lanka was increased at the average annual growth rate of nearly 12% in 1992-1998. During this period, production of plastics for industrial use increased at 18% per annum. If Sri Lanka succeeds in an integrated upgrading of its manufacturing structure in the future, it is expected that the country will further increase its per capita consumption. In general, a growth of the plastic industry is related to economic and industrial development of one country. Plastic production is expected to expand in proportion to the future economic growth of Sri Lanka. Eventually, it is important to understand that there is a potential for the plastic industry to enjoy an enlarged domestic market, if the industry is advanced enough to catch up with the growing needs of customers.

It is assumed that Sri Lanka will expect a slightly higher growth rate of per capita plastic consumption than a growth of per capita GDP. Elasticity of plastic consumption to GDP, defined as a coefficient of growth rate of plastic consumption to GDP growth rate, is assumed to be 1.1 between 1998 and 2004, and 1.2 between 2005 and 2010. (As observed in other countries, a growth rate of basic materials usually records a higher value than that of GDP growth, particularly during the take-off period of the economy.) If this is the case, apparent plastic consumption will reach 270,000 by the year 2010, with per capita consumption of 12.7kg. This figure seems to be somewhat conservative, because 12.7kg per person is still at the level of half of Thailand in 1998, though industrial integration in Thailand is well advanced.

Growth of Plastic Consumption and Production

(Thousands Tons)

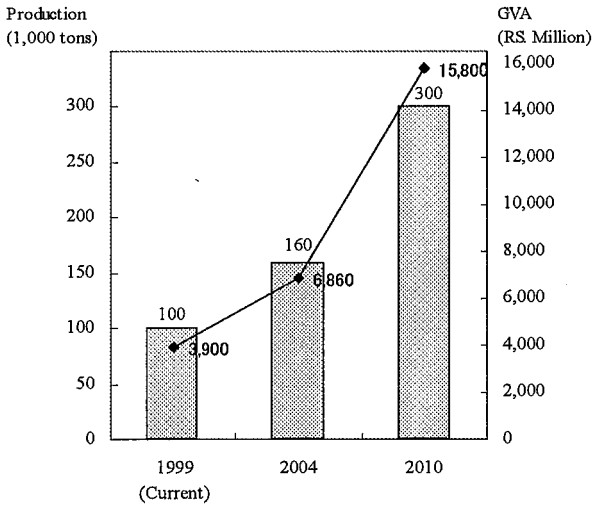
	1999	2004	2010
GDP Growth Rate (%)	5.5	6.5	7.5
Plastic Consumption per Capita (kg)	5.0	7.6	12.7
Growth Rate (%)	-	7.2	9.0
Domestic Consumption [C]	90	150	270
Exports of Plastics [X]	20	30	60
Imports of Plastics [I]	10	20	30
Production [P]	100	160	300

Note: [P]=[C]+[X]-[I]
Source: JICA Study Team

In view of increasing domestic demand and customers' changing needs for higher value added products, the plastic industry in Sri Lanka should be eager to cope with this business environment, and to promote further development of the industry in a strategic manner. Moreover, Sri Lanka would be ready to increase exports of plastic products, if the industry is

capable of sourcing varieties of competitive products. Statistics show that the current structure of exports in plastics relies heavily on low-priced commodity products. More than 80% of total exports (20,000 tons) is polyethylene and polypropylene, which are valued at less than Rs. 100/kg. However, when the plastic industry in Sri Lanka is developed to enhance competitiveness in some specialized products, it would upgrade and diversify product range for exports. If this is the case, Sri Lanka would be capable of keeping its import ratio of plastic products at the current level, or about 10% of domestic production.

It is proposed that Sri Lanka establish strategies to promote integrated development of its plastic industry to cope with an above-mentioned growth scenario. As previously discussed, it is advisable to identify "focal" products and concentrate industrial efforts on strengthening manufacturing capabilities of those focal products at the first stage, and then to diversify products at the later stage.



Growth of Production and GVA

2) Analysis of "Product-Market" Matrix

For product-market analysis, plastic products are broadly classified into electric/electronic uses and industrial uses. The products for electric/electronic use are further classified into four groups; i.e., cabinet, electronic cabinet, electric cable, and switch/connector/others. The products for industrial uses are classified into five groups; i.e., automotive, architectural, railway, agricultural, and packaging. Potentials of product market for each group have been surveyed through interviews with industrialists and discussion with institute and associations. As a result, a product-market matrix table has been worked out as shown on the following page. The product-market matrix table describes the current manufacturing situation and potential markets of the plastic industry.

Products-Market Matrix

(1) Electric & Electronic

	Products	Kev technology	Domestic	India	SAARC *	ASEAN	Europe	USA	Japan	Africa. Mid.east
1	Electric: large size cabinet	Mold, appearance, cost	△X	△	△	△	△	△	△	△
2	small size cabinet	Mold, appearance, cost	△X	△	△	△	△	△	△	△
3	Electronic: large size cabinet	Precise, productivity	○△	△	△	△	△	△	△	△
4	: small size cabinet	Precise, productivity	○△	○	○	○	○	○	○	○
5	Electric cable: Wire Insulation	Technical quality data	○△	○	○	△	△	△	△	△
6	: Power cable coating	Technical quality data	○△	△	○	△	△	△	△	△
7	Switch, Connector, others	Precise, mold, cost	○△	+	+	+	+	+	+	+

(2) Industrial Products

	Products	Kev technology	Domestic	India	SAARC *	ASEAN	Europe	USA	Japan	Africa. Mid.east
1	Automotive : inside Parts *1	Surface appearance,	△	X	△	△	△	△	△	△
2	: Outside parts *2	Surface strength, cost	△	X	△	△	△	△	△	△
3	: Others *3	Gen. quality, cost	△+	+	+	+	+	+	+	+
4	Architecture: Housing goods	Competitive cost,	△+	X	+	+	+	+	+	+
5	:Thermal Insulation	Quality, tech. support	△+	X	+	+	+	+	+	+
6	: Flooring sheet	Technology, cost	○△	X	○	+	+	+	+	+
7	Rail Way :car inside	Low cost	△X	X	○	△	△	△	△	△
8	Agricultural: heavy duty bag	High tech. & invest.	○△X	△	○△	△	△	○△	–	○△
9	: Greenhouse Film	Weather resistance, cost	○△X	X	○	△	△	△	–	○△
10	: seed bed film	Cost , UV control tech.	○△X	X+	○X	△	△	△	–	○△
11	Packaging: thin wall bag	Formulations, cost	○○	○	○	○△	○△	○△	–	○△
12	: heavy gauge bag	Printability, cost	○△	○	○	○△	○△	○△	–	○△

*1: Instrument panel, roof inside, sheet & inside floor *2: Bumper bar, side mole, lump housing

*3 : Grip, handle wheel

* SAARC is SAARC countries except India.

○: Big Potential、△: Medium、X: Small、－: Out of target、＊: except India、＋: Attractive

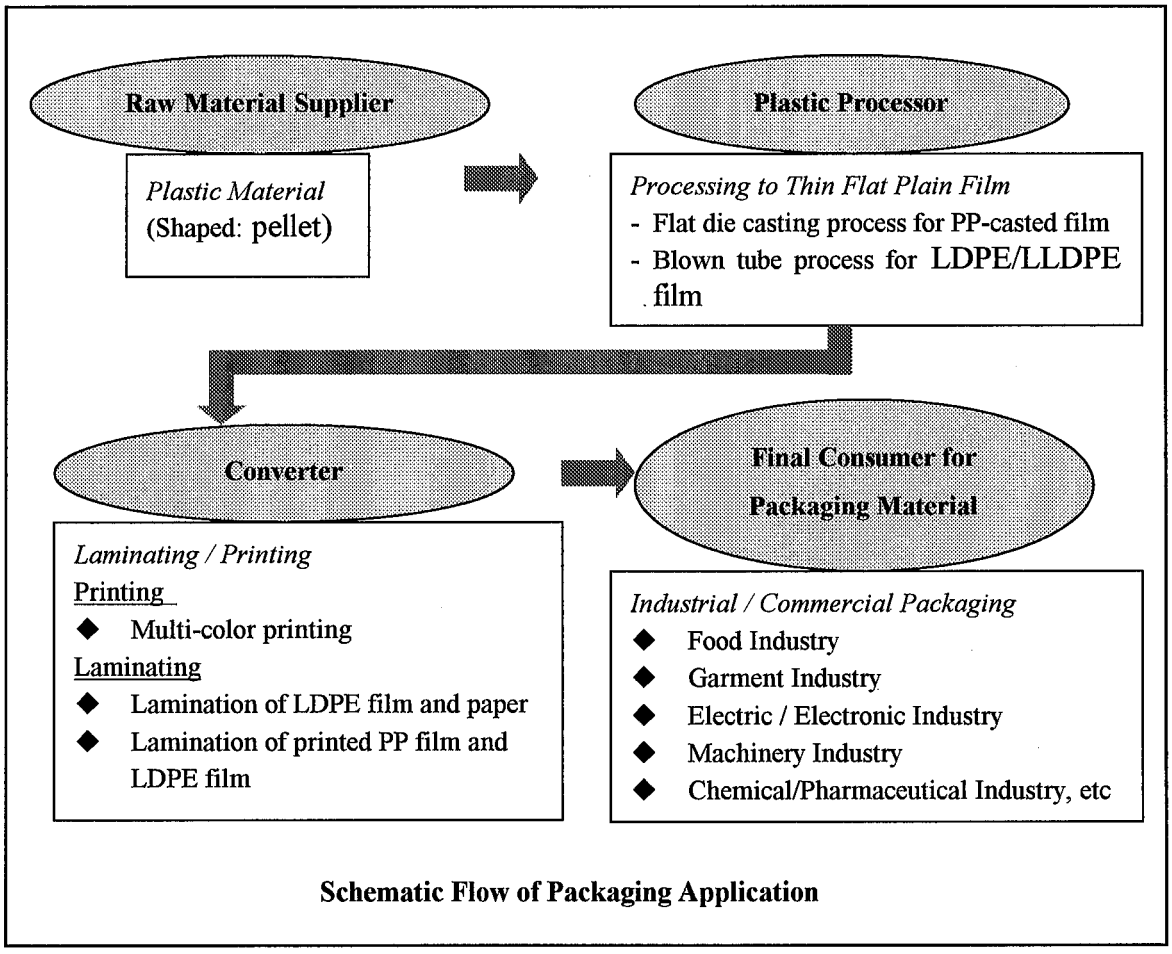
The above table reveals that products having big market potentials are electronic small size cabinet, electric cable wire insulation, and power cable coating for electric and electronic uses, as well as architectural and packaging for industrial uses.

3) Selection of "Focal" Products

In evaluating the products-market matrix, packaging products and electric/electronic products are selected as "focal" products in the plastic industry in Sri Lanka towards the year 2010.

(i) Plastic Packaging Products:

There are two categories of packaging products; one is product of flexible packaging, (e.g., packaging for snack food and cookie/biscuit), and the other is product of heavy gauge bags for transport of grain or granular/powder chemicals. Woven cloth bags made of stretched tape are used for the latter purpose. The figure below illustrates the schematic flow of plastic products for packing application.

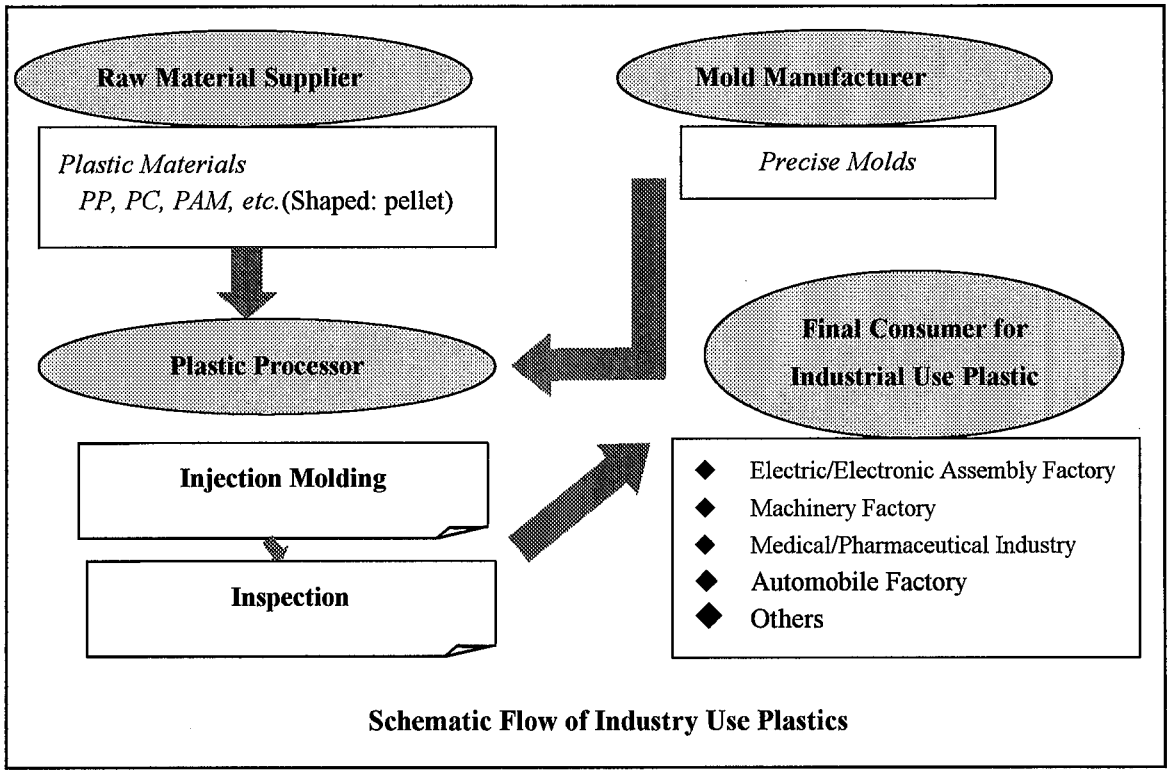


Schematic Flow of Packaging Application

(ii) Plastics for Electric/Electronic Industry

Major industrial uses of plastic molded products are for the electric/electronic industry,

including small key blocks, small cabinets and cases, housing and TV cabinets, parts of mobile-phones and radio-cassette recorders, and others. In addition to uses in the electric/electronic industry, plastic molded products are used for plastic syringes, oil-less bearings, gear wheels, and so forth. The figure below illustrates a schematic flow of manufacturing industrial use plastics.



Schematic Flow of Industry Use Plastics

4) Strategies for Marketing

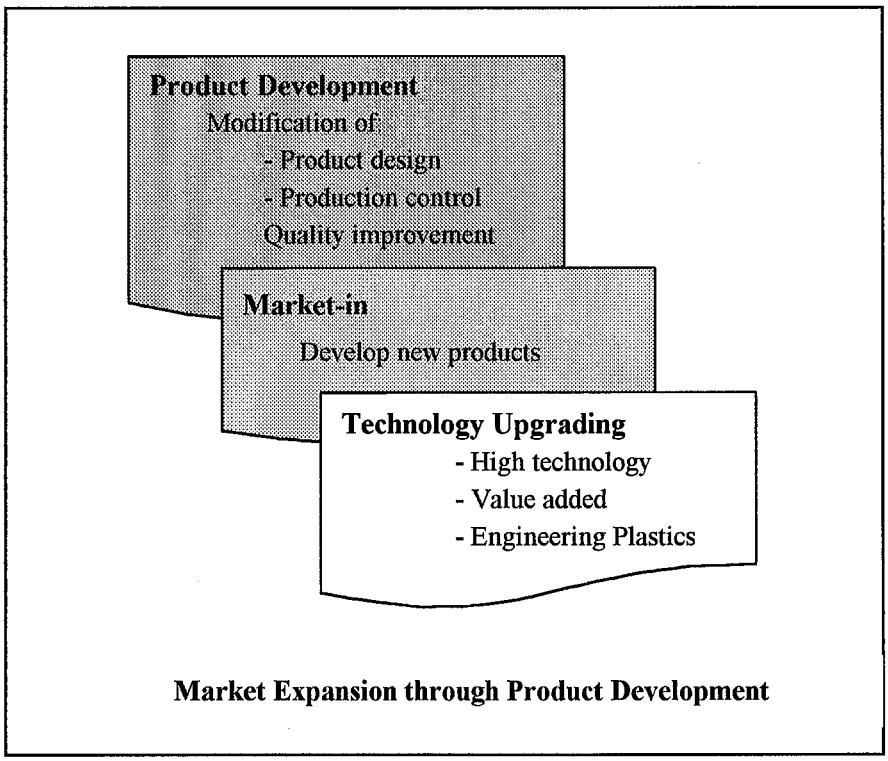
It is important to have an idea of "Market-In" to select targeted products and to draft a plan for their further development. "Market-In" requires a detailed analysis of changing customers' needs for functions and performance of products. The plastic industry in Sri Lanka should start with efforts of following and understanding customers' needs and requirements for the selected focal products (i.e., plastic packing products and plastic for the electric/electronic industry).

As the first step of "Market-In", a list of all plastic products currently manufactured in Sri Lanka should be prepared in a formal information brochure of the plastic industry, and be further distributed in both domestic and international markets. Secondly, a detailed market research and direct marketing efforts both in domestic and international markets are required

by means of visiting potential customers. Thirdly, it is essential for the industry to clarify changing market needs and required product function, and specify the most appropriate products for the Sri Lankan plastic industry to concentrate their efforts on product development. In this connection, it is recommended that the Internet be used internationally and domestically for Market-In by the above steps.

(i) Market Expansion through Product Development

It is recommended that expansion of the domestic market through product development be promoted for several years. There exist lots of application fields of plastic products which only require some modification of product design, production control and quality consideration of the current technology and products. Focal products and their required functions should be carefully examined to develop new products around existing technology and products in the efforts of "Market-In". This will facilitate stepping into "technological upgrading" to increase the industry's development and manufacturing capabilities by calling for collaborations among enterprises and technical transfer from abroad. Another key issue is the industry's capability of shifting consumer plastic products to industrial products, requiring high technology of extrusion and molding. New product development and its marketing efforts would bring about substitution in some applications from wood, paper and other materials to plastics.



Market Expansion through Product Development

(ii) Competitiveness in Markets

Plastic products to be exported from Sri Lanka will be divided into packaging and non-packaging items. The current production practices using low to middle technology-based extrusion and molding would suit for packing items (e.g., plastic sacks and bags). If Sri Lanka succeeds in expanding its domestic market of plastic products, particularly of focal products through new product development, the Sri Lankan plastic industry will have the opportunity to expand exports. The targeted export products should have characteristics of light weight and easiness for transportation.

3.3 Technological Upgrading, Quality Control, and Productivity

1) Technological Upgrading

Technology is a key for success of any manufacturing industry. However, it is important to understand that there are different technological fields, e.g., (i) product design, (ii) production control and productivity improvement, and (iii) process evaluation/improvement. Designing and enhancing an integrated plan in all three stages is required, with an understanding of the different stages of technological upgrading.

The first step of enhancing technological upgrading is to establish a "corporate mission" and to share it among all the people in the company as a basic business philosophy. Secondly, a detailed plan for technological upgrading should be designed and shared in the company. Thirdly, revitalization of human resources should be promoted through in-company education and practical training to increase their technological knowledge level and technological skills in their operations. Finally, proactive introduction of new technologies abroad should be promoted through technical cooperation with foreign partners and joint ventures.

As a period of establishing a solid foundation of further development, efforts by plastic manufacturing enterprises should be concentrated on the following issues by the year 2004.

