

CLUSTER DIAGNOSTIC STUDY

PVC Pipes Cluster

Lahore



Turn Potential into Profit

Small & Medium Enterprise Development Authority

Government of Pakistan

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1. WHAT IS PVC

Polyvinyl chloride, PVC – commonly known as vinyl – is 2nd most sought after thermoplastic with a global consumption of approximately 22 tons per annum, with annual growth of 6%. It is a chlorinated hydrocarbon polymer - its basic building blocks are chlorine, carbon and hydrogen. While most plastics are made mostly of petroleum, only 40 percent of the PVC molecule comes from petroleum; 60 percent of it is chlorine, from salt, NaCl.

PVC is used for producing high quality leakage free pipelines for conveying water, sewerage or effluent, insulating material for electric cables in construction industry, covering for floors, Door & Window Profiles, Toys, Food packaging, Furniture, Automobile industry, Electronics, Medical usage and shoe manufacturing industry.

Different Properties of PVC

- *Thermoplastic*
- *Lightweight, toughness and durability*
- *Low thermal conductivity*
- *Good insulation properties*
- *Variety of Colors*
- *Corrosion and abrasion resistance*
- *Weatherability*
- *Fire retardant properties*

1.1 Poly Vinyl Chloride Pipes

PVC is a versatile material for piping and has replaced conventional pipes made from conventional materials such as Galvanized Iron (GI), Cast Iron, Asbestos Cement and Concrete Cement. Its compatibility with most fluids, lower cost of material handling and installation, unique combination of properties and availability of highly reliable jointing system makes it an excellent competitor in the piping world, resulting in a product that is a viable competitor to pipes made from other materials in dimensions up to 20 inches.

2. GLOBAL MARKET OF PVC

Vinyl's low cost, versatility, unique set of properties and performance makes it the material of choice for dozens of industries such as health care, communications, aerospace, automotive, retailing, textiles and construction. In the product form it can be as rigid as a pipe or as pliable as a plastic wrap. Over the past few years the market for PVC is on a steady rise. The major driver for the growth is the increased penetration of PVC in insulation cables and pipes. However, the building and construction industries are the basic marketplaces for pipe and the pipe industry usually finds itself firmly ensconced among those boom and bust industries which ride the coattails of our nation's economic fortunes. Another factor of growth in PVC pipes is innovations in pipe resins, pipe structures and pipe processing technology.

In the global market PVC pipes and fittings constitute the largest volume application at 36% of the marketplace. Worldwide demand for these pipes is forecasted to increase more than four percent per year through 2007. In the European pipe market, plastic pipes rank first among other materials and globally plastic pipes are used at about 54% of the total pipes used. Polyvinyl chloride (PVC) takes the lion's share at around 62% of the global market. Polyethylene (PE) has 33.5%, while polypropylene (PP) takes about 4.5%. In Europe, 1.5 million tons of PVC was used in 2002 to make pipes. Similarly in case of USA pipe demand is projected to grow 2.5% annually to 15.5 billion feet in 2007.

3. PVC Pipes Manufacturing Industry, Global Scenario

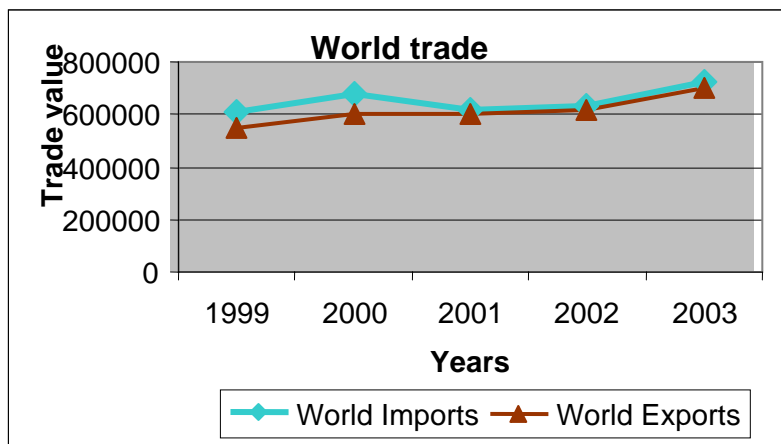
International Trade Performance

Overall world imports of PVC Pipes shows an encouraging trend during the mentioned five-year period. The growth percentage in 2001 shows a drastic slump decreasing to -10.3 from 10.2%, but it again jumps to 1.8% in the year 2002 and finally reaches 12.7% in the year 2003. The following table gives a clearer idea of the overall world imports of PVC Pipe.