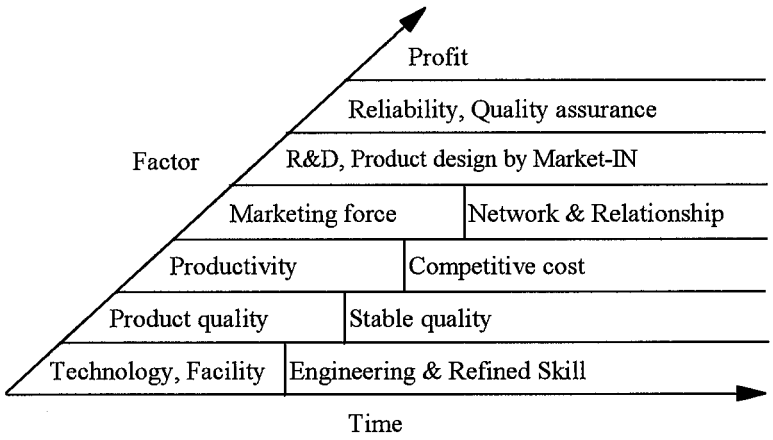
(i) Technical Assistance

A mechanism of giving and receiving technical assistance in relation to factory diagnosis and technological upgrading should be established as a common resource of the plastic industry in Sri Lanka with some assistance by the public sector. Practical advice by experts would have major impacts on redesigning management policies and process modification.

Observations at the factory inspections suggest that some plastic products currently manufactured in Sri Lanka could be improved enough to be internationally competitive ones in terms of both quality and price, given a certain level of technical assistance. For example, a company is producing co-extrusion sheet products by feeding two types of plastics with different colors, from which yogurt cups are being manufactured. This production brings profit to the company; however the technology level is low and less competitive in quality. Technology upgrading is attainable if technical assistance is extended to this company. It is therefore recommended that further research of technological level of each products be performed to find out required fields of technical assistance to make the product internationally competitive.

(ii) Enhancement of Competitiveness

To make the plastic industry competitive in domestic and international markets, restructuring of management and marketing will be required. To this end, the layer of management factors, as shown below, should be carefully examined.



Management Factors to Enhance Competitiveness

Of particular importance is "management for human resources", as it is observed that most enterprises in Sri Lanka utilize less than 50% of potential human resources. Top managers should make efforts to develop and utilize hidden talents and capabilities of their human resources by giving them opportunities to develop new products and technologies.

2) Technology Transfer

An effective way of technological upgrading is technology transfer from advanced countries. Technological transfer is to be realized in the following manner:

- Each enterprise should search for growth products and focal products through research on advanced company's products through the Internet.
- Each enterprise should find out a source of technology transfer and define the terms and condition with the technology owner.

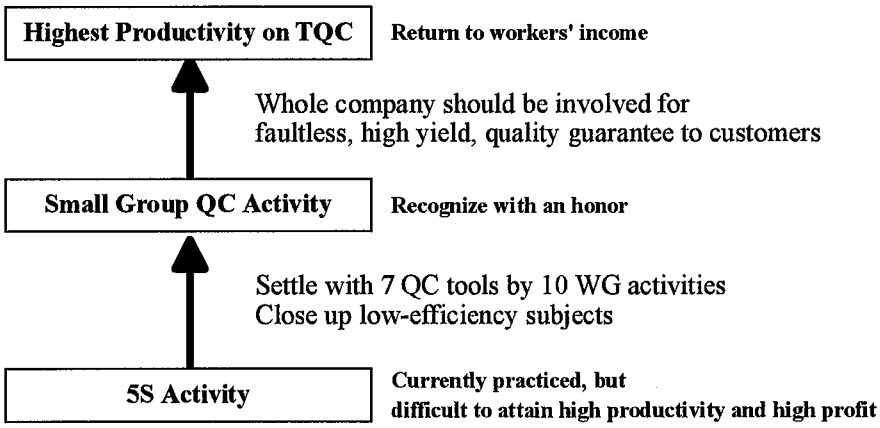
A few examples of technology that needs technology from abroad are listed below.

- Industrial plastic parts manufacturing technology,
- Engineering plastic products manufacturing technology, and
- Technology in profile extrusion for architectural material and nonflammable printed wall sheet of PVC.

3) Quality Control

Efforts by each enterprise of the plastic industry in Sri Lanka should be concentrated on improving production quality control and establishing the quality assurance system at least at its initial stage of technological upgrading by 2004. It is appropriate for a company to focus efforts on some core products and their respective quality control method should be designed. Introduction of "small group activities" for quality control is proposed. "5S" activities would be another option. Middle management and engineers should be proactively and deeply involved in "small group activities". At the same time, importance of "on-the-job quality control" should be repeatedly addressed and actual implementation plan should be designed in detail.

From 5S Activity to Highest Productivity by TQC



"Problem finding" is always a starting point for technological upgrading, and there are some techniques to solve this issue by quality control methods. One simple way is to introduce a system of questioning repeatedly "Why, why, and why?". This technique is quite practical and effective, when it is introduced in combination with seven QC tools. Workers should understand that QC activities revitalize his/her own capabilities and may develop their hidden talents.

4) Productivity

Productivity is an important factor for any manufacturing business. Higher productivity increases cost competitiveness of the products, and the plastic industry in Sri Lanka should pay serious attention to this issue along with quality improvement.

Through factory inspection of the plastic industry, the yield ratio (output volume/input volume) is found to be 98-99% at almost all the factories inspected. However, it should be understood that there are different levels of the yield ratio, and management and engineers should take those differences into account and use proper guidelines for effective production control. One case is that products with defects, which were rejected during a long production line, are put again into the production flow as a recycled input. In this case, though the yield ratio of finished products might be seen as 98% with finally rejected products of 2%, the "total yield ratio" which includes an amount of recycled input is far below 98%. Because labor cost, electricity and other valuable cost are required to even to produce recycled in-line defected products, efforts which let the "total yield ratio" increase is essential to improve cost-competitiveness of products.

Another example is a lack of consideration for the importance of "continuous operation" of plastic production line. Plastic processing machines are continuously operated with necessary short-time stoppage. Machines are generally designed at 600 hours of the monthly operation. However, in case of most plastic processing factories in Sri Lanka, monthly operation hours are limited to around 400 hours. The main reasons for these limited operation hours are frequent stoppage and restart of production lines due to mechanical problems and blackouts. The problem in limited operation hours results in low productivity.

5) Establishment of Testing Organization

Currently, there is no positive and negative evaluation for "Made-in-Sri Lanka" plastic products due to a small scale of production, as well as concentration on bulk-type, low-priced products. However, it is essential for the industry to create a good image of "Made-in-Sri

Lanka" brand, when it tries to diversify its product range to much higher end, as well as to increase its efforts on exports. The industry should establish a fair and open quality assurance testing system, and disclose results widely to the public, with assistance and collaboration with the public institutions.

While there is an official testing organization, namely ITI (Industrial Technology Institutes, formerly called Ceylon Institute of Science and Industrial Research), it is recommended that ITI be strengthened to cope with increasing needs for quality assurance. It is proposed to reorganize ITI substantially. When ITI takes an initiative to perform strict inspection, particularly for exports, and to issue an official guarantee for those products, reliance on quality assurance for plastic products made in Sri Lanka will be further developed. ITI could also perform official tests for exporting products and issue an "approved seal" for inspected products to appeal an established quality assurance system by Sri Lanka. Inspection and approved seals would be given at certain cost sharing by plastic enterprises. Function and organization of proposed restructuring of ITI is discussed further in Section 3.7.

6) Environment and Recycling

With the growth in plastic consumption, packaging plastic products will spread to the living necessities, as plastic goods are characterized as lightweight, water-insoluble and durable. However, it will be scattered on public spaces, unless proper systems are introduced for handling plastics composing of distribution, collection, and disposal (if 50% of plastic consumption is used for packaging and disposed of as household wastes, plastic waste will amount to approximately 400 tons/day in the year 2010). In many countries, garbage including plastic disposal is collected and incinerated by public incinerators. However, incineration of plastic products is not favorable for incinerators (if plastic content exceeds 25% of waste disposal) and air pollution. To prevent environmental hazards, it is desirable to introduce recycling in and outside factories.

Recycling in factories

Inferior plastic goods produced in a factory can be recycled and reused by controlling quantity and quality. If the inferior plastic goods do not have alien substances and are supplied uniformly in terms of both quality and quantity, they can be reused by mixing them into raw plastic material within the range of 10-20% of raw plastic materials.

Recycling plastic products outside factories

In some advanced countries, collection and recycling systems are introduced for used plastic

goods such as PET (polyethylene terephthalate) bottles for mineral water and expanded polystyrene boxes for transportation of low-temperature and frozen products. Essential issues for recycle use of plastic goods as industrial raw material are cleaning to prevent mixing of alien substances, stabilizing quality, and ensuring recycling volume.

3.4 Manpower Development and R&D

Human resources is a key to develop technological bases for the plastic industry in Sri Lanka. It is important for academia, institutes and enterprises to recognize a situation of human resources and to design a map for a proper responsibility sharing among them. Even though a critical shortage of human resources has not occurred in the plastic industry until now, further development into a more broader area of engineering plastics would certainly increase requirements for educated engineers.

1) Prospects of Human Resource Development

There are limited human resources in teaching in the fields of polymer, chemistry, and polymer engineering in Sri Lanka. Two universities, i.e., University of Moratuwa (UOM) and University of Sri Jayawardanapura (USJ) have a faculty with several professors; however, the total number of teaching staff is only 18, including teaching assistants.

In UOM, a part time masters course in polymer technology is offered every other year and ten students take the course at present. In the engineering courses for four-year undergraduates, 20 are studying material engineering and 20 are studying chemical engineering. In these engineering courses, students related to Polymer Science/Technology/Engineering are covered during the four-year academic period. The National Diploma of Technology (NDT) (2 year course) in Polymer Technology has 10-15 students. The National Certificate Course in Polymer Technology (2 year course) has 15-20 students. In addition to the above courses, several advanced degree programs are being conducted with up to a maximum of 5 graduates every year. In the year 2000, it is planned to start a degree course in polymer engineering with an intake of 20-25 students initially. For students taking some of these courses, industrial training and exposure is given to students for a period of between six months and one year.

2) Approaches to R&D

Current strengths in university education and R&D are analyzed by academia as follows:

(i) Services of the professionals are available,

(ii) Testing facilities and advanced equipment are available to carry out research work, and
(iii) Charges for testing, development and sorting problems on trouble shooting are minimal.

On the other hand, current weaknesses in university education and R&D are analyzed as follows:

(i) Lack of cadre provisions for R&D,
(ii) No funds for training and R&D in the advanced engineering fields, and
(iii) Lack of trained technical staff to maintain sophisticated equipment and non-availability of after-sales services.

There is, in fact, a limitation of resources for R&D. However, it is recommended that the limited resources be directed to some specific areas of technology that might result in greater effects of application and manufacturing by private enterprises. Some ideas on such specific technologies to be further studied by academia and private enterprises are introduced below.

(i) Composite Technology

Composite technology is one of the key applications to make a diversification of products and technology. To develop a new type of polymer which is tough, soft-touch, and strengthened for impact by blending etaslomer with cheaper plastic materials (e.g., LLDPE, LDPE and PS), a practical approach is to accumulate application technique for plastic processing.

(ii) Co-extrusion technology

This is a newly developed application technology, but it has already been in commercial production in a large scale in Europe and the USA. Even in Sri Lanka, a seed is seen in one small plastic company with a combination of a knowledge base of the USA, extrusion flat die by India, and an entrepreneurship in Sri Lanka. This is a basic plastic processing technology of further technological development in the fields of extrusion and injection molding, therefore, to enhance a solid technological base of this area would make a large potential to diversify such product range as automotive parts, electric/electronic parts, and consumer goods, in the future.

3.5 Restructuring and Enterprise Development

As reviewed in Section 2.1, the technology level of the plastic industry in Sri Lanka remains much to be improved to attain competitiveness in the international market. To enhance technology level and competitiveness, it is suggested that plastic manufacturers take

appropriate measures for restructuring, including measures as proposed hereunder.

(i) Plastic Manufacturers for Electric/Electronic Use:

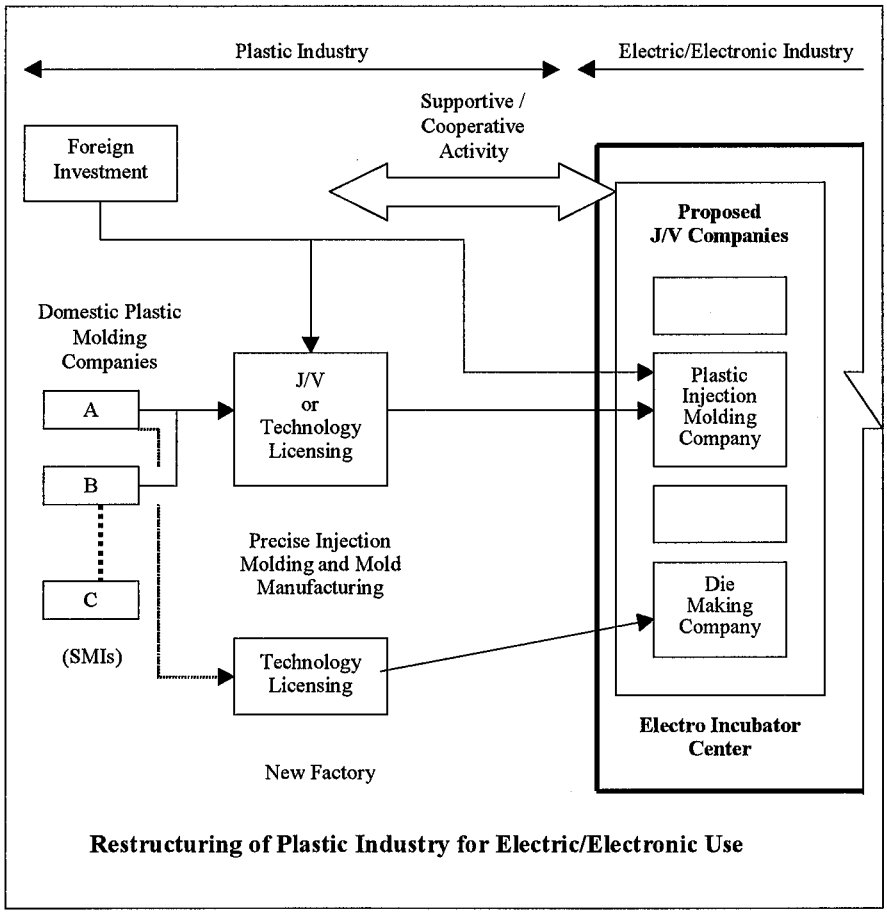
Most enterprises are SMIs, and individual enterprises do not have any economy of scale. To establish larger scale joint venture companies through mergers and acquisitions, or joint "cooperative" companies, would be one option to realize a higher efficiency in management and operation. To this end, the following options are considered:

(a) Establish J/V company by domestic plastic molding companies without foreign licensing,

(b) Establish J/V company by domestic plastic molding companies under foreign licensing, and

(c) Establish J/V company by domestic and foreign companies for plastic molding.

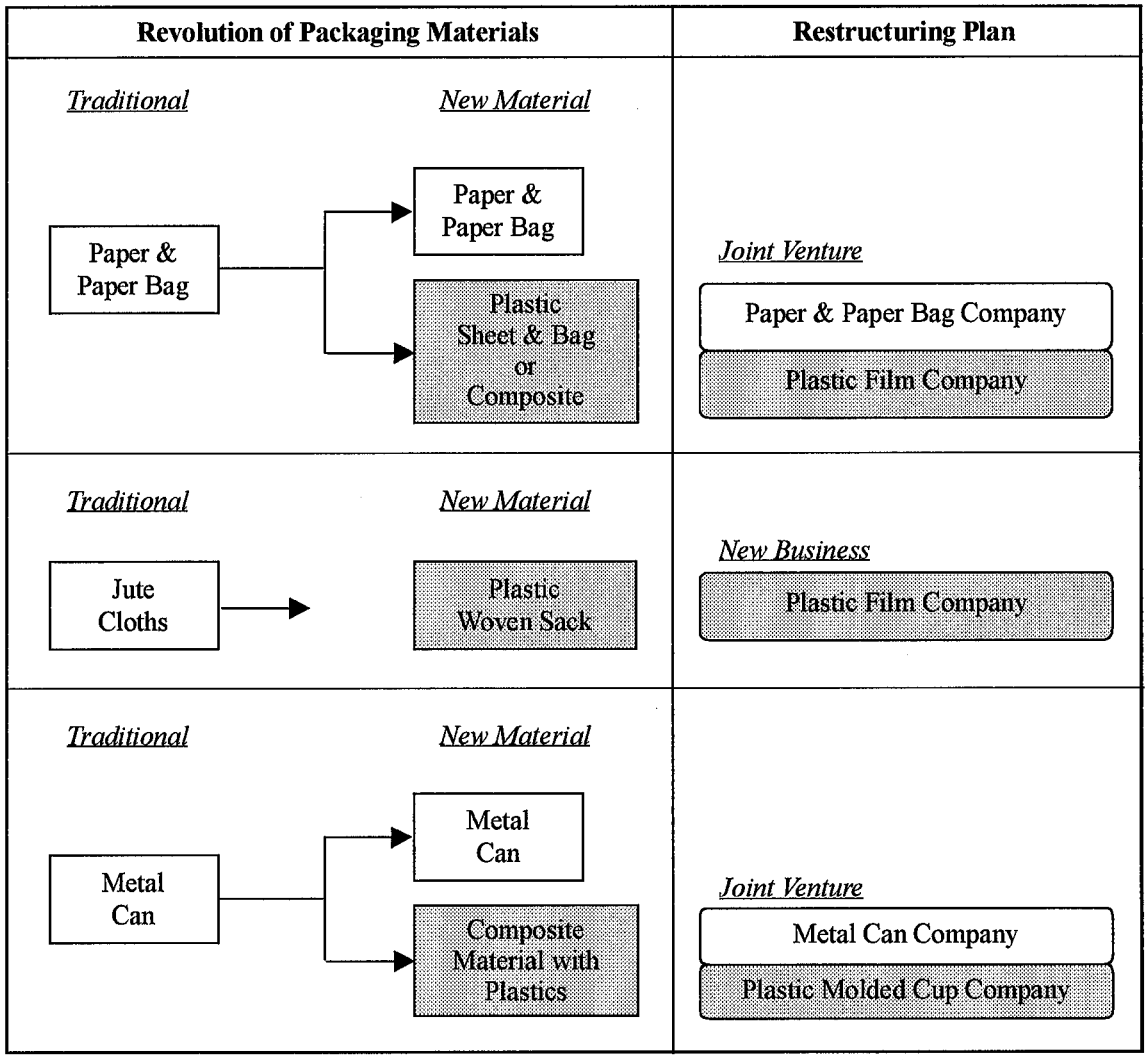
Concentration of technologies, equipment, human resources, and capital on larger scale business entities would contribute to an increase in competitiveness of the plastic industry in Sri Lanka.



Restructuring of Plastic Industry for Electric/Electronic Use

(ii) Plastic Manufacturers for Packaging Use:

Revolution of packaging material is in progress in Sri Lanka, because of superior functions and lower prices of plastics. It will be feasible to form joint ventures by traditional packaging manufacturers and plastic manufacturers as illustrated below.



(iii) Creation of Packaging Technology Association:

Establishment of an association of packaging enterprises will be recommended to improve packaging technology.

Concept of Packaging Technology Association

The proposed association will have functions for trade/marketing, packaging technology information, packaging journals, and training of member enterprises.

3.6 Clustering Program

As the plastic industry is a basic material supplier to other manufacturing industries, there is a clear correlation between its growth to other subsectors' growth. In this respect, there should be effective cooperation and coordination among the related industries to expect a maximum effect of "clustering".

1) Clustering with Rubber Industry

Both plastics and rubbers are important basic materials of advanced manufacturing. Because the rubber industry in Sri Lanka has been developed as one of the key "global-linked" industry, an effective clustering of the plastic industry with the rubber industry would be expected.