	Value in US\$ "000"				
	1999	2000	2001	2002	2003
World Imports	611962	681632	617759	628777	720223
Growth %		10.2%	-10.3%	1.8%	12.7%
World Exports	551043	604875	605053	616064	698117
Growth %		8.9%	0.03%	1.8%	11.8%

Source: PCTAS HS

HS Code: 391723



International trade figures show after experiencing a steady growth till 2000 there was a decline in terms of value during 2000-2001. However, for the last five years the world trade has increased with an annual average growth of approximately 4% by value. It is also observed that top 10 trading countries have shown contrasting trends but as an average they have shared 63-65% of overall trade in previous 5 years.

Major Importing Countries of PVC Pipe

Top Importers	Value in US\$ "000"				
	1999	2000	2001	2002	2003
USA	77898	88753	84755	70010	79911
France	66256	63556	58246	71873	96216
Mexico	61086	79049	51738	56125	73319
Canada	27438	43406	29958	28216	32653
Ireland	30999	29315	29381	26554	40848
Belgium	32588	32011	26773	26788	29005
UK	24762	25362	21962	27681	34239
Hong Kong	22456	21005	20761	19167	21378
Spain	20576	19203	17980	19074	26113
Czech Rep.	15781	13688	12481	22043	20588

Source: PCTAS HS

HS Code: 391723

France, USA and Mexico have been the top importers of PVC pipes over the past 5 years, contributing to approximately 35% of world imports.

Major Exporting Countries of PVC Pipe

Top exporters	Value in US\$ "000"				
	1999	2000	2001	2002	2003
USA	71173	105773	68414	79381	92469

Germany	75011	68339	80183	70045	70380
Canada	66413	75906	73553	59002	62245
UK	47410	43212	46736	46408	61608
Italy	45371	46435	41248	50432	60755
Netherlands	22396	24318	30312	37210	49855
Spain	13505	14597	24176	39230	37420
China	15718	16162	20238	23630	25352
France	21447	16577	12237	14708	17600
Belgium	13816	15502	11652	13195	15083

Source: PCTAS HS

HS Code: 391723

USA, Germany and Canada are the top three exporters of PVC pipes in the last five years, contributing to 32% of world exports.

4. Pakistan PVC Pipes Manufacturing Industry

The PVC pipe manufacturing industry has presence in all major industrial cities of Pakistan (i.e. Karachi, Multan, Burewala, Lahore, Sialkot, Narrowal, Faisalabad, Gujranwala, Gujrat, Jhelum, Rawalpindi & Peshawar) which consists of around 400 manufacturing units and manufactures 45,000 metric tones annually. According to the statistics (for the financial year 2000), these units are operating at 60% of their installed capacity. These producers can be classified as part of organized and unorganized sectors. The units can be classified as follows:

- Large Units: 24-30 units
- Medium Units: 100-125 units
- Small Units: 250 units

Major characteristics of this industry are:

- There are in around 350-400 units in Pakistan scattered all over the country.
- Major cluster of PVC Pipes manufacturing industry is in Lahore (250 units).
- Second largest cluster is in Gujrat (around 25 units).
- PVC pipes industry has an obsolete technology base having 75% units equipped with local single screw-extrusion machines. Rest 25% units are using twin-screw type refurbished old machinery of 80's imported Western Europe.
- Few top line units are also using modern machines imported from China, Korea and Germany.
- Total number of people directly employed in this sector is 5,000. Most of these individuals are uneducated and acquire hands on training in the factory.
 - Large Units: 25+ people
 - Medium Units: 10-15 people
 - Small Units: 5-7 people
- The educational level of most of the workers is under matriculation.
- Plastic pipes are the main products produced by this industry used for Water supply, drainage, conduits and ventilation.
- The installed capacity of these units is 75,000 metric tons per year.
- Estimated production of these units is 45,000 metric tons per year.
- Total production capacity of this industry is 89.11 million kilo grams per year.
- The capacity being utilized by this industry is only 68%.
- There still exists a huge potential of more than 41,000 Metric tons usage of PVC pipes to serve as replacement of other products over the next five years.
- There are approximately 10-15 manufacturers in the organized sector, which are making good quality PVC pipe that adheres to specified standards of BS. 3505.
- These top level manufacturers account for only 25% of the industry capacity. Machinery used by these processors is mainly of European origin (Refurbished).
- Unorganized sector accounts for the rest of industry capacity which are manufacturing pipe from recycled PVC and those who are even making pipe

from virgin PVC resin are using exorbitant amount of filler (Calcium Carbonate) which makes a very low quality pipe. The pipes produced by this unorganized sector adhere to no specific standards and compete on price, sacrificing heavily on quality.

- Industry is playing an important role in the construction, agriculture sector and especially for transport of portable drinking water. By a large the industry is catering to the upcoming needs of agricultural sector for irrigation.
- It has 95% penetration in the conduit sector, 65% in tube well sector and 15% and 20% in drainage and water supply sector.
- Current per capita PVC consumption in Pakistan is only 0.28 Kg.
- The consumption-production gap is currently around 50% of the current rate of production. The potential major players in the public sector are the Public Health Engineering Departments (PHED), WASA, Military Engineering Supplies and various Housing Societies. The estimated total incremented potential for the next five years in these sectors is approximately 12,000 metric tons (statistics 2000).
- The major reasons for the slow growth of the PVC industry are the unawareness of consumer about quality consciousness, and not being able to introduce innovation in their production lines. Due to the lack of quality awareness on part of consumer, cottage sector has really flourished in last decade or so.
- Lack of awareness of modern technology among the industry stakeholders.
- There are low levels of operational and managerial skills within the industry.
- Quality manufacturers in industry are using BS. 3505 as a standard specification.
- Some manufacturers are also using international standards like ASTM, DIN & ISO certification. There is a need to introduce ISO 9000 in the industry.
- Manufacturers supplying to the Public Sector are required to get them-selves approved and registered with respective departments. Compared to 7.75 Kg in USA and 5.11 Kg in Japan, current per capita PVC consumption in Pakistan was only 0.28 Kg. This highlights the growth potential of the PVC Pipe manufacturing sector in Pakistan. However due to unawareness in Pakistan the use of PVC pipes is limited to the water supply, drainage, conduits, and tube wells. The current rate of utilization of these pipes in Pakistan is quiet low.

Consumption of PVC Pipes	
USA	7.75
Japan	5.11
China	0.66
India	0.42
Pakistan	0.28

Source: EAPCL

Imports by Pakistan

Top Import Partners of Pakistan						
Value in US\$ "000"						
Countries	1998	1999	2000	2001	2002	2003*
World	2863	2658	2058	6603	6634	22507
Korea Rep.	1043	1645	858	2440	3106	3749
Saudi Arabia						2068
Turkey				2177	42	5395
Austria	281	76		287	1032	313
Dubai	619	170	150	35	523	3035
Germany		227	7	836	145	741
China				195	646	183
UK	132		345	464		703
USA						1592
Malaysia						1330

Source: FBS

SITC Code: 5812003

*HS Code: 39172300

Over the past five years Pakistan has been importing PVC pipes from Korea, Dubai, Austria and Germany on regular basis to fulfill local demand.

Exports by Pakistan

Top Export Partners of Pakistan						
Value in US\$ "000"						
Countries	1998	1999	2000	2001	2002	2003*
World						7870
Afghanistan						7492
Dubai						378

Source: FBS

SITC Code: 5812003

*HS Code: 39172300

Pakistan has exported pipes of other material but FBS does not show exports of PVC pipes from Pakistan to any other country, prior to 2003. However, these exports were of minimal nature. Only in recent years due to demand arising from different development schemes in Afghanistan, the export figures are significant.