Particularly, collaboration between the two sectors in R&D would be a promising area. For example, development of composite technology is a field where both sectors are to be involved, and technological upgrading and product development would be expected to achieve this important technological field. It is proposed that UOM (academy), Rubber

Research Board, ITI, and PRI (Plastic and Rubber Institute) promote joint research projects in such fields as plastic/rubber blending, plastic property analysis, and modification with natural rubber. Another example of possible joint research is R&D of co-extrusion technology. This is a much advanced area, and requires a lot of basic research, and learning of theories and applications from the advanced countries. If both sectors of plastic and rubber could build a mechanism for cooperation, they may be able to share human resources and costs for development. When the two sectors establish an organization to promote technology transfer in this field, it could work as a center of technical assistance to domestic enterprises, as well as a core entity to establish a joint venture company with foreign partners.

2) Clustering with Electric/Electronic Industry

The electric/electronic industry is another promising target industry. If the plastic industry in Sri Lanka succeeds in supplying competitive, advanced materials to the electric/electronic industry, industrialization of the country will be accelerated and upgraded. Eventually, it is important to develop a competitive electric/electronic "supporting" industry, namely engineering plastic manufacturers which source materials to electric/electronic parts and components manufacturers. These materials include nylon, poly-carbonate, polyester plastics and polyoxymethylene (POM).

3.7 Financing and Institutional Arrangement

1) Financial Arrangement

Nearly 60% of plastic enterprises are SMIs, and they are in need of financial resources. They expect that public support will be extended to financing in concessional terms. According to the questionnaire survey, the demand for future borrowing of the existing plastic enterprises is estimated to be Rs. 440 million for the public loan and Rs. 330 for the commercial loan. This demand is based on the operation contemplated at the moment by plastic enterprises. When the production of plastics is increased as proposed in this Master Plan, the demand for financial borrowing will be further increased. It is recommended that efforts be further made by the government to secure enough funds to meet the demand for such borrowing.

Public financial support will also be required when R&D and human resource development is to be promoted for the plastic industry, particularly for polymer processing and development of packaging technology. Although the private sector is expected to take initiative in

introducing such technologies, some public support would be necessary, including a support for establishment of the Plastic Technology Center in the public institution.

2) Promotion of FDI

Foreign direct investments (FDIs) are expected to share a substantial contribution to increase production and GVA of the plastic industry. To meet the domestic consumption (270,000 tons minus import of 30,000 tons) and exports (60,000 tons) in 2010, large investments are required as estimated below, and the majority of investments are expected to be made by FDIs.

Expected Capacity toward 2010

		Production (1,000 ton)	Number of factories	Employee	Investment (Rs million)
Packaging Products		160	7	920	12,300
	Flexible packaging*1	100	4	560	8,400
	Rigid Packaging	60	3	360	3,900
Industrial Products		140	12	1,300	7,500
	Electric/electronics	50	3	300	2,000
	Industrial goods	50	5	600	2,500
	Automobile and others	40	4	400	3,000
Total		300	19	2,220	19,800

*1: Examples of flexible packaging are film and laminated goods; rigid packaging are bottle, containers and cups; and industrial goods are ropes, sheets, and architecture.

FDI in production of packaging film is of prime importance, because (i) large demand (100,000 tons in the year 2010) is projected, (ii) high technology abroad is needed for high quality film by thin flat die casting, and (iii) large investment is required for building a thin flat die casting plant. To promote FDIs in the plastic industry, it is recommended that the following measures be taken:

(i) The government and BOI designate the plastic industry as a thrust industry and extend incentives,

(ii) The government and BOI make appeals to petrochemical enterprises in Singapore, Qatar, and Saudi Arabia, and

(iii) Plastic enterprises develop human resources through practical training by the cooperative organization with leadership of PRI.

3) Establishment of Plastic Technology Center

The plastic industry is positioned as a policy-driven industry for industrialization of Sri Lanka, and it is desirable that some supportive measures to improve the technology base and to promote technology transfer to SMIs be extended by the public institution in addition to the efforts to be made by private enterprises individually or in association. In this context, it is proposed that a Plastic Technology Center (PTC) be established in ITI or alternatively in IDB (for reference, the current organization of ITI is explained in the box below). PTC is planned to have the following functions:

- Polymer characterization/analysis,
- Analytical assistance in R&D for PRI,
- Technical assistance/consultation to SMIs, and
- Coordination among PRI, academia, and other related institutes.
- Skill and knowledge standardization

Current Organization and Function of ITI

ITI (Industrial Technology Institute)

- Agro and Food Technology Division
- Chemical and Environmental Technology Division
- Materials Technology Division
- Process and Plant Engineering Division
- Corporate Services Division
- Calibration and Measurement Unit
- Electro Technology Unit

Functions	Services
Consultancy for industry	Advisory services
Calibration of laboratory and industry equipment	Information services
Development of products and processes	Instrument facilities
Supporting PRI for R&D activity	
Measurements, industrial and laboratory	Library facilities
Repair of electronic equipment	
Research contracts	
Testing and analysis of industrial raw materials and products	
Training of technical personnel	
Trouble shooting in industry	

Standardization of skill and knowledge of technicians and operators is quite important for promotion of the plastic industry. In this context, it is proposed that PTC will lead the role for skill and knowledge standardization by setting up a system for certifying the achievement level of skill and knowledge of technical people. Factories, on the other hand, should motivate their technicians and operators to obtain such a certificate to enhance their level of technology.

PTC will be equipped and staffed properly, including facilities required for polymer characterization/analysis.

4. ACTION PROGRAM (2000-2004)

Action programs to be implemented in the short term (2000-2004) should be designed respectively for the private sector, academia, and the public sector, as proposed below.

1) Program to be implemented by the private sector

(i) Analyse the product-market situation and select/concentrate on some focal products, either in plastic packaging products or in plastics for electric/electronic industry (refer to discussion in Section 3.1. (2) and (3)).

(ii) Study and implement market expansion through product development and Market-In (refer to discussion in Section 3.1. (4)).

(iii) Promote technological upgrading, including introduction of composite technology, co-extruction technology, and other technologies abroad through technical cooperation (refer to discussion in Section 3.3. (2)).

(iv) Promote cooperative relation among enterprises under the membership of the Plastic and Rubber Institute, including exchange of information among enterprises.

(v) Reinforce the Plastic and Rubber Institute to tackle jointly with product development in the field of packaging products (if appropriate, a Packaging Technology Association can be envisaged as discussed in Section 3.5).

(vi) Promote recycling in factories and implement environmental protection programs to be formulated by PRI and individual enterprises.

(vii) Promote and implement clustering with major plastic-using industries, including electric/electronic industries and packaging industries.

2) Programs to be implemented by academia

(i) Introduce curricula of more practical technologies and a credit system of practices at institutions/enterprises.

(ii) Extend cooperation in R&D and training to be promoted through ITI and PRI.

(iii) prepare textbook of practical engineering in view of the shortage in engineering textbooks/handbooks.

3) Programs to be implemented by the public sector

(i) Reinforce ITI or IDB by establishing a Plastic Technology Center, and extend technical support to SMIs for their restructuring, product development, R&D, and training.

(ii) Secure funds for financing to SMIs in their restructuring, product development, and environmental protection

(iii) Cooperate in promoting FDIs and J/V, particularly in the field of packaging film, composite products, and multi-layered co-extrusion products.

APPENDIX-H

MACHINERY INDUSTRY

H. MACHINERY INDUSTRY

Table of Contents

H. MACHINERY INDUSTRY

1. OVERVIEW OF MACHINERY INDUSTRY

1.1 General Situation of Machinery Industry

The Phase I study identified that the machinery industry was not a strong industry in Sri Lanka, but it was an industry indispensable for industrial development of Sri Lanka. For that reason, the machinery industry has been selected as a target industry for further study in Phase II.

The 1995 annual industrial survey shows that the industry was rather small in scale. To obtain basic information on the recent situation of the industry, the questionnaire survey was conducted for 50 enterprises of machinery makers, which are almost all the machinery manufacturing enterprises in Sri Lanka. There are many enterprises that are trading as wholesalers or retailers, which may cause slight inaccuracy in the statistics. Further, a preliminary Input-Output table in 1994 is referred to in the discussion. This I-O table shows a different value of GVA in the machinery and equipment industry. However, it will not have any significant effect on the discussion in this study. Therefore, the development plan will be discussed on the basis of the questionnaire survey, while discussions related to the input-output will refer to the figures in the I-O table. The results of these surveys are summarized below.

General Characteristics of Machinery Industry

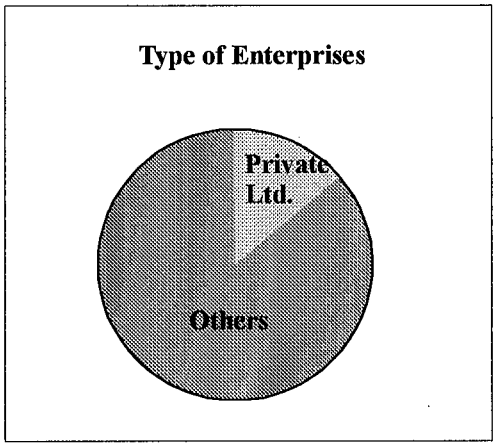
Code	Description	No. of establishment	Employment	Output (Rs. million)	GVA (Rs. million)	Productivity	
						Rs. 1000 per employee	US$ 1,000 per employee
382	Machinery 1995 survey	42	4,019	3,186	812	202	3.94
382	Machinery 1999 Questionnaire survey	50	2,214	2,090	533	241	3.44
45	Machinery & Equipment 1994 I-O Table				2,493		

Remark: 1999 GVA is assumed to be the same value added ratio as in 1995 survey.

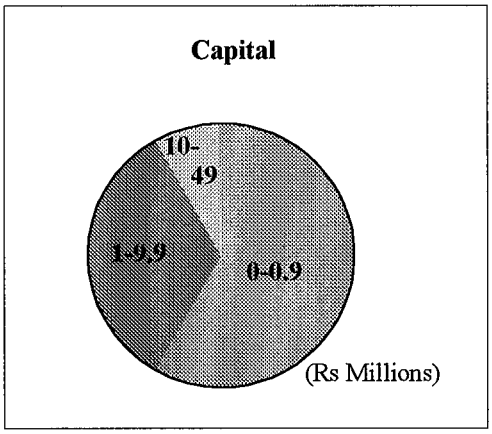
From the two surveys in 1995 and 1999, it is obvious that the machinery industry has been shrinking in recent years.

1.2 Machinery Enterprises

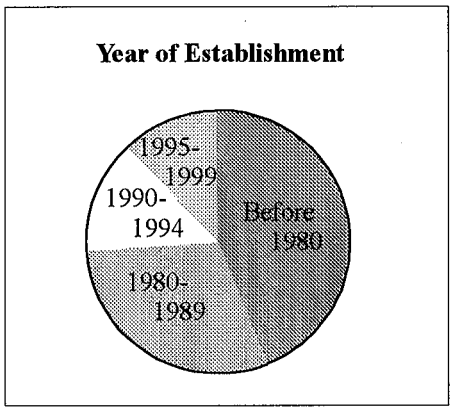
The figure below shows that 86% of machinery enterprises is small-scale industry operated by the owner himself. In most of the companies, the major share is held by an entrepreneur and his family.



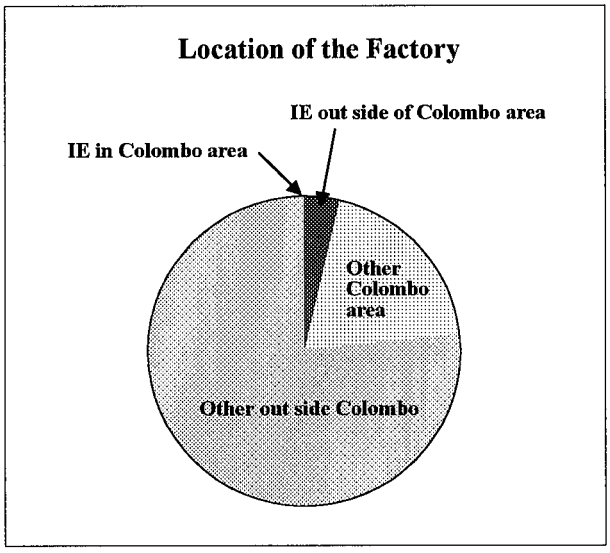
No enterprise has paid-up capital of more than Rs.50 million, with the implication that all enterprises are small and medium in scale. As shown in the figure below, 58% of enterprises have a paid-up capital of less than Rs. 1 million, and 98% of enterprises have a capital of less than Rs. 10 million. Only four enterprises are medium size, having more than Rs. 10 million paid-capital.



The following figure shows that the enterprises had a rather good history in the industry. More than 44% of factories were founded before 1980. It is feared that closed factories might have exceeded new creation of factories since 1980. It is noted that all 50 enterprises are of 100% Sri Lankan capital. It appears that nationalization of major industries in 1979 had adversely affected the expansion of the machinery industry in Sri Lanka.

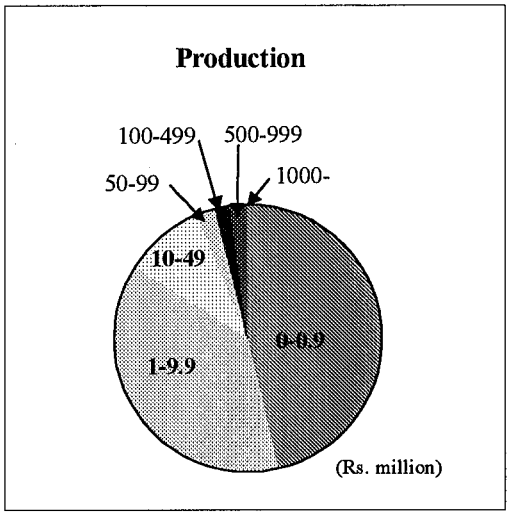


As shown in the figure below, 78% of the factories are located outside Colombo, and only two factories are located in the Industrial Estates (IEs). The factories are not concentrated in an area, but widely scattered outside Colombo. Therefore, collaboration among factories are quite weak. The machinery industry has little relation with other industries in IEs at the moment.

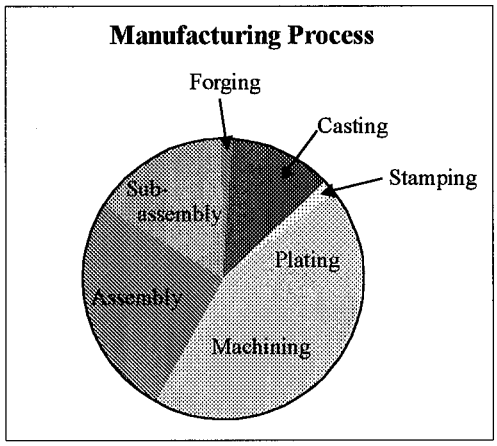


1.3 Production and Employment

Annual production of the machinery industry is quite small. As shown in the next figure, 46% of enterprises have a turnover of less than Rs. 1 million, and enterprises of less than Rs. 10 million account for 84%. Only three companies have a turnover of more than Rs. 10 million. The low level of production is caused by poor marketing and weak demand for the product of machinery industry, as explained later in Section 2.4.

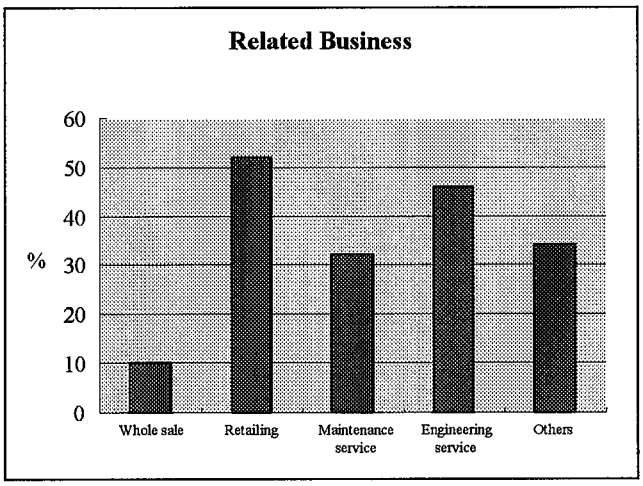


Machining, assembling and sub-assembling are the common practices in the factories, as shown in the figure below. Casting and plating also prevail; however, forging and stamping are weak in technology, because only two companies have small facilities for forging and stamping. Further gear cutting is a weak point of the industry, because no hobbing machine is operating in the country. The leaders of the machinery industry are well aware of these facts but introduction of these processes have been neglected by investors for many years.



Among 50 enterprises, 2 companies are operating metal processing businesses and a company is manufacturing electric equipment in the same factory. More than a half of enterprises do retail sales of their own products and other related products. As market of the machinery industry has not been adequately developed in Sri Lanka, machinery manufacturers are directly marketing most of their products. Their marketing power is weak, having little support by commercial firms. It is also observed that some enterprises stopped their

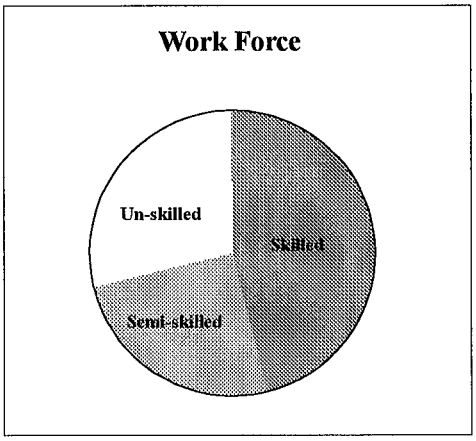
production and became dealers of imported products or knock down assemblers of imported parts. This trend is seen mostly in mass-production type products.



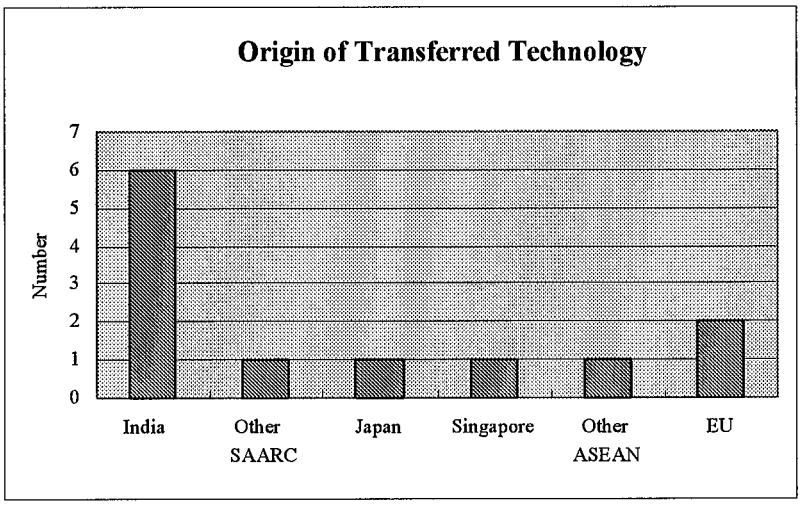
Total number of employment in the machinery industry is about 2,200, as tabulated below. It appears that the number of managers is excessive, but managers are also operating machinery in small factories. In comparison with the total direct labor force of 1,495, total indirect labor force of 719 (or 48%) appears to be too large.

Manager	Engineer	Designer	Others	Sub-total	Worker	Total
181	58	24	456	719	1495	2214

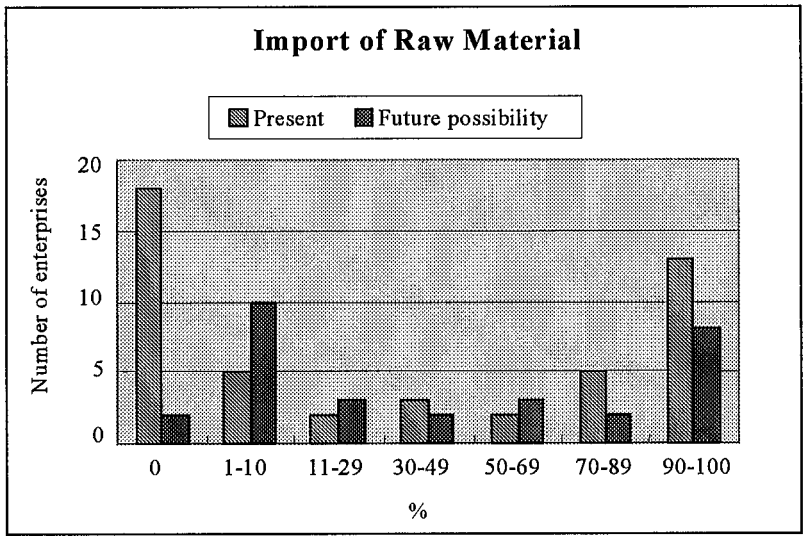
The machinery industry, at present, has a rather good proportion of skilled labor force. It may be a result of recent shrinkage of the machinery industry. In other words, they can serve for rapid expansion of the industry in the future. In spite of obsolete facilities in the factory, the industry has produced comparatively good products by the effort of skilled labors. Modernization of the production line will be the issue to be addressed for revitalization of the machinery industry.