4.1 Market of Pipe Industry in Pakistan

There are different types of materials used for piping in Pakistan such as Asbestos Cement (AC), Mild Steel (MS), Galvanized Iron (GI), Poly Vinyl Chloride (PVC), Cast Iron (CI), Reinforced Concrete Cement (RCC) and Ductile Iron (DI). Majority of piping applications used in Pakistan range from 0.5" to 60" dia sizes.

Sector wise alternatives to PVC are depicted in the table below:

Water	HDPE, Concrete, Copper, PEX
Sewer	Concrete, HDPE
Conduit & Ducting	HDPE, Steel, Aluminum
Drain Waste and Vent (DVM)	Cast Iron, Copper, ABS, PEX
Agriculture & Drainage	HDPE, Concrete

ABS – Acrylonitrile butadiene styrene

HDPE – High Density Polyethylene

4.2 Products and Uses

In Pakistan, the PVC Pipes are being used in four major areas: Water supply, drainage, conduits and tube wells. The main products produced in Pakistan constitute of Polyvinyl Chloride and UPVC Un-plasticized Polyvinyl Chloride. UPVC is used in the drinking water supply system. PVC is used in agriculture, drainage and sanitation. These pipes usually fall in four categories as per their composition are:

- Scrap based
- Resin based
- Scrap resin mix
- Compact type

Their sizes vary from range ½” to 16 inch diameter and PS. 3051 Standard. However, pipes can also be divided in two categories as following:

- a) Pressure pipes Used for Water Distribution & in Tube wells
- b) Non Pressure pipes Used for drainage/sewerage and as Conduits

Water Distribution

Water supply can be for the purpose of household or for municipal sector. Water supply segment can be divided into internal and external applications. The size of pipes used for water distribution range from 0.5” to more than 60”. These pipelines are commonly known as External Water Supply lines, and are usually of AC (60%), PVC (20%), and MS (20%). PVC has a lot of growth potential in this segment as AC pipes are now becoming extinct in international arena and MS pipes are much expensive than PVC pipes. Usually inside the house GI pipe are used and these lines are called Internal Water Supply lines.

Tube Well

Pakistan being an agricultural country needs the use of PVC Pipes in large quantities for the irrigation purposes, due to their inherent characteristics. Tube wells are used for water supply or to drop the sub soil water level. Material used for this application is PVC and MS ranging from 4” to 12” dia. PVC enjoying 65% market share due to its longer life span in sub soil conditions dominates this segment. MS has 25% market share followed by Fiberglas with 10% share.

Drainage/Sewerage

The pipes are used to transport waste and sewage water to the main sewerage system. Average size of pipes used for this purpose ranges between 3” to 12” dia. Materials used for this application are PVC, CI, RCC and AC. Internal Drainage segment is dominated by RCC 35% and AC 30%. CI has 20% market share followed by PVC having 15% share. CI is becoming popular because the required fittings are available. Internationally however PVC is the dominant player in this market as it has a very long life. However, in external drainage RCC has 90% market share in dia sizes from 8” – 48”.

Conduits

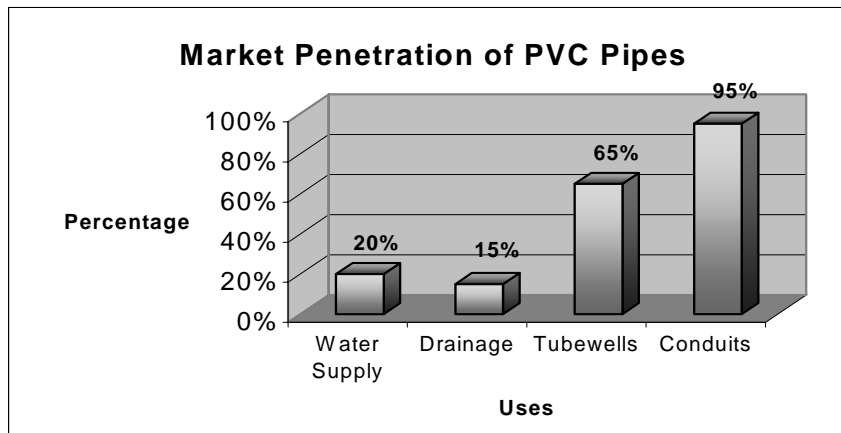
Conduits are used for installation of electric cables in construction industry. The size of conduit pipe ranges from 0.5” to 4”. Conduits are used for underground cabling for telephone lines. This segment is totally dominated by PVC and has more than 95% market share. In the conduit market, PVC enjoys a monopoly and enjoys almost 100% market share. Growth in this segment is 5% related to sluggish growth in construction sector.