Technology transfers from foreign countries in the machinery industry are rather limited; i.e., transfer from India in 6 cases, EU in 2 cases, and Japan, other SAARC, Singapore and ASEAN in one case respectively, as shown below.



The machinery industry is largely dependent on imported materials. Many small enterprises have not adequate route to import their materials, and they are looking for diversification of import sources. Although the industry is willing to utilize high carbon steel and alloyed steel for high value added products, these materials are rather difficult for small enterprises to obtain. There are some opinions proposing to produce materials for the machinery industry in Sri Lanka; however, scale of the machinery industry is too small to support such material industry at present. Therefore, materials such as stainless steel, steel plate, forged steel and cast steel should be imported, except for cost iron.

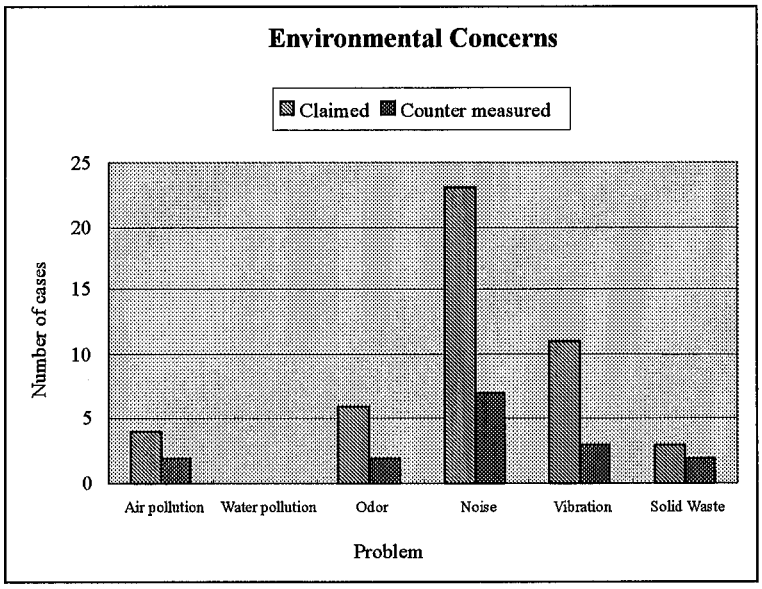


1.4 Environmental Protection

Machinery industry may cause following hazard:

Assembly and test:	Vibration, Noise
Machining:	Solid waste, Noise
Casting:	Air pollution by dust
Forging & stamping:	Vibration, Noise, and Air pollution

Noise and vibration are major problems of the machinery industry at present. Water pollution problem is not reported; however it may be a serious problem in the plating process in future. Air pollution, water contamination and solid waste will be more serious at the further stage of the industry.

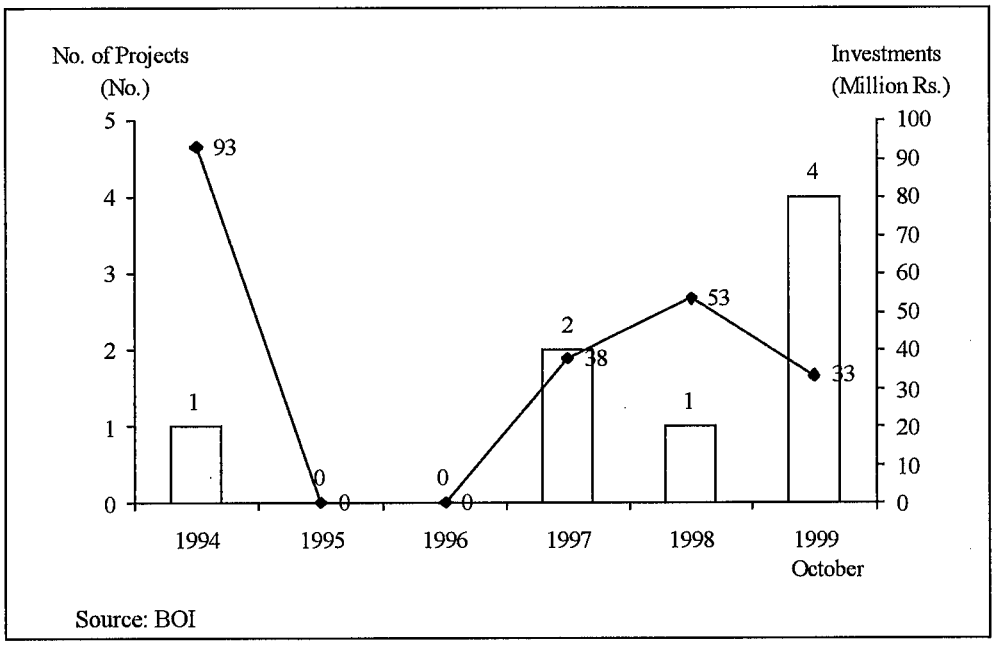


The machinery industry indicates keen interest in protection of environment, but the actual level of environment protection technology remains at a low level. Fortunately the machinery industry is still small in scale and hazard is not so serious.

On the other hand, the machinery industry is a supplier of environmental protection equipment such as garbage combustion boiler, water treatment equipment and so on. For example, the Moratuwa area has water contamination by sawdust disposal to the lake. If Sri Lanka has a good boilermaker, sawdust will serve to generate electric power.

1.5 Investment in Machinery Industry

The number of investment projects in the machinery industry approved by BOI is quite a few as shown below.



Numbers of Projects and Investments in Machinery Industry approved under Sec. 16 & 17 of the BOI Law

Since the machinery industry is not designated as a thrust industry, the machinery industry is categorized as a general export oriented project when investors want to enjoy incentives offerred by BOI. The incentives granted to general export oriented projects are tabulated below.

BOI Incentives for General Export Oriented Projects

Description of Activity	Qualifying Criteria			Incentives				
	Minimum Investment in Rs.mn	Minimum Direct/ Indirect Export Requirement (% of output)	Minimum New Employ-ment Required	Full Tax Holiday	Concession-ary Tax at 15%	Import Duty Exemption		Exemption from Exchange Control
						On Capital Goods	On Raw Materials	
New export oriented enterprise locating outside a designated industrial estate and not qualifying for incentives specified elsewhere								
• Manufacturing (plastic, general machinery and so on)	12.5	90%	None	None	20 years	Yes	Yes, if utilized for export	Yes

Source: BOI

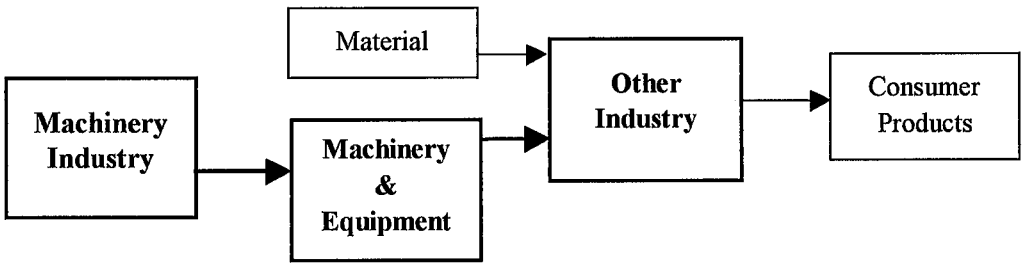
2. BOTTLENECK OF MACHINERY INDUSTRY

The machinery industry has a less comparative advantage in Sri Lanka as the country has no natural resources for the industry, and the machinery industry remains small in scale and low in productivity. However, the machinery industry is an indispensable industry for the industrial development of a country. It is because the machinery industry provides production machines and equipment to every industry in the country. Historically, no industrialized country has developed without its own machinery industry.

2.1 Importance of Machinery Industry

1) Relations with Other Industries

The machinery industry is not only a consumer goods producer but also a supplier of production machinery and equipment. The machinery industry provides its product to every industry, including itself, and improves productivity of such industries.



Relations between the machinery industry and other industries are seen in the Input-Output table. Sri Lanka's I-O table in 1994 is still under adjustment, and figures are subject to change; however a general situation is clearly observed from the table (an abstract of I-O table is shown on the following pages). Apparently the relations of the machinery industry with other industries are quite limited, empty added value columns in the table showing absence of the Sri Lankan machinery industry. These empty columns should be filled if Sri Lanka intends to attain well-structured industrial development.

Relations between General Machinery Industry and Other Industries (I-O Table)

	Industry	Related General Machinery Products			Advise for development
		Domestic products	Domestic Value Added as Input (Rs1.0 million)	Import products	
1	Tea Growing	Primitive leaf harvester			Advanced machine design
2	Tea Processing	Tea roller & etc.	184.1	CTC plant	Advanced machine design
3	Rubber Growing				New design
4	Rubber Processing	Simple rubber roller		Advanced roller	Advanced machine design
5	Coconut Growing		3.8		Mechanization
6	Paddy Growing	Hull remover Rice polishing machine & etc.		Small tractor Forged steel tools and parts	Restriction to the import products Knock down production
7	Livestock			Butchering plant	Develop technology Licensing
8	Fishing			Engine Refrigerator Ice maker	Licensing
9	Logging & Firewood			Sawing machine Wood machine tools	Forging & heat treatment technology
10	Forestry	Repair work	2.0	Sawing machine	Forging & heat treatment technology
11	Other Agriculture	Engineering & repair	66.0	Processing plant	Mechanization
12	Mining & Quarrying			Crusher Excavator	Steel casting
13	Milling		18	Mill	Steel casting
14	Dairy Products			Milk plant	Welding stainless steel Licensing
15	Bread	Small oven		Bakery oven	Welding stainless steel
16	Other Bakery Products	Simple oven		Oven Mixer	Welding stainless steel
17	Confectionery			Oven Mixer	Welding stainless steel
18	Beverages	Installation Repair	2.9	Bottling machine	Design Licensing
19	Bottled Fruit			Bottling machine Boiler	Design Licensing
20	Alcoholic Beverages	Simple distiller		Bottling machine Boiler Distiller	Design Licensing
21	Desiccated Coconut			Coconuts processing plant	Design
22	Other Processed Food			Refrigerator Canning machine, Packaging machine,	Design Licensing

23	Tobacco Manufacturing			Tobacco processing plant	Licensing
24	Textiles			Textile machines	Licensing
25	Garments	Knock down of sewing machine Repair		Sewing machines	Licensing
26	Wood Products			Wood work machines	Forging & heat treatment technology
27	Paper & Paper Products			Paper plant	Design
28	Printing & Publishing			Printing machine	Licensing
29	Leather & Leather Products			Waste treatment	Design
30	Rubber Products			Tire manufacturing plant Hydraulic press Boiler Roller	Licensing
31	Chemicals & Chemical Products			Chemical plant Waste treatment	Licensing
32	Toilet Preparation			Mixer	Licensing
33	Pharmaceuticals			Chemical plant	Licensing
34	Fertilizer & Chemicals			Chemical plant	Licensing
35	Oil & Fats			Processor	Licensing
36	Coconut Fiber & Yarn	Primitive machine		Advanced processor	Mechanization
37	Petroleum & Coal Products			Refinery Petrochemical plant	Licensing
38	Structural & Clay Products	Clay making machine			Design
39	Ceramic, Glass & Glass Products			Ceramic plant Glass plant	Design
40	Cement & cement Products			Cement plant	Licensing
41	Basic Metals & Rolling			Electric arc furnace	Licensing
42	Light Engineering	Welding fabricate			
43	Electrical Appliances			Press Insert mounter	Licensing
44	Transport Equipment			Machine tools	Licensing
45	Machinery & Equipment			Machine tools Sub-contract work	Import advanced machine tools
46	Other Manufacturing Products			Machinery	Licensing
47	Construction	Repair Installation Small mixer	891.0	Excavator Bulldozer Cement mixer	Licensing Design
48	Electricity & Water	Pump Manhole Installation	733.4	Pumping station Power station	Licensing Design
49	Road Passenger Transport			Engine & parts	Licensing

50	Railway Transport			Engine & parts	Licensing
51	Trade & Other Transport	Repair	278.0	Engines	Licensing
52	Banking	Air conditioning (Engineering)	147.1	Air conditioner	Licensing
53	Insurance	Air conditioning (Engineering)	9.6	Air conditioner	Licensing
54	Ownership & Dwellings			Kitchen equipment	Design
55	Communication	Installation Manhole	122.7		
56	Hotels & Restaurants Tourism	Kitchen equipment	6.1	Air conditioner	Licensing
57	Other Services	Furniture		Furniture	
58	Health Service			Medical equipment	Licensing
59	Education Service	Furniture	6.1	Air conditioner Scientific equipment	Licensing
60	Govt. Admin & Defense	Furniture	40.6	Arms	Design
61	NGO	Furniture	8.3		
62	Non profitable Government Institute	Furniture	39.7	Scientific equipment	Licensing
	Gross Total		2493.4		

As it is clear from the many empty columns in the above I-O table, Sri Lanka has a small and retrogressive machinery industry; GVA is only Rs. 2,493 million (about US$36 million) which corresponds to the output of an enterprise with about 120 employees in the advanced country.

2) Importance of Machinery Industry

The machinery industry is not only a consumer product maker but also a production-machinery and production-equipment manufacturer of the country. The machinery industry supplies all production machinery to every manufacturer. Therefore, the machinery industry is fundamentally the basic industry. If the machinery industry were absent, industries of the country would become quite vulnerable because import of machinery products might be affected sometimes by international conflicts and international fluctuation of economy. For this reason, many countries protect their machinery industry for the national interest. For instance, ASEAN countries have been eager to develop the machinery industry, and their machinery industry had been protected. Malaysia and Thailand have been successful to develop their own machinery industry and their industrialization is supported by development of their own machinery industry.

When other conditions are similar, a country that imports production-machinery is apparently at a disadvantage than a country that manufactures production-machinery. It is because in the importing country, production machines and equipment become expensive due to the transportation cost, custom taxes, importing finances and so on. Further, considerable delay in new technology application is unavoidable because a machinery maker often invents new production machinery and system.

At present, foreign competitors in the machinery industry are penetrating into the Sri Lankan market at a low price. If Sri Lanka continues to be defenseless, Sri Lanka's machinery industry might be destroyed. Without a domestic machinery industry in Sri Lanka, foreign exporters might increase production facility prices freely and it will cause an increase in costs of manufacturing products in Sri Lanka. Further, if there were no domestic machinery supplier, repair and maintenance of the machine and equipment would be found difficult. Spare parts would not be timely available. Then, stoppage of the machine would be prolonged and productivity would be lowered substantially. To avoid vulnerability and to improve productivity of the industry as a whole, it is of prime significance to adequately develop the machinery industry in Sri Lanka.

3) The Machinery Industry based on Small and Medium Enterprises

Two different approaches are seen for industrial development. One is to develop industries based on the large-scale assembly industries, like in the case of Korea. The other is to develop industries based on the small and medium enterprises, typically seen in the case of Taiwan. In general, the machinery industry is based on small and medium size enterprises. In the recent Asian financial crises, Taiwan's industry suffered less than Korea. Sri Lanka has no large domestic market to support large demand for assembly work or mass production in the economy of scale. Accordingly, it is more practical to develop the machinery industry based on small and medium enterprises.

Small and medium industries (SMIs) are rather difficult to develop under the government regulations. They are expected to develop under the liberated vigorous environment. SMIs expand under the process of frequent creation and extinction of enterprises, adapting to the evolution of the economy. Generally, large-scale industries are apt to mass production of consumer goods, while SMIs are specialized in customer oriented high value added product of limited demand.

For the expansion of the machinery industry, creation of new SMIs should be strongly encouraged. When creation of new SMIs exceeds failure of SMIs, the industry will expand.

Further, in SMIs, the entrepreneur's role is quite important, because his/her decision results in direct and decisive performance of his/her company. Entrepreneurship should be advanced in a traditional way or through creation of venture capital and education for good factory managers.

2.2 Bottleneck: Problems Faced Machinery Industry

1) No Development of New Product

Most of the machinery is manufactured in Sri Lanka based on old traditional design. This implies that products of Sri Lanka's machinery have no originality and are less efficient, compared with foreign competitors' advanced products. Technical license is granted in a certain area but it is still rare in the machinery industry. Such services as dispatch of engineers and training of employees in the advanced country are offered but are limited to the enterprises established by FDIs. Even in such cases, design know-how is not transferred to Sri Lanka. Design is an important factor of productivity and cost, because products are totally decided by design. Lack of proper design is common to Sri Lankan industry, and this is one of the most decisive factor of competitiveness.

CAD (Computer Aided Design) is not so popular yet in Sri Lanka, while it already becomes popular in China. CAD makes sophisticated design calculation easy; e.g., finite element method which assist complicated calculations based on fluid dynamics, heat transfer, stress and strain calculation. These advanced technologies are not utilized yet by the machinery industry in Sri Lanka.

2) Obsolete Production Facility

Productivity of the machinery industry is rapidly increasing in NIEs, ASEAN and China. For reference, NIEs achieved productivity of US$50,000-100,000/employee in the machinery industry, while ASEAN countries and China attained productivity of US$10,000/employee or more. However, the Sri Lankan machinery industry remains at the level of US$ 3,500/employee. This difference in productivity is mainly attributable to the delay in facility modernization in Sri Lanka.

Development of advanced technology and modernization of machinery is delayed in Sri Lanka. There is little numerical controlled machine in the factory. Old shaper carries out gear cutting, and no efficient gear-cutting machine with hob is introduced. Facilities in the factories are mostly as old as the 1940's. Old type lathes are popular machines, and shapers

and plainers are used everywhere. Soldered tip cutter is still used in Sri Lanka, while many other countries introduced removable throwaway tip of high-hardness. Milling is more efficient than shaper and plainer; however only shapers and plainers are used and no large milling machine is available for flat surface finishing.

There are several foundries; each foundry has cupola of about 3-tons/hour capacity; however it is old and lacks in modern auxiliary equipment and technology. Technology of foundries is generally primitive. One or two foundry has induction furnace but no ductile cast iron is produced. Mould sands are not prepared well in general. Then, JICA extended cooperation for a foundry technology center in IDB, and is trying to improve technology. Training, however, takes time. An exception is Edna Engineering's foundry, which has complete facilities of compacting and fettling sand mould, sand treatment and shot blasting facility. It has a 1-ton/hour-induction furnace and has technology to produce ductile iron. Two foreign specialists assist its operation. This foundry is planned to be a benchmark of the JICA- IDB foundry center.

Forging technology is lagged in Sri Lanka, and even a simple agricultural tool (e.g. sickle and hoe) is imported. Forged steel products (e.g. crankshaft, turbine rotor, machine tool shafts) are not produced. Accordingly, heat treatment technology is lacking, and hard steel products and tools are imported. Welding technology is also lagged, though demand for welding is high. CO2 semi-automatic welding is not introduced in the factory except in case of foreign joint venture, which is 5 times more efficient than ordinary arc welding.

Technology of the machinery industry is lagged in every aspect. In order to compete with imports from other countries, investment in new machines is required to a certain extent; e.g., CNC lathe, CNC milling machine, and machining center. Fortunately, labor productivity in the machinery industry in Sri Lanka has not been lowered substantially, as explained is TFP increase. If adequate investment in facilities is realized, the machinery industry in Sri Lanka still has the possibility to be revived as competitive.

An example of the Sri Lanka's machinery industry has been analyzed as shown in ANNEX 1: Case study on "C" Company.

3) Competition with Imported Machine

The machinery industry in Sri Lanka is seriously suffering from competition with low price imported products. It is reported that several agricultural machine factories have been closed or about to close, because competitor's prices are less than or equal to the material cost of Sri

Lankan products. This competition is mainly attributable to export at marginal prices.

Managers of Sri Lankan industries are misunderstanding that the export country's government subsidizes these low price exports. It is simply based on direct costing. Unless associations of the machinery industry take appropriate action together with the government, export at marginal prices might destroy Sri Lankan machinery industry.

Dumping is not a rare occasion in international trade. As production cost is composed of fixed cost and marginal cost, it is known that selling slightly above marginal cost is profitable in a certain case. Exporters attack new markets at marginal prices in many cases, keeping its domestic market at ordinary prices. Some exporters are attacking the Sri Lankan market, because the country is defenseless. The anti-dumping law is ineffective in Sri Lanka. The anti-dumping law causes many times a sort of conflict between trading countries, unless diplomatic negotiation is held on this issue. The explanation on marginal price: How Chinese can export to Sri Lanka at the price less than material cost, is explained for reference in ANNEX 2:

Machinery had been exported from Sri Lanka in old days; however it is quite exceptional now, because it has no comparative advantage, due to low productivity and lack of natural resources.

4) Custom Policy

Factory managers complain that the custom duty is quite adverse to the machinery industry, because it is high for imports of materials and parts, and tax free for the equipment import. The fact is that import tax of material such as coke, pig iron, thin steel plate is 0.5%, while complete equipment such as pumps and small engine are free.

ASEAN countries had imposed a high custom tariff on the complete equipment and low tax or no tax on the machinery parts, with the results that their industries have developed from 100% knockdown assembly to local parts production. ASEAN countries had also discriminated imported products by sales tax or VAT. Further, nationalization ratio or local content has been defined in manufacturing to allow more participation of domestic parts suppliers. Further discussion will be required on this issue, with a view to promote fair competition and to promote industrialization with an appropriate industrial system.

5) Foreign Direct Investments (FDIs)

The machinery industry is basically domestic industry and conservative. FDIs will not be so

frequent as in the case of other industries. For reference, in order to know opinions of the Japanese machinery industries on direct investment in Sri Lanka, a questionnaire survey has been carried out to 101 enterprises in the general machinery industry, and 34 replies have been obtained. The results of this survey are summarized below:

(i) There are many enterprises having the intention to expand both domestic and foreign activities; however they place more importance on domestic investment and/or renovation of their existing facilities.

(ii) Japanese machinery industries are trying to concentrate their production on high value added products at domestic factories, and transfer other production to developing countries for cost reduction. However, they admit at the same time that they are not willing to abandon relationship with the current subcontractors.

(iii) Japanese machinery makers have built their factories in USA or NIEs, where they have customers. Then they expanded to ASEAN, according to industrial development of the ASEAN countries.

(iv) Low labor cost is attractive to investors; however market size is more important. Infrastructure is another factor of importance.

6) Poor Management

The Sri Lankan machinery industry face difficulty in their operation. One of the major reasons is capital rotation. Sri Lankan enterprises have a capital rotation ratio of 0.5 or less, while foreign capital companies have more than 1.0. Inadequate management for production and inventory makes the difference. A low capital rotation ratio means inefficient utilization of invested capital. A comparison of management between foreign capital enterprise and domestic capital enterprise in the machinery industry is presented for reference in ANNEX 3.

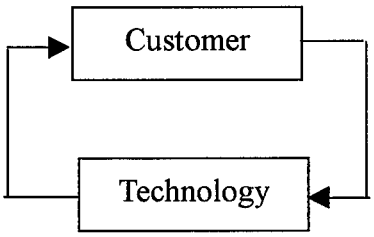
2.3 Industrial Clustering

1) Linkage to Other Industries

As discussed in the Input-Output table in Section 2.1, linkage of the machinery industry to other industries is limited at present, and further efforts are required for the machinery industry to expand its relation with other industries.

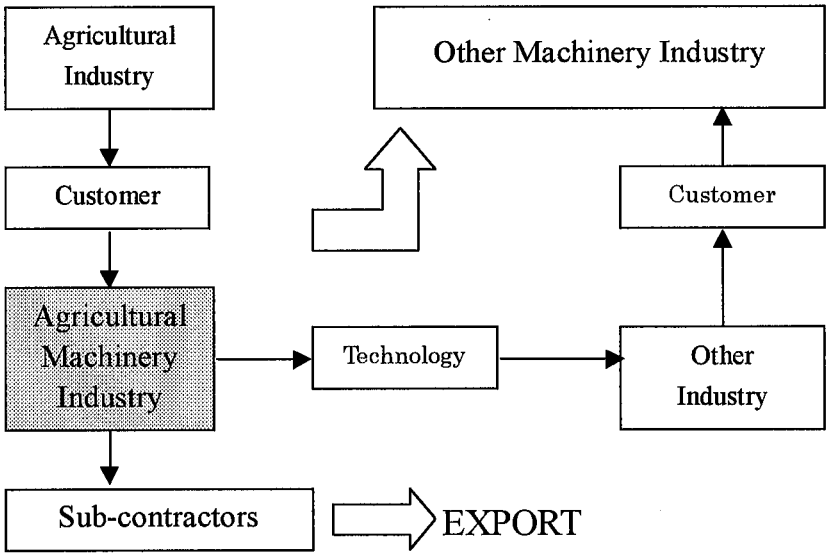
Agricultural industry should be selected as a starting point to reactivate the machinery industry because its domestic market is comparably large. Development of the agricultural

machinery industry is, in a way, dependent on customers.



The machinery industry in Sri Lanka should accumulate technical experience first in the agricultural machine area. Then, the accumulated know-how and technology should be transferred to other product areas. As the I-O table reveals in Section 2.1, there are many blank columns of product areas where the machinery industry can enter.

When basic technology is accumulated, a machine maker can create new industry in a technology related area. And, when a subcontract system is formed to a certain extent, ventures can easily start new business with an advanced idea and/or invention in the machinery industry. Further, if machinery parts and subcontract jobs are freely crossed to India, Pakistan and Bangladesh, Sri Lanka's subcontractors would have a larger possibility of expansion.



In agricultural machinery development, creation of a subcontract system is quite important. It promotes not only development of the agricultural machinery industry but also other areas of the machinery industry, because machinery technology and production facility is common in many directions. For example, reduction gear, as well as heat exchangers, are used commonly

in almost every industry. In general, the machinery industry has strong relations in the following areas:

34	Fertilizer & Chemicals	Chemical plant Boiler Reaction tower Pump Compressor Heat exchanger Evaporator Distiller Extractor Absorber Grinding machine Mixer Filter
37	Petroleum & Coal Products	Refinery Petrochemical plant Boiler Reaction tower Pump Compressor
40	Cement & cement Products	Cement plant Kiln Crusher
41	Basic Metals & Rolling	Steel plant Arc furnace
42	Light Engineering	Boilers
43	Electrical Appliances	Press Die and mould
44	Transport Equipment	Machine tools Engine
45	Machinery & Equipment	Machine tools Forging machine Press Castings Sub-contract work
46	Other Manufacturing Products	Machinery
47	Construction	Excavator Bulldozer Cement mixer Cranes
48	Electricity & Water	Pumping station Power station Boilers Turbines Engines

Development of agricultural machinery should be followed by production of such machines as listed above, utilizing advanced technology in machining, welding, plating, casting and forging.

2) Probable Products

Recommendation on specific products other than agricultural machinery is rather difficult at this stage. However, products having potentials for development in Sri Lanka will be discussed in a provisional form in this section. For development of these machine and equipment, further detailed study should be made on marketability and feasibility.

(i) Boiler and Absorption Type Cooler

A possible candidate of products are boilers. Boilers are imported and installed in many hotels and restaurants. These hotels and restaurants also need air conditioning. A combination of a boiler and adsorption type cooler will not consume so much electricity. Manufacturing of this equipment will not require a large factory. Besides, processing of agricultural and fishing products also needs the same equipment. Boiler technology will also contribute to environmental protection. Sawdust disposal in the Moratuwa area, for instance, may turn to an electric supply by making use of the incineration boiler.

(ii) Excavator and Concrete Mixer

Sri Lanka should develop the infrastructure, and construction machines are in large demand. Excavator and bulldozer require cast steel caterpillars. When cast steel technology is developed on the basis of steel producing arc furnace, engine and hydraulic parts are imported, and construction machine are assembled by domestic factories.

(iii) Pumps

For agricultural development in the rural areas, particularly in the northern and eastern provinces, irrigation systems are required. There is a large demand for irrigation pumps for rehabilitation and development. Irrigation pump and small hydraulic power station for local life improvement; these two technologies are based on a common theory of hydro-dynamics and can be developed together.

(iv) Die and Mold

Plastic injection molding is prevailing in Sri Lanka, and demand for mold is increasing. However molds are mostly imported from India at present. The injection molding industry is looking for domestic supply, because purchase from India takes a long time. Although, economic effect of domestic mold production will be small, it may contribute to the plastic industry. No independent mold maker is in operation but it may be started when the plastic industry expands. Mold making needs experience and know-how. Even for a mold manufacturer of long experience, trials by a test injection molding machine and re-adjustment is necessary to make a mold for precision parts. Mold is manufactured by Electric

Discharging Machine (EDM), which forms a shape on hard metal, by a spark of electricity originated from a carbon pattern. A small EDM machine is operating in the IDB workshop at present.

(v) Packaging Machine

Sri Lanka produces various bulky products such as tea, desiccated coconuts, rice and cashew nuts. These products are packed in various shapes. At present, they are packed manually in most cases. Automatic and continuous measuring and packing already prevail in other countries, and they would be marketable in Sri Lanka. An automatic packing machine requires specific design and adjustment so that it is not mass production equipment.

(vi) Medical Equipment

Most of medical equipment requires specific design and elaborate handwork. Starting with manufacturing of surgical knife and scissors, manufacturing can be expanded to advance equipment such as an X-ray inspector and laser beam surgical operation equipment in the customer-dependent markets.

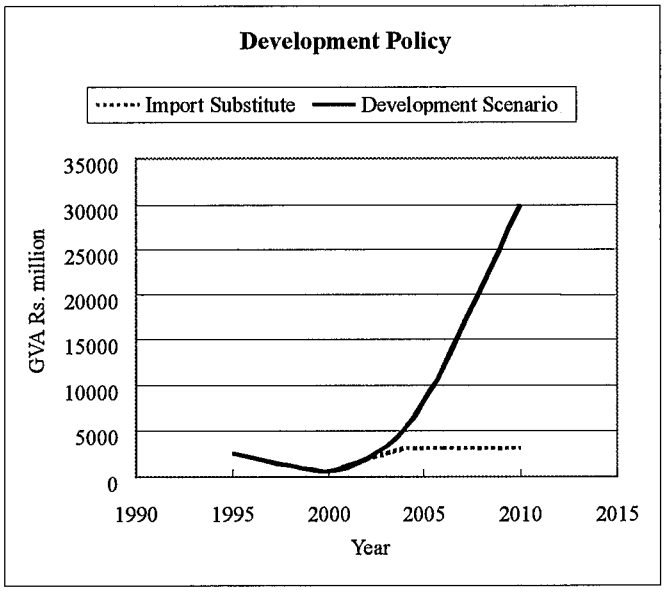
2.4 Development Policy

Domestic value added and imported value added are taken from the I-O table of 1994, as tabulated hereunder. The table shows that GVA of the domestic machinery industry was Rs. 2,493 million, while GVA of the imported machinery and equipment were Rs. 3,316 million. If import substitute policy is taken, domestic production would increase but import of material and parts for increased production might also increase to about half the value of the imported GVA.

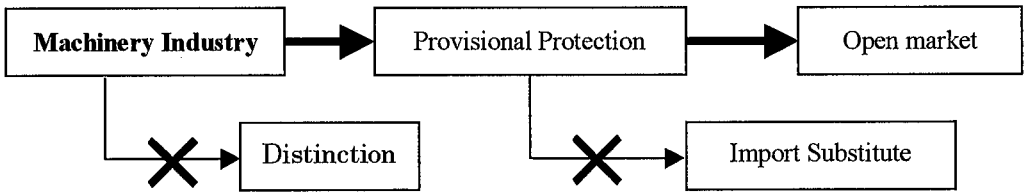
	Industry	VA (Rs. million)	
		Domestic	Import
1	Tea Growing		
2	Tea Processing	184	
3	Rubber Growing		
4	Rubber Processing		
5	Coconut Growing	3.8	
6	Paddy Growing		
7	Livestock		
8	Fishing		
9	Logging & Firewood		
10	Forestry	2	
11	Other Agriculture	66	12.0
12	Mining & Quarrying		31.4
13	Milling	18	84.3
14	Dairy Products		20.3
15	Bread		7.2
16	Other Bakery Products		9.4
17	Confectionery		4.6
18	Beverages	2.9	5.2
19	Bottled Fruit		0.5
20	Alcoholic Beverages		17.8
21	Desiccated Coconut		7.6
22	Other Processed Food		50.3
23	Tobacco Manufacturing		25.9
24	Textiles		141.1
25	Garments		530.0
26	Wood Products		19.6
27	Paper & Paper Products		37.8
28	Printing & Publishing		78.3
29	Leather & Leather Products		9.7
30	Rubber Products		16.0
31	Chemicals & Chemical Products		15.4
32	Toilet Preparation		8.8
33	Pharmaceuticals		11.6
34	Fertilizer & Chemicals		20.0

	Industry	VA (Rs. million)	
		Domestic	Import
35	Oil & Fats		6.3
36	Coconut Fiber & Yarn		3.3
37	Petroleum & Coal Products		41.2
38	Structural & Clay Products		5.1
39	Ceramic, Glass & Glass Products		6.8
40	Cement & cement Products		15.8
41	Basic Metals & Rolling		19.6
42	Light Engineering		87.8
43	Electrical Appliances		16.6
44	Transport Equipment		34.8
45	Machinery & Equipment		1,512.4
46	Other Manufacturing Products		41.2
47	Construction	891	33.9
48	Electricity & Water	733	39.8
49	Road Passenger Transport		
50	Railway Transport		
51	Trade & Other Transport	278	287.1
52	Banking	147	
53	Insurance	9.6	
54	Ownership & Dwellings		
55	Communication	123	
56	Hotels & Restaurants Tourism	6.1	
57	Other Services		
58	Health Service		
59	Education Service	6.1	
60	Govt. Admin & Defense	40.6	
61	NGO	8.3	
62	Non profitable Government Institute	39.7	
	Gross Total	2,493	3,316

Import substitution never makes the industry strong and the increase in production would not last long. For instance, under the import substitution policy, the machinery industry would approach to 1.5 times the value of 1994 production and keep this level as shown in the next figure.



Import substitution policy is not desirable for the Sri Lankan machinery industry, and it is far from the scenario in this development plan. Protection of the machinery industry should not end in import substitution. In order to avoid this, new products different from the currently imported product should be developed. In fact, there were several products including small home use pump and conventional agricultural machines which had been domestically produced before the opening of the market but are imported now. Returning to production of these products should be avoided, because it might repeat the same course after provisional protection or public support is terminated.



From the facts obtained through factory inspection, it is clear that considerable items and volume of domestic products have been replaced by import in the agricultural machine area. The I-O table shows that machinery import covers almost every industry except for industries related to agriculture, forestry and fishing industries. Development of new areas in machinery industry should be deliberately selected in domestically marketable areas.

The machinery industry should develop new products that are competitive in the international market. Products of mass production should be avoided, because these products are frequently sold at marginal prices in the international market. Consumer goods are mostly in this category.

2.5 Material Imports and Marketing

Imports of material and parts are important for the development of the machinery industry; however SMIs have insufficient access to credits. Commercial firms backed up with import finance should realize short and punctual delivery of the material and parts at reasonable prices. It is desirable that an adequate material distribution center provided, or a concept of the International Procurement Operation (IPO) be introduced as in the case of the Electric/Electronic Industry.

At present, the machinery industry has weak marketing power in the domestic market, when compared with importers of industrial products. In other countries, commercial distributors of industrial products are playing a major role in marketing. Commercial firms should assist the marketing and distribution of domestic industrial products with adequate financial support of the public sector.

3. MASTER PLAN FOR MACHINERY INDUSTRY DEVELOPMENT

3.1 Framework and Strategy

1) Basic Policy and Strategy

As repeatedly discussed in the previous Section, development of the machinery industry should be recognized as a basic industry for Sri Lanka to attain overall industrial development. The machinery industry produces production machinery and equipment for every industry; therefore the machinery industry is a mother of other industries.

As a member of WTO, Sri Lanka should basically accept non-discrimination of foreign products. However, Sri Lanka should make a wise choice not to sacrifice its machinery industry for the sake of totally open trade. It is suggested that the public support be extended for development of the domestic machinery industry, at least for 5 years, in order to consolidate foundation for development. It will not be too late to create free competition and open domestic market of the machinery industry after consolidation of the foundation for development.

2) Development Target

Up to 2004:

Public and private efforts should concentrate on specialization and revitalization of the machinery industry. The government should take adequate measures to support the machinery industry and provisionally protect it from import at marginal prices and dumping.

(i) The machinery industry should first develop technologies, particularly in the agricultural area.

(ii) The machinery industry should introduce advanced design by licensing.

(iii) The machinery industry should organize a well-equipped subcontract system.

(iv) The machinery industry should invest in modernization of its facilities.

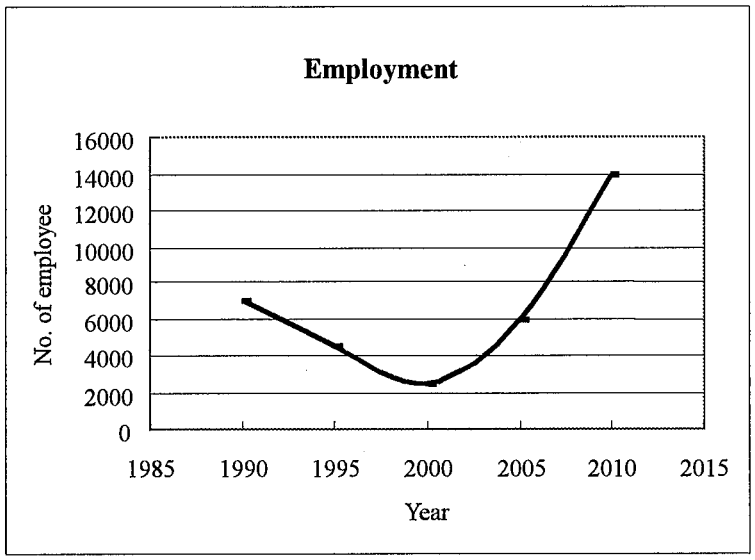
If appropriate measures are taken at this stage, productivity may increase by more than 4 times and value added will increase 10 times, with progress in the agricultural machinery industry combined with other development. The machinery industry should recover to the former status during this period.

Between 2005 and 2010:

The machinery industry may start export of machinery parts under subcontract to India and other countries by making use of a strong subcontract system in the country. Productivity may double and value added will increase 5 times between 2005 and 2010. Developments of the machinery industry would be consolidated and attain a substantial status by 2010.

Development Targets of Machinery Industry

	1999/2000	2004	2010
Productivity (US$1,000/Employee)	3.5	15	30
Value Added (Rs.Million)	600	6,000	30,000
Employment	2,500	5,700	14,000



3) Development Scenario and Strategy

(i) Development of Agricultural Machinery (up to 2004)

Sri Lanka does not have a large domestic market as India, China and ASEAN, and development of the machinery industry should start with a comparatively advantageous area and be expanded to other areas. In this connection, agricultural machinery and equipment should be the first product to be developed by the machinery industry in Sri Lanka.

To examine the scale of market in agriculture, fishing and forest industries, the Input-Output table in 1994 is referred to as follows:

	Agriculture, Fishery and Forestry	GVA (Rs. Million)
1	Tea Growing	12,170.5
2	Tea Processing	24,675.8
3	Rubber Growing	4,254.0
4	Rubber Processing	6,546.5
5	Coconut Growing	14,569.4
6	Paddy Growing	23,138.8
7	Livestock	15,552.6
8	Fishing	25,212.5
9	Logging & Firewood	10,327.0
10	Forestry	4,005.0
11	Other Agriculture	85,807.1
	Gross Total	226,259.2

It appears that agriculture, fishery and forestry industry has an adequate scale of markets for development of the machinery industry. An the example is the tea industry; an average tea growth in small-scale fields is reported to be 2,192kg/ha, while a cooperative field grows only 1,360kg/ha on an average. If a cooperative field is mechanized and land productivity is improved up to the small-scale field level by mechanization, production will increase by 1.6 times, and substantial investment will be made to the machinery industry. Input of the machinery industry to agriculture and forestry is calculated to be Rs. 256 million in the Input-Output table. This is only 0.11% of the output of agricultural and forest industry and only 10.3% of the total output of the machinery industry. Judging from these figures, the agricultural machine industry has a potential even more than 100 times expansion in domestic market.

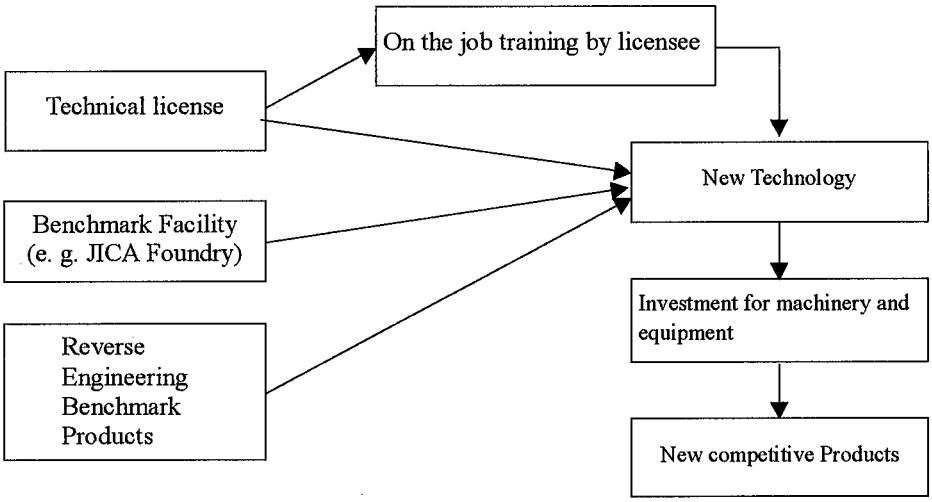
(ii) Concentration of Products (up to 2004)

In Sri Lanka, several machine makers manufacture the same type of products in a closed market. This situation makes the market vulnerable to attack by foreign competitors. It is desirable that each company concentrates on a small number of products in accordance with "Products Portfolio". It is not advantageous for a small company to make various machines. Production will certainly improve if each company is specialized in a few certain products and concentrates its work. In the event that the existing enterprise wishes to continue manufacturing of various products, it would be better to divide the company into plural independent enterprises specialized in each product or service. Jinasena Group is cited as an example; they divided their business to several independent enterprises according to products or service and they realized better productivity, or 1.5-2.0 times higher than other companies in Sri Lanka. Unprofitable business is to be discriminated against in accordance with "Product Portfolio" as proposed by the Boston consultant group.

(iii) Introduction of New Products and Technology (up to 2004)

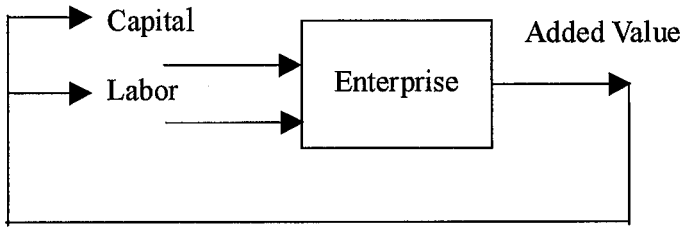
The machinery industry should introduce new products by means of licensing agreements with foreign machinery industry. The Input-Output table may hint areas of new products. However, it might not be wise to compete with foreign mass-production machine. Niche products for specific demands with relatively high value added should be looked for. A technical licenser will provide good production technology and know-how together with drawings. It will also provide on-the-job training to engineers and workers. Reverse engineering is also effective to accumulate technology. The Sri Lankan industry should study products of the advanced country by sketching and testing for benchmarking.

The public sector is requested to facilitate introduction of technology, through fiscal incentive to the enterprises that introduce and develop new technologies.



(iv) Productivity Improvement

To improve productivity of the machinery industry, improvement of production facility is indispensable. Without adequate investment in facilities, the industry is unable to improve its productivity. In general, productivity is expressed by value added per employee. Added value is distributed as labor wages and share to capital as expressed in the following figure:

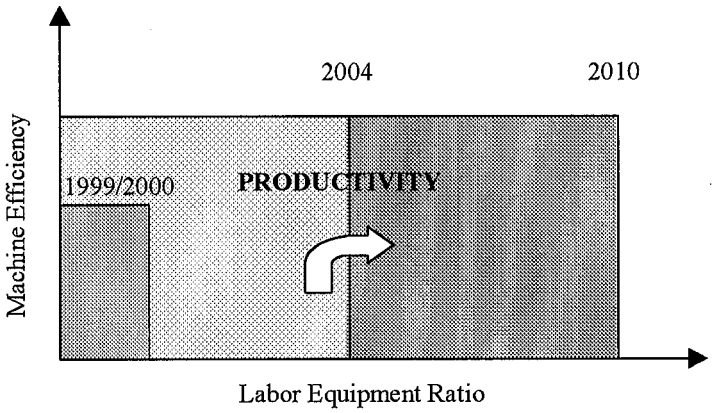


Productivity of an industry can be improved by two ways; one is to equip with good efficient machines in the factory, and the other is to enhance efficiency to operate the machine. Good combination of these two factors is vital for improvement of productivity. Those two factors can be evaluated by following formula:

$$\frac{\text{Value added}}{\text{Number of employee}} = \frac{\text{Value added}}{\text{Machines \& Equipment}} \times \frac{\text{Machines \& Equipment}}{\text{Number of employee}}$$

$$= \text{(Machinery Efficiency Ratio)} \times \text{(Labor Equipment Ratio)}$$

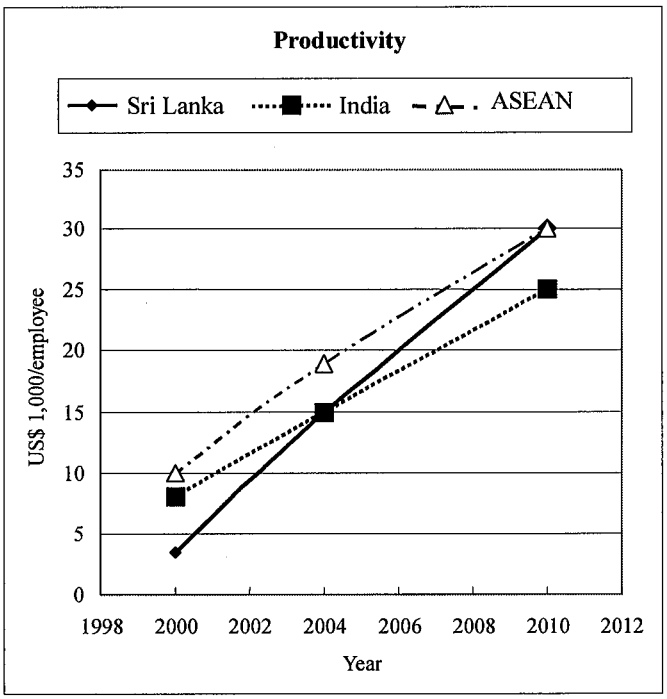
Judging from experience in other developing countries, machinery efficiency rate of 4 will be realistically achievable by Sri Lankan machinery industry. Likewise labor equipment ratio may increase up to Rs.267,000/employee in 2004, thus attaining productivity of Rs.1.08 million/employee (US$15,000/employee).



By the year 2010, labor equipment ratio of Rs.532,000/employee will be a target with productivity of Rs.2.16 million (US$30,000/employee). When Sri Lanka achieves these targets, Sri Lanka can join the common market with India as a competitive partner by 2010. Further investment and improvement in productivity makes Sri Lanka export some specified products to ASEAN countries by 2010.

Productivity and Investment in Machinery and Equipment

	1999/2000	2004	2010
Productivity(US$ thousands/employee)	3.5	15	30
Efficiency Ratio		4	4
Labor equipped ratio (Rs. 1,000/employee)		263	532
Total Amount of Investment for machinery and equipment (Rs. million)		1,500	7,500



3.2 Products and Market

1) Selection of Products for Agricultural Machinery Market

As noted above, agricultural machine is selected as products to be promoted first by the Sri Lankan machinery industry. There are many products used in the agricultural area. Among the agricultural industry, tea is the most important industry to revitalize the machinery industry. The next table shows some examples of products of the agricultural machinery industry.

	Agriculture, Fishery and Forestry	Machinery Products
1	Tea Growing	Leaf picking machine Tree planting machine Tree removing machine Spray Weed removing machine
2	Tea Processing	Tea roller Dryer Stalk extractor Dust remover Leaf sifter Breaker CTC
3	Rubber Growing	Latex collector Wood cutter Chain saw Tree planting machine
4	Rubber Processing	Rubber roller Tire manufacturing press Tire mould Boiler Latex grove machine Mixer
5	Coconut Growing	Coconuts collector Coconuts peeler Desiccated coconuts processor Coconuts oil plant Coconuts milk separator Boiler Coir press Coir dryer Coir fiber separator
6	Paddy Growing	Small tractor Rice transplanter Combine Cultivator

	Agriculture, Fishery and Forestry	Machinery Products
6	Paddy Growing	Weed remover Thresher Hull remover Separator Rice polisher Dust and stone remover Grain dryer Storage cooler
7	Livestock	Butchery plant Meat processing plant Refrigerating plant Can factory Milk processing plant Plate heat exchanger Filter Centrifugal clarifier
8	Fishing	Can making machine Canning plant Engine Fish net machine Rope making machine Hauler and winch Angling machine Refrigerator Freezer Ice maker
9	Logging & Firewood	Sawing machine Wood machine tools
10	Forestry	Chain saw
11	Other Agriculture	Can and bottle plant Juice extracting machine Juice condensing evaporator Boiler Essence extracting plant

Some items shown above have been once manufactured by the machinery industry in Sri Lanka. Accumulated experiences should be revitalized, and apparent improvement should be achieved in their design. Obsolete or non-competitive design should be improved.

2) Examples of Agricultural Machinery

When machinery enterprises and the government take necessary actions for recovery of the agricultural machinery industry, advanced technology should be applied and should never repeat old products. The following are possible areas to be developed, though further detailed marketing study should be made for realization:

(i) Mechanization and Automation in Tea Industry

Automation should be taken in account in elaborating new design. Mechanization and automation of tea processing should be studied in order to revitalize the tea industry in the international market. Energy saving is important for environmental protection and cost saving and it should be taken into account in the new design.

(ii) Leaf Picking Machine

Leaf picking is hard work in tea agriculture. Female workers are employed for picking. Mechanization of this work would attain higher productivity in the tea industry. Picking by mechanical sickle and collecting leaves by a vacuum suction to a cage may be an idea. It is suggested to study various examples of mechanical leave picking and design the best-suited machine for Sri Lanka.

(iii) Small Tractor

Small tractors had been manufactured in Sri Lanka, but their production was ceased due to import of tractor at lower prices. Since the small tractor is a popular machine among rice growing countries, it is desirable that production be restored in Sri Lanka, by means of knock down production under a certain custom protection during the period of consolidation. In view of the terraced paddy field in Sri Lanka, a powerful and lightweight compact tractor should be developed.

(iv) Can and Bottle Making Plant

The canning and bottling process preserves agricultural and fishing products. These are important processes for the agriculture and fishery industry. A canning and bottling machine requires comparatively a complicated mechanism; however it does not require high technology for production. Necessary design and know-how can be introduced through licensing from an advanced country.

(v) Press for Coir

Coir dust is compressed in the shape of a block and exported. Coir fiber is also pressed to form planters for export. A simple hydraulic press is used for this process. Further, a good hydraulic press has demand in the rubber tire industry. A hydraulic power unit may be imported, but other parts may be produced in Sri Lanka.

(vi) Agricultural Tools and Wood-Machine Tools

At present, Sri Lanka imports basic tools for agriculture; e. g. sickle, hoe, spade and shovel, which are manufacturing by forging and heat treatment. Recently two enterprises started this

process in Sri Lanka. Forging and heat treatment can also produce wood machine tools (e.g. wood machine saw and chain saw). These tools are technically primitive products but indispensable tools for agriculture and the wood processing industry. Import of high quality material is important for development.

(vii) Heat Treatment

Heat treatment is an indispensable process to develop tool industry. It is also important to produce hard steel machinery parts by subcontractors. Heat treatment industry should be developed as a part of subcontractors.

(viii) Welding Fabricated Products

Welding is a popular technology in Sri Lanka. This technology is widely used in construction and machine element building. Although CO^2 semi-automatic welding is widely prevailed in other countries, it is not popular yet in Sri Lanka. Introduction of CO^2 semi-automatic welding is suggested. Welding electric source is also advanced with adoption of an inverter, by which the flexibility of the welding condition is much improved. Improvement of welding technology will make plate fabricated products (e.g. centrifugal blower) competitive. Stainless steel welding is another area to be developed. It uses tungsten inert gas welding (TIG welding). Small stainless tanks and other apparatus for food processing equipment and medical equipment will be manufactured by this method. Invention of jigs and fixtures is also important for efficient welding, because fine and accurate positioning is essential for efficient welding.

(ix) Conveyer and Belt Drive Equipment

Sri Lanka has good rubber products. The machinery industry can utilize rubber for belt conveyers, and other belt drive equipment. The agricultural industry uses many conveyers and elevators, which utilize rubber belts. Likewise, timing belts are used for automation and sometimes for bicycle because it drives noiseless and smooth. Combined with step motors, various automatic equipment can be developed, including small semi-automatic welders and packing machines.

(x) Vacuum Evaporation Plating and Metal Plating on Plastic

Conventional electric plating prevails in Sri Lanka, so advanced plating technology should be newly introduced. Hard chromium plating is used to prevent wear down of the hydraulic power piston and shaft journal. Vacuum deposition plating is also common technology to plate ceramic material (e.g. NiTi), which has a golden color. Metal plating on engineering plastic is also a popular technology in other countries. These new technologies will make the

Sri Lankan product more attractive.

(xi) Consumer Packing Machine and Labeling Machine

Tea, cashew nuts and coconuts are retailed in consumer packing. A consumer packing machine makes small plastic film bags filled with products for retail. Bag manufacturing, measuring and sealing are made automatically by a machine. It has a wide demand in Sri Lanka and South India.

(xii) Labeling Machine

Canned and bottled food are labeled. An automatic labeling machine may have a good market in Sri Lanka in developing food processing industries. Likewise, a small semi-automatic labeling machine may have demand among small wholesalers and retailers.

2) Export Market

The Indian machinery industry is stronger and has more vigorous vitality than the Sri Lankan industry at this moment. However, when Sri Lanka recovers its vitality and restores the machinery industry as proposed in this development scenario, Sri Lanka might have chances to compete with the Indian machinery industry in domestic and Indian markets. A disadvantage of the Indian machinery industry is its infrastructure, especially road conditions and port facilities. Electric supply is worse than Sri Lanka. Consequently, if sea-transportation is improved, Southern India may be nearer to Sri Lanka than the northern industrial area of India where machinery industry is located. Machinery makers may have a possibility to export their products to Southern India, if their productivity is improved.

ASEAN will be the second target to export products and service by the machinery industry. ASEAN has many assemblers of automobiles. ASEAN contemplates to produce automobile parts jointly, and Sri Lanka may have chances to join the group of car parts manufacturers. The rubber processing machine and coconuts processing machine might be candidates products for export from Sri Lanka, because both rubber and coconuts are common products in the ASEAN countries.

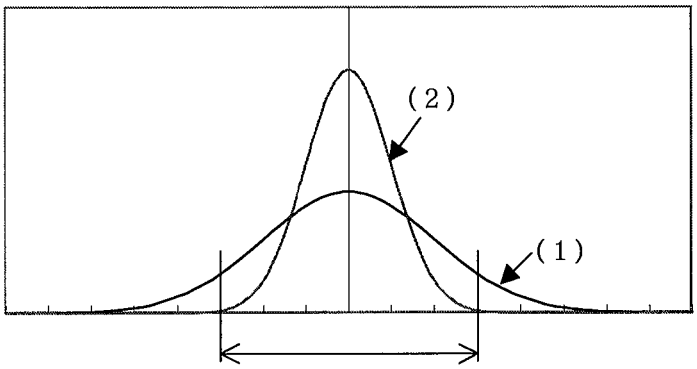
3.3 Production Control Technology Improvement

1) Quality Control

Regretfully, most Sri Lankan industries failed to control quality of their products, due mainly to inaccuracy of machines and lack of adequate facilities to produce high precision products.

Quality is the most important factor for productivity and value added, because market prices are dependent on quality. Sometimes, discrepancy is observed in viewpoints between manufacturers and customers, because customers evaluate quality differently from manufacturers' concept of quality. Marketing, therefore, plays important roles. "Customer's Satisfaction" is a key-ward to quality control. In this concept, competitiveness means that selling price is a value of quality evaluated by customers.

The figure below shows two examples of error distributions in the product. (1) has larger deviation than (2). When tolerance of the product is defined, (1) has more rejection than (2) by inspection. It should be observed that products passed through inspection have apparently different error distribution, which will be evaluated by customers. (2) has higher quality than (1). Product (2) has better controlled quality than (1). Controlled quality has a relation to rejection ratio. The machinery industry in Sri Lanka should study the control chart to attain controlled quality. CP (Capability of Process), an example of control charts, and other aspects related to quality control are presented for reference in ANNEX 4.



Controlled Quality

2) Daily Scheduling and Process Control

Poor production control causes two problems in the industry; one is a long delivery time and/or delay of delivery, and the other is a low operating rate of machine. These two factors spoiled the Sri Lankan industry.

Short and punctual delivery is one of the most important factors for customer's satisfaction, or for competitiveness. Although labor cost is cheaper in Sri Lanka, machining cost is expensive because of the low operating rate of the machinery. Management, in general, pays little attention to idling of machine. If a machine does not operate at a high operating rate, a charge for amortization becomes high and loan interest for the purchase of a machine increases; thus

profit is not attainable. As loan interest rate is high in Sri Lanka, the machinery expense might reach more than 25% of purchase price of machine per annum in many cases. For reference purposes, methods of production control are explained in ANNEX 5.

3.4 Manpower Development and R&D

1) Training System

Sri Lanka has an adequate educational and training system for the machinery industry. Unfortunately, however, lack of adequate manufacturing facilities causes a gap between education and practice. For modernized industrial development, the training facilities should also be equipped with advanced facilities. Computer and mechatronics knowledge should be advanced, in addition to quality control, statistics and probability theory.

2) Importance of On-the-Job Training

In general, the United States and Japanese enterprises attach more importance to on-the-job training than off-the-job training, while Chinese enterprises are more dependent on off-the-job training. Experience shows that on-the-job training is more effective because off-the-job training and education does not meet actual practice in the factory. It is encouraging that the questionnaire survey indicates that more emphasis is put on on-the-job training in the Sri Lankan machinery industry.

3) R&D

Research and Development (R&D) in the machinery industry in Sri Lanka is limited to cottage industry development. Private enterprises have no capacity for R&D. Consequently, no new product has been developed by the industry, other than cottage industrial equipment.

Foreign direct investment brought new technology to Sri Lanka; however technical transfer is limited, because all production machines and equipment are imported. The public sector R&D institutes should focus on development of advanced technology and facilities for the machinery industry, while the private sector should enhance designing capacity and create new products in the machinery industry.

4) Reverse Engineering

In order to acquire advanced technology, a developing country should learn from the advanced country's products. A study on the advanced product is called "reverse engineering".

For new development, a benchmark product should be selected and studied. Then, the design target should be equal or superior to the benchmark products.

3.5 Restructuring and Enterprise Development

1) Subcontract System

In Sri Lanka, every enterprise has a full range of machine tools and equipment to produce every kind of machinery and equipment. Consequently, each machine has insufficient jobs for continuous operation, and the operating rate of machine tools is quite low. Adoption of the advanced efficient machine could not be appreciated under the current production system. Therefore, introduction of a subcontract system is indispensable. A subcontract system realizes a better operating rate of machine tools, and higher learning effect in the production, by collective orders from a greater number of customers. At an early stage of development, specialized subcontractor may be difficult to start, and each enterprise should collaborate as a subcontractor to the other. Even a large enterprise should be a subcontractor to a small company. It is noted that forging and heat treatment are indispensable processes for the machinery industry, and subcontractors of forging and heat treatment should be developed as early as possible. A reduction gear manufacturer should also start timely.

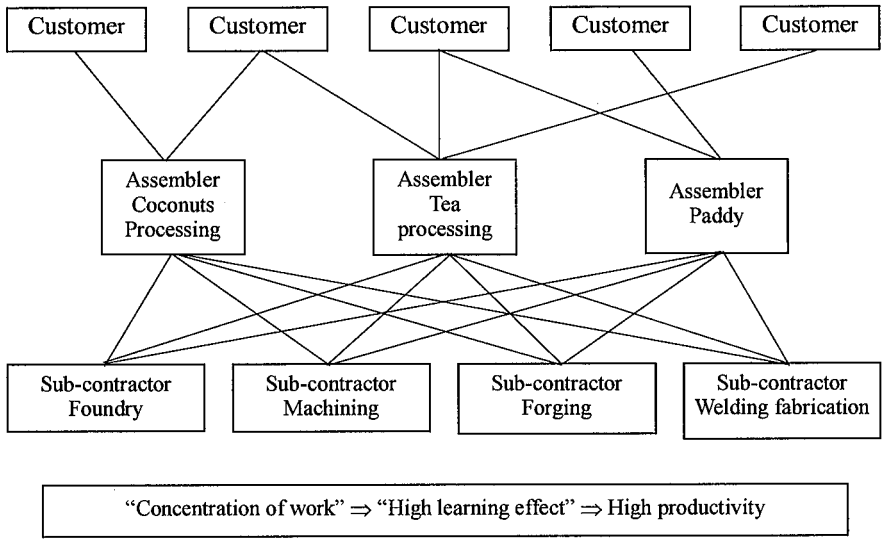


Image of Subcontract System for Machinery Industry

Sri Lanka had previously adopted a turnover tax, but realized that this system had encouraged inefficient vertical business integration and prevented growth of subcontract system. Since April 1998, the turnover tax has been changed to GST (Goods and Service Tax) that is

charged on the value added of intermediate products. GST is not levied on small business of less than Rs.1.8 million. Subcontractors in the machinery industry should appreciate this tax reformation and utilize the benefit.

2) Financial Support to SMI

Small subcontractors have difficulties in obtaining loans from commercial banks, due to lack of collateral. For development of SMI and for promotion of the subcontract system, it is desired to introduce a credit guarantee system. Further detail on this issue is discussed in Financial Sector and Fiscal Policy Study.

3) Assistance in Export Promotion

When quality and price of the Sri Lankan products are proved, the machinery industry's market will expand from domestic market to export. Subcontractors may have earlier chance for export. When their work and/or products are proved to be competitive, foreign assemblers would purchase such products. Likewise, foreign subcontractors will directly invest in Sri Lanka to export machinery parts to the SAARC countries. Even Indian subcontractors would come to invest if Sri Lankan work force and systems are better than those of India. It is noted, however, that most of the general-purpose machinery are consumer goods and small in production scale, and their export will be difficult. Therefore, niche products of high value added should be developed to ensure competitiveness in international markets.

3.6 Clustering Program

1) Advantage of Cluster

In the case of agricultural machine production, the industry should cluster in view of its small manufacturer's scale and necessity for collaboration among assemblers and subcontractors. Further, active competition among manufacturers will make the industry strong, and the concentration attracts more customers. It is suggested that an Internet home page be jointly opened to show the manufacturing ability anywhere in the world.

2) Coordinator System

Small and medium scale machinery industries are suggested to study on possible introduction of a coordinator system. In this system, a leader of the group of industries or association should coordinate or organize production of new machinery and equipment.

3) Cooperative

Small enterprise has insufficient individual resource to develop new machinery, and they are suggested to organize cooperatives. Several enterprises in the same business form a cooperative and distribute jobs among the members. The cooperative can obtain better evaluation than individual enterprise, because other cooperative members will cover if any trouble occurred in an enterprise. Likewise, several enterprises in different technologies can form a cooperative, which is more effective in developing new products by combining each company's specialty.

4) Commercial firms

The Sri Lankan machinery industry has a tendency to object marketing through commercial firms, but this attitude should be altered because it will not allow expansion of the market. Commercial firms should collaborate with the machinery industry for marketing and distribution of the products in both domestic and export markets. Commercial firms should also collaborate for imports of materials and parts, because small and medium enterprises have lack of credit to foreign exporters. Commercial firms will provide necessary credit for import, particularly for import of advanced machine tools for the machinery industry.

4. ACTION PROGRAM (2000-2004)

1) Private Sector Program

(1) Concentration on profitable products:

The private sector should start with restructuring of the industry, by terminating unprofitable production and concentrating on production profitable products. Surplus of manpower and capital should be used for development of advanced products.

(2) Investment in production facility:

Investment should be made effectively for enforcement of the production facility. A labor equipment ratio of more than Rs. 263,000/employee should be attained by 2004.

(3) New design for advanced agricultural machine and equipment:

New advanced machines should be designed to improve agricultural productivity in the fields of tea, rubber, coconuts and paddy, as well as in fishery and forestry. Automation and energy saving should be combined in the new design.

(4) Production of high value added products:

Return to import substitution should be carefully avoided by effort of the private sector. New products should be selected in the specialized area of high value added products.

(5) Licensing of foreign advanced technology:

In parallel with new design development, foreign advanced technology should be actively introduced by licensing, in order to supplement new design development. Engineers and workers should be trained through on-the-job training.

(6) More on-the-job training:

On-the-job training should be effectively enforced to increase skilled labor. A work rotation system should be established in the factory for training of skilled labor. A foreman's performance in on-the-job training should be fairly evaluated.

(7) Marketing of products:

Marketing of the products should be enforced with collaboration of the commercial firms.

(8) Import of material and parts:

An adequate route for import of materials necessary for advanced machines should be found in collaboration with trading firms.

2) Public Sector Program

(1) Adoption of policy to develop agricultural machinery industry:

The government should decisively adopt a policy to develop the agricultural machinery industry and support the industry technically and financially. Particularly, it is advised that an expert team be organized for survey of the current facility of the tea industry for revitalization.

(2) Diplomatic negotiation on export at marginal prices:

The government should take appropriate measures to prevent import at marginal prices or dumping through diplomatic negotiations. However, the government should avoid an import substitute policy, clearly declaring the limited period of protection and strictly keep the discipline of the fair trade.

(3) Revision of custom tariff:

In the event that diplomatic negotiations are unsuccessful, a necessary measure should be taken on custom tariffs.

(4) Public sector R&D:

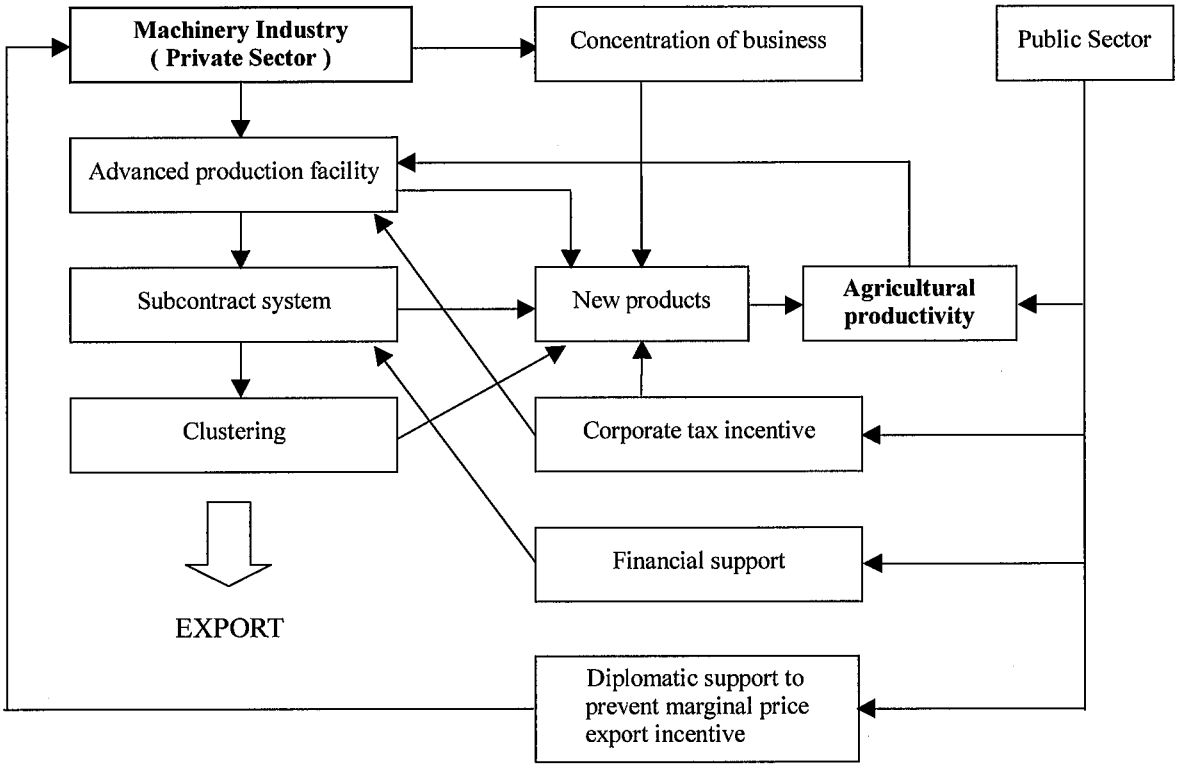
The public sector R&D institutes should be strengthened by the advanced machine tools to pioneer new industrial development in the agricultural industrial area. Effective technical transfer from the public sector to the private sector should be followed.

(5) Corporate tax incentives:

Desirably, R&D and licensing costs for new product development of agricultural machines are subject to a corporate tax incentive for the limited period. In order to avoid a moral hazard, the incentive should be given to innovative R&D and licensing that contributes to productivity enhancement of the agricultural industry. Likewise, investment in advanced machinery and equipment by the machinery industry should also be subject to a corporate tax incentive for the limited period.

(6) Concessional loans to subcontractors:

Subcontractors are not developed yet in Sri Lanka. In order to promote foundation of the subcontract sector in the machinery industry, financial support to the investors are required. In the initial stage, both long-term finance for fixed asset and short-term finance for working capital should be provided at a low interest rate.



Development Action Program 2000-2004

Case Study on Machinery Enterprise ("C" Company)

As a process of pinpointing constraints of the machinery industry in Sri Lanka, a case study has been made on a company which succeeded in traditional tea machine production since its foundation by a British firm. Observation and suggestions presented in this paper would be useful to other enterprises in Sri Lanka. For the convenience of explanation, the company is called "C" Company.

1) Historical Background

"C" Company is a machinery manufacturer, established under the British controlled era and passed through nationalization under the socialist regime, and finally privatized. British industrial policy at that time was to construct infrastructure for transport of colonial products. As tea leaves were not transportable, tea processing factories were built in the colony.

"C" Company was founded as a part of British owned tea plantation in 1870s for repair of machines. The company developed machines and equipment necessary for tea processing and its operation became profitable. There were three tea processing machine manufacturers at that time (i.e., CCC, Walker's and Brown). Each manufacturer had a group of fixed customers, with no competition among them.

Products manufactured by the company were exported to Ethiopia and other African countries at that time. In 1976, the company was nationalized, and the British capital was withdrawn. Nationalization had deteriorated the industrial structure, as no new investment was allowed from the return of profit. The company accumulated loss of Rs. 337 million by January 1998 when it was bankrupted. The company was taken over by a private group in February 1998. The privatized company has diversified its products to other areas than tea processing machine, such as construction and air conditioning. However, the diversification has not been successful to date.

2) Foundry

The factory has one large foundry. At the tender for brake blocks to the National Railway, "C" Company's price of cast iron product proved to be more than double the price of the tender winner's. The reason is more man-hours charged to the products.

At the foundary, melts are made totally by experience of foremen. Though casting is not so bad, no new technology nor improvement has been expected. Oil sand is used for core making without an oil sand miller. No frame is used for sand mold, with mold directly on the factory floor. It makes moisture control difficult. The factory's compressed air line is in failure. Therefore, no pneumatic tool can be used. No sand rammer is used, and the mold sand is rammed manually. It results in low compactness of mold sands and deform after casting. Neither air hammer nor vibrator is used for fettling, consuming too many man-hours.

The cupola has a capacity of 3-tons/hour; however, cast iron production is 15-33t/month and melting of 3-5 times per month. In the foundry, direct workers are 26, and indirect workers are 31 (too much indirect labor). Dimension of the cast iron is inaccurate, and a large machining allowance is provided, making machining hours considerably larger. Sandblast is broken, and a hand grinder is used to clean the surface of casting, consuming large man-hours.

Action Required:

(1) Repair compressed air pipe line and air compressor.
(2) Repair sandblast as soon as possible.
(3) Purchase air-drive tools for mold making and fettling.
(4) Make frame for mold, and dry up mold.
(5) Purchase oil sand mixer.

3) Machining and Assembling Workshop

The company has a machining and assembling workshop mainly for tea roller production. The workshop has 40 machines and 113 workers (skilled and semi-skilled workers totalling 53). It is reported also that 7 out of 40 machines are not operating due to failure. Indirect labor is too many. Tea roller production takes 53% of man-hour.

Records of man-hour consumed for each product is as follows:

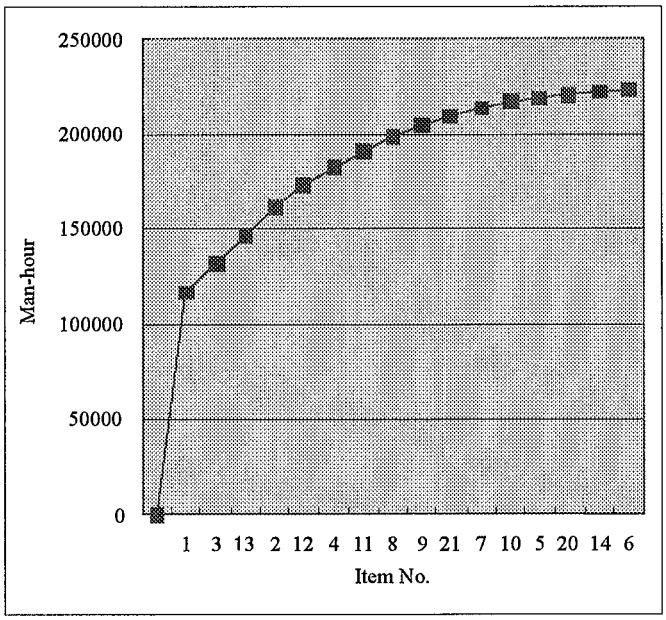
No.	Description	Qty.	Standard man-hour		Total	Annual total
			Machining	Assembly		
1	Tea roller	56	1,600	475	2,075	116,200
2	Through fans	56	52	206	258	14,448
3	Winnowers	34			450	15,300
4	Made Tea	10	140	784	924	9,240
5	Withered	10			200	2,000
6	Double	6			200	1,200
7	15"Rotor	3			1,500	4,500
8	8"Roller	6			1,250	7,500
9	3A Roll	12	170	288	458	5,496
10	Tarry	6			500	3,000

11	Myddletor	6			1,500	9,000
12	Myddleton	6			2,000	12,000
13	Middletion	6			2,500	15,000
14	H.R. Roll	3	170	288	458	1,374
15	Rubber mill	6				0
16	Mill rolls	15				0
17	Branch orders					0
18	Orthodox					0
19	FBD	18				0
20	3A Heaters	12	154	2	156	1,872
21	Heat exchanger	18	278		278	5,004
	Total					223,134

Action Required:

(1) Remove unused machine from the factory.
(2) Stop production of unprofitable products.
(3) Separate the assemble shop from the machining shop
(4) Improve operating rate of the machinery by daily scheduling
(5) Introduce modern technology and equipment
(6) Develop jig and fixture

The chart below shows accumulated man-hours from large to smaller volume work. The chart indicates too much small works in the factory which should be decreased and concentrated to main work for better efficiency.



Man-hour saving should be intensively studied in the main work. Main work and small work should be separated, and small work should be subcontracted in principle. Further, it is advised to carry out a production process study on tea roller and prepare process chart. Then, operating time should be measured by a stopwatch. Based on these data, standard time should be revised. Likewise, improvement of the manufacturing process and machinery arrangement should be studied. A Gantt chart should be prepared for each project.

A production technology section with a few engineers should be organized for designing jig and fixture to the factory. It is better to divide assembly shop from the machining shop. Parts should be strictly inspected between two shops. Manual adjustment of parts dimension should be avoided. Rejection of the parts should be recorded and studied before the remedy. A load distribution plan should be prepared and delivered to the sales department for adjustment to make equal distribution of work. The production technology section should study introduction of new machinery and new tools.

4) Dryer and Structural Shop

The company has another factory which produces dryers in the same area. The dryer and structural shop has 58 machines, with 83 workers. Five teams of workers operate the shop; each team undertaking one project throughout the whole production. However, this system deformed load distribution among the teams and caused much loss time for waiting arrival of material and parts. Each team has a large fluctuation of workload. A more flexible system should be organized. Movement of workers from one team to another should be controlled. Likewise, jobs should be divided into: (i) Component manufacture, and (ii) Final assembly and test. Job card, material requisitions, product attach card should be prepared by computer. Cost calculation should be done in connection with production control.

Action Required:

(1) Establish exact standard man-hour for each process
(2) Establish exact cost calculation
(3) Carry out dispatching by computer based on Gantt chart
(4) Study production process and make production process chart
(5) Make standard Gantt chart for each product

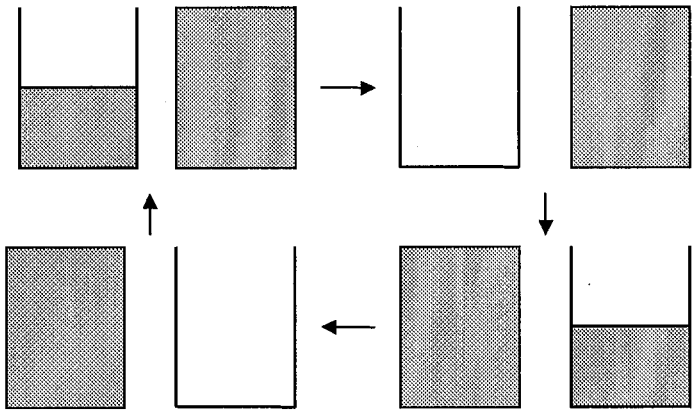
5) Branch Operation

The company has local branches to do repair works for customers. Branch operation of "C" Company has a turnover of about 70% of the company's total turnover. Six branches are

operated with 227 members. Among them 42 are indirect labors. Compared with the main factory, productivity is more than 4 times higher.

	Factory	Branches	Total
Employee	400	227	627
Turnover Rs millions	74	186	260
Turnover/Employee	0.185	0.81938	0.41467
Productivity US$ thousands/Employee	1.3	6	3

Productivity of the main factory is extremely low, or US$3,300/worker, even compared with other Sri Lanka's industry. The branch clerk purchases repair parts, ordering at each occasion, This makes delay in work and place a burden on clerk's job. Small deposits should be stored by the two-bin method.



Two bin method

Action Required:

(1) Introduce adequate inventory control of repair parts

(2) Prepare adequate manual for repair service

6) Organization

The company has a complicated organization, succeeding from the British management and deformation under nationalization. As a company of about 600 employees, "C" Company has too many managers, but nobody is responsible for design development, production, sales and finance. Responsibility of these 4 functions should be clearly divided among each manager, and each manager should inspect the function of other managers. The production manager should be responsible for production cost and delivery of the products and service. The finance manager should be responsible for finance and inspect production cost. The sales manager should be responsible for sales and supply of enough market information to

designing section. The sales manager should also collaborate for normalization of workload for high productivity and punctual delivery, and inspect production cost based on market price. Meanwhile the design manager should be responsible for research and development. He is also responsible for product cost. Cost reduction should be studied under his initiative. New products should be designed on the basis of marketing price. Strict budget control should be carried out by each section. A profit target should be placed at each section.

Action Required:

(1) Simplify the company organization
(2) Reduce the number of managers, duplicate management should be avoided
(3) Right and responsibility of the manager should define clearly
(4) Unable managers and unnecessary managers should be removed from the position

Explanation on Marginal Price:

[How Chinese can export to Sri Lanka at the price less than material cost.]

1) A Dangerous Attack

The Sri Lankan machinery industry faces attack from foreign machinery industry by export at marginal prices. It might not be true that foreign industry is making a loss by low price export, even if it is exporting without any subsidy from its government as insisted by Sri Lankan competitors. Foreign industry can get even profit by marginal price export without any subsidy or assistance of the government. Therefore, such attack may not cease soon. This is not the matter to be solved by improvement of productivity, but seriously related to diplomatic matters to be solved, in order to save Sri Lankan machinery industry from extinction.

In order to understand how the export price is calculated, a direct cost calculation method should be understood. This direct cost calculation method is explained in comparison with the conventional method of cost calculation.

2) Conventional Costing

Cost is calculated as summation of material cost, manufacturing cost and overhead in a usual way. The following example will explain the conventional cost calculation:

Assume a factory of:
Direct workers: 300
Annual working hours: 2000 hours
Factory general expense (fixed cost) incl. labor cost and overhead: Rs. 500, 000,000

In order to make discussion simple, it is assumed that production cost is calculated on the basis of the above factors plus material cost. Likewise, it is assumed that all cost other than material cost is fixed cost. In old days, wage to workers was a variable cost, but nowadays labor cost is calculation as a fixed cost.

Assuming that the products are two (A and B), and each product is produced by working man-hours as follows:

Product	Sales Price per unit (Rs.)	Man-hours per unit	Material cost per unit (Rs.)
A	1,000,000	240	500,000
B	910,000	272	350,000

Annual production and sales are assumed as follows:

Product	No. of units
A	840
B	700

Then, the annual working man-hours is calculated to be:

$840 \times 240 + 700 \times 272 = 392,000$ (Man-hours)

The unit cost of a man-hour is:

500,000,000 / 392,000 = 1275.5 (Rs/man-hour)

Then, the unit cost of products is calculated by conventional cost calculation:

Product	Unit material cost	Unit manufacturing cost	Unit cost
A	500,000	240 × 1275.5	806,120
B	350,000	272 × 1275.5	696,936

Annual sales amount, cost, and profit are calculated as shown below:

Product	Sales Amoun (Rs.)	Cost (Rs.)	Profit (Rs.)
A	840,000,000	677,140,000	162,860,000
B	637,000,000	487,860,000	149,140,000
Total	1,477,000,000	1,164,997,600	312,002,400

3). Direct Costing for Export

If the factory is asked to export to another country by a price as follows:

Product	Unit Price (Rs.)	No. of units	Sales amount (Rs.)
A	600,000	500	300,000,000
B	400,000	300	120,000,000

From the conventional calculations this proposal should be rejected; however it is not right. When the factory accepts the proposal, it can increase profit. If machinery and equipment are not changed, and labor is not increased, general expense would not change. Material cost will be changed proportional to increase in production.

Total man-hours required for the job is:

Product	Man-hour/unit	No. of production	Sub-total man-hours
A	240	840+500=1340	1340×240=321,600
B	272	700+300=1000	272×1000=272,000
Total			593,600

Then, total man-hours are less than 300×2000=600,000 (man-hours), which means the factory does not need any expansion of labor and facility. Consequently, cost and profit are calculated as follows:

Product	General expense	Material cost	Total cost	Sales amount
A		500,000×1340 =670,000,000		1,140,000,000
B		350,000×1000 =350,000,000		757,000,000
Total	500,000,000	1,020,000,000	1,520,000,000	1,897,000,000
			Profit	377,000,000

This profit is about 20% higher it compared with previous calculation of profit without export: Rs. 31,202,400. In this way, this enterprise can easily export to Sri Lanka. In a certain country, most materials are domestically produced and materials are over production, then the maker can obtain materials far less than its competitor in Sri Lanka. In case of direct costing, price can be low, when material cost is low. Thus, Sri Lankan industry faces difficult competition by the product that is produced in the country where material is less expensive than Sri Lankan materiel cost. In this method, material cost is the marginal cost. When one additional unit of product is increased in production, actual cost is increased by marginal cost. The price based on marginal cost is called marginal price.

4) Counter Measure to Marginal Price Export

It is rather common for a developing country to export products at marginal price, because they have no comparative advantage other than low price to enter the market. If a company exports in a price less than its production cost, it is dumping. Pure dumping may be in case of sales after a fire or bankrupt of outerprise, and this sort of dumping cannot continue for a long time.

In case of marginal price export, it may continue up to destroy all competitors in the country importing the product. It is an actual danger that Sri Lanka is faced with. Marginal price exporter does not receive any subsidy nor assistance from the government, and it is difficult to say simply as unfair.

An effective way to stop marginal price export is to attack the exporter's domestic market at marginal export price. Then, the exporter will lose its domestic market where it sells its product in ordinary price and cannot continue marginal price exportation. However it might be difficult for the Sri Lankan industry. The Sri Lankan government should make intensive research on the matter together with association of the industry, and discuss the matter with the government and manufacturer's association of the exporting country through diplomatic channel. If they do not agree to stop the marginal price export, Sri Lanka might have to apply a high custom tariff on such export for protection of the domestic machinery industry.

Comparison of Management

In order to study the management issue to be addressed for development of the Sri Lankan industry, two manufacturers in the "Handbook of Listed Companies 1977" are taken for reference. One; indicated as "S", is a foreign capital company and another indicated as "M" is a domestic capital company. The former made profit, and the latter made deficit. Difference is analyzed on the basis of data listed in the book. As available data are insufficient, comparison of productivity is impossible but analysis can clearly explain the difference.

Balance sheets of both companies are shown on the following page. It is rearranged to meet the Japanese balance sheet form in order to make an easy comparison. It is apparent that "S" Company has no long-term loan, which contributed to profit. On the other hand, as shown in the profit/loss statement, "M" company made loss, and about Rs. 3,830,000 in interest was paid to Bank.

However, a major reason of loss is found in the difference in capital rotation, which is calculated by dividing the turnover by total capital. Low capital rotation means investment is not efficiently used in the factory, under poor production control. Capital rotation should be more than 1.0 in normal case. "S" company, on the other hand, operates admirably in this respect.

This situation apparently affected the profit/turnover ratio. "M" company makes deficit, because production cost is excessively higher than the competitor. If production is adequately controlled, the profit/turnover ratio will be around 3%.

PROFIT & LOSS 1996

Company	S	M
Turnover	719,892	137,277
Profit/Loss before tax	40,157	-9,522
Interest (assumed as 17%)	0	3,810

Balance Sheet Unit: Rs1000

	Company	S Foreign		M Domestic	
		1995	1996	1995	1996
	ASSET				
	Current asset				
1	Cash	1,040	305	1,381	378
2	Other	153,347	211,142	101,141	115,508
3	Total	154,387	211,447	102,522	115,886
4	Fixed asset				
5	Fixed asset	56,295	62,614	133,247	132,415
6	Investment	16,500	16,500	3,621	3,621
7	Total	72,795	79,114	136,868	136,036
8	Total Asset	227,182	290,561	239,390	251,922
	CAPITAL				
9	Current debt				
10	Overdraft	117,260	150,717	21,946	34,777
11	Other liability	20,424	38,324	6,000	
12	Deferred liability	12,400	14,858	64,959	72,338
13	Total	150,084	203,899	92,905	107,115
14	Fixed debt				
15	Long term loan			22,366	22,413
16	P&L Account	14,151	13,715	443	573
17	Shared capital	38,463	38,463	31,000	31,000
18	Reserves	24,484	34,484	92,677	90,822
19	Total Own capital	77,098	86,662	124,120	122,395
20	Total Capital	227,182	290,561	239,391	251,923

Analysis 1996

Company	S	M
General		
Profit/Total Capital %	15.05	-3.28
Capital Rotation	3.17	0.47
Profit/Turn over %	4.75	-6.94
Profit/Own capital %	44.37	-10.99
Finance		
Fixed Asset/Own Capital %	94.42	91.29
Current asset/Current debt %	102.9	103.7
Own capital/Total capital %	33.94	29.83
Turn over/Fixed asset	9.89	1.74

Quality Control

Normally, the Capability of Process (CP) is used as an indication of quality control level, which is shown by following equations:

In case of two side allowance:

$$CP = \frac{(\text{Upper limit}) - (\text{Lower limit})}{6 \times (\text{Sigma})}$$

In case of one side allowance:

$$CP = \frac{(\text{Average}) - (\text{Lower limit})}{3 \times (\text{Sigma})}$$

or

$$CP = \frac{(\text{Upper limit}) - (\text{Lower limit})}{3 \times (\text{Sigma})}$$

Controlled quality is shown by standard deviation: sigma. Relations between Sigma, CP and failure rate PPM are as follows:

SIGMA	CP	PPM (Two side)
1	0.33	317310.5195
2	0.67	45500.1241
3	1.00	2699.9344
4	1.33	63.3721
5	1.67	0.5742
6	2.00	0.0020

It has not been exactly measured, but quality of the Sri Lankan machinery products may be in the range between 2 sigma and 3 sigma. Sri Lanka should achieve better than 3 sigma level by 2004, and 4 sigma level in 2010. In case of 5 sigma or 6 sigma, failure rate is extremely small, so that only statistical figure such as standard deviation: sigma can prove it.

TQC (Total Quality Control) and/or TQM (Total Quality Management) have significance because management should organize and assist adequate statistical quality control.

The customers always appreciate durable and stable performance of products, which can be assured by precise and stable quality. Consequently, the machinery industry should always

follow this direction. Inspection in accordance with a certain standard is one way to assure the quality of products. However, it is not sufficient for competition in the free trade international market. Stability of the precision is more important, which is evaluated by standard deviation of the product's precision.

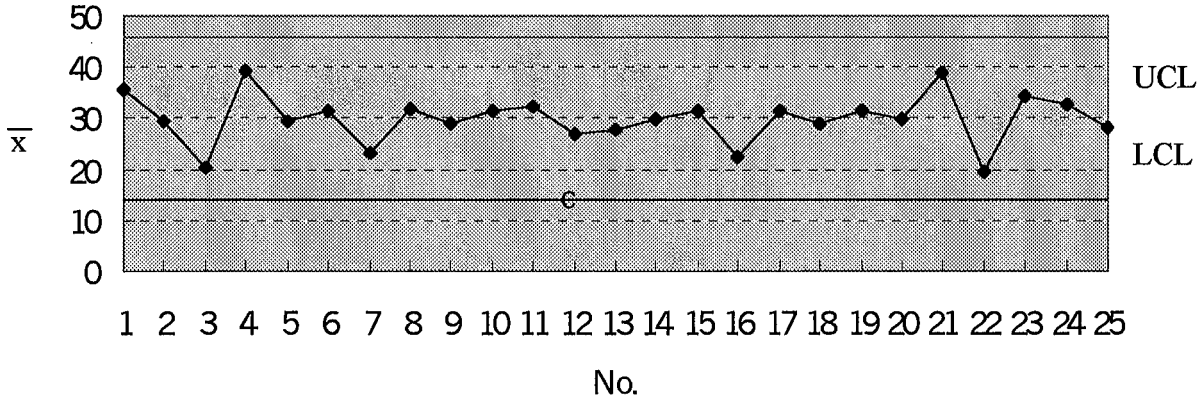
6 sigma movements in US industries are fight back in this respect. 6 sigma means standard deviation of products is 1/6 of allowance and failure rate of 2/100,000,000 that is normally considered as zero-defect.

TQC may improve product quality to some extent; however it is indispensable to adopt Statistical Quality Control (SQC) such as control chart in the industry. A control chart is a popular way of statistical control and "Quality Control by Dr. Ishikawa" should be referred to for further study. An example of x-bar R control chart is shown in the following page.

To spread adequate statistical quality control in Sri Lanka, provability, normal distribution, standard deviation and other related mathematics for statistics should be taught at the higher education.

An example of x-bar R control chart

Name		Standard			Work No.			
Character		Limit	Max. Min.		Job unit		Inspector	
Unit		No. of sample Interval			Production		Factory	
Method					Machine			
Instrument					Operator			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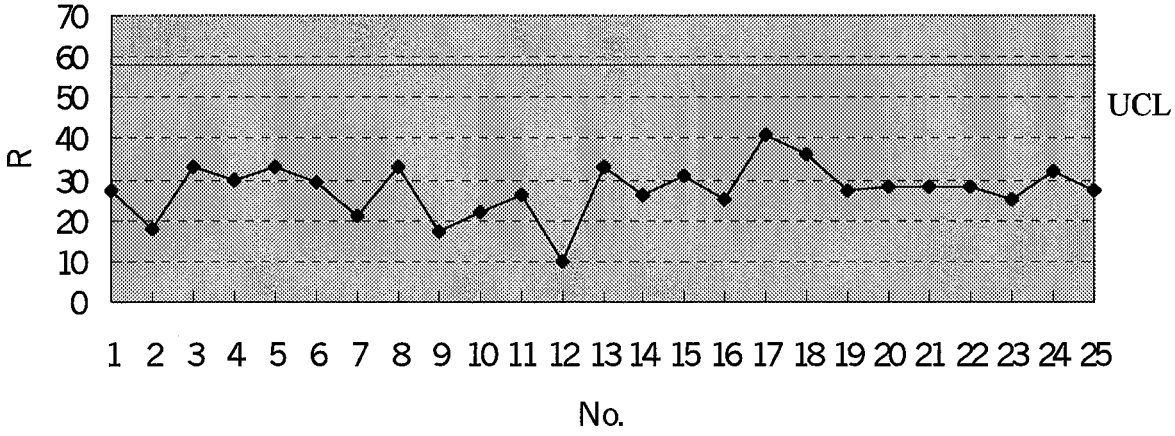
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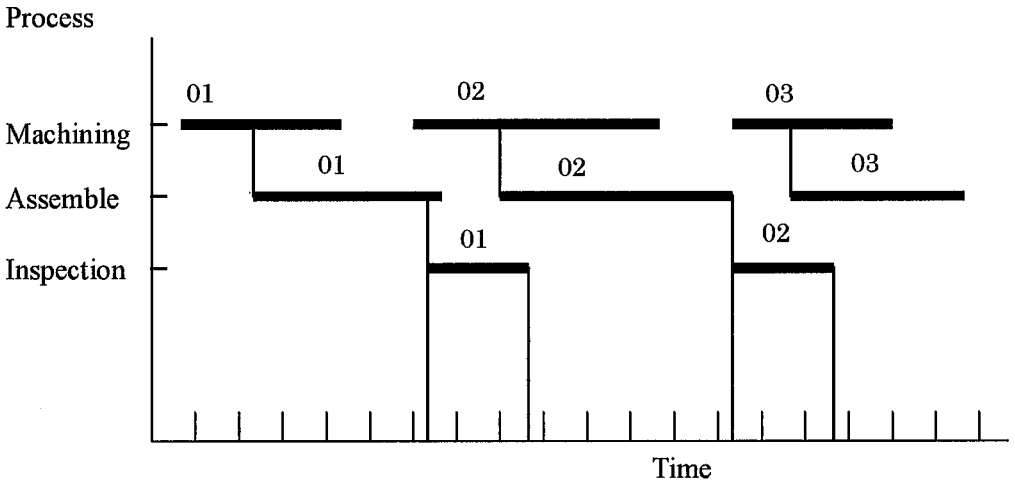
Production Control

1) Gantt Chart

Adoption of the Gantt chart for scheduling and adequate dispatching in recommended for factory management. Standardized and accurate man-hour or machine-hour for each process can be established for production control, as well as for cost calculation.



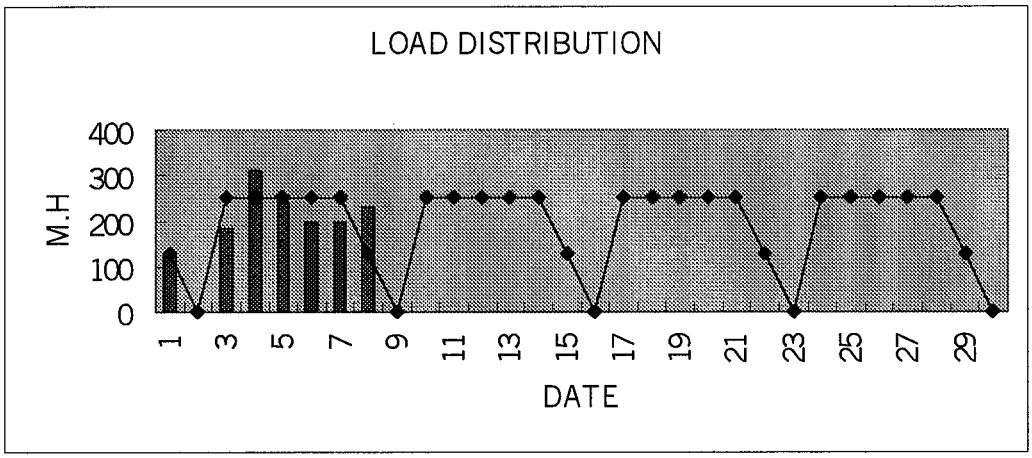
Daily Schedule (Grant Chart)

A daily schedule should be provided for each major machine by means of the Gantt chart. Subsequently, an operating rate of the machine will be maximized on the chart.

2) Load Distribution Chart

A load distribution chart is to be provided to improve factory operation. Sales and production should collaborate in high factory operation by using a load distribution chart (refer to the figure on the following page). The load distribution chart can easily be maintained by a personal computer.

In highly automated or mechanized production, financial cost for equipment becomes high, and increase in the operation rate is the most important factor for the factory management, as the expensive machines are operated day and night, by 2 shifts or 3 shifts. However, such operation may not be enough to amortize expensive machines, because these machines require complicated preparation work for operation, causing comparatively large duration of stoppage. Consequently, the next issue: DANDORI should be studied.



Load distribution chart made by EXCEL

3) DANDORI: Preparation

Large efforts should be made for preparatory work to prevent stopping of the machine, which is called SOTO-DANDORI; machine preparation without stoppage. A fully automated production line is operated 24 hours without stop in the advanced factory. In a certain case, preparation works are carried out in the daytime without any stoppage of machine and the factory is operated without an operator at night.

In order to improve DANDORI, adequate research study is necessary on the production line. Based on this study, jobs are to be rationalized and work for SOTO-DANDORI is prepared as far as possible. Simple methods to fix jig, fixture, and/or die are also effective to reduce stoppage for preparation. Several sorts of one touch fixing and losing mechanism are also available for the purpose.

It is recommended that DANDORI be introduced to production control of the factory operation, in addition to the 5S movement which has become popular in Sri Lanka.