4.3 PVC Growth Potential in Pakistan

- At present only the most basic PVC applications are being made in Pakistan and that also of low quality. Reasons being:
 - ✓ Lack of exposure in international markets
 - ✓ Lack of information about PVC processing and its versatility
- If Pakistan’s per capita consumption (presently around 0.5 kg/person) becomes at par with world average PVC per capital consumption of around 4.5 kg/person, then Pakistan would need 585,000 tons of PVC per annum at present population level.
- The number of jobs created by setting up the integrated facilities to produce PVC and by setting up PVC processing units will be more than 50,000.
- The incremental impact of producing and processing PVC on GDP can amount to a staggering figure of \$ 1 billion.

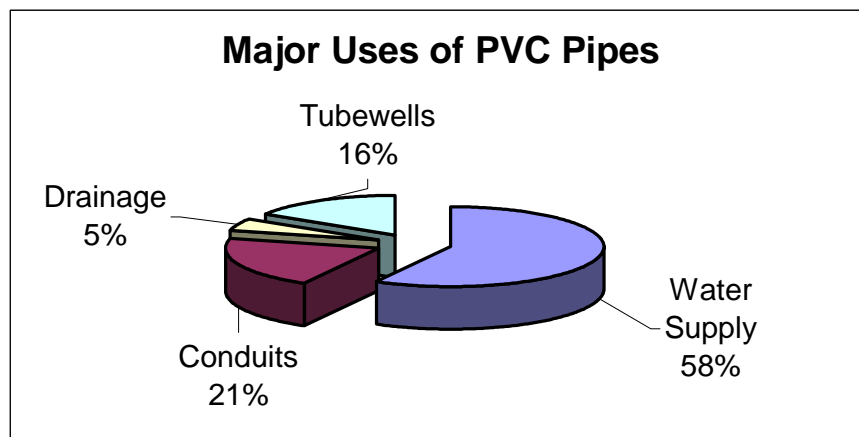
✓ Import substitution	\$345 Millions
✓ Export (25% of domestic production)	\$187 Millions
✓ Domestic sales	\$561 Millions
✓ Energy saving in processing PVC pipes only	\$48 Millions
- In most of the countries the PVC demand exploded due to increase in use of PVC pipes in construction and agriculture industries.
- Pakistan is short of 6.5 million housing units. There is additional backlog of 0.15 million units every year. Promoting the PVC in construction industry would help:
 - ✓ Reduce construction cost by Rs. 32,000 per housing unit of 120 sq. yards.

- ✓ Conserve energy/oil by replacing Cast Iron and steel in piping system
- ✓ Conserve and control environment by replacing wood
- Promoting PVC in agriculture sector would help:
 - ✓ In utilizing far flung areas for cultivation through drip irrigation
 - ✓ In salinity control and land reclamation (SCARP)
- Transfer of technology will also help in boosting local technology base and machinery manufacturing



Source: EAPCL &

APPMA



Source: EAPCL & APPMA

5. PVC PIPES INDUSTRY, LAHORE CLUSTER

5.1 Geographical Location:

Lahore cluster has the largest number of PVC pipes manufacturing units – making 62.5% of the total manufacturers. Majority of the cluster exists along the line of Shahdrah, Brandreth road, Band Road, Kana Kacha and Bhagwanpura. Shahdrah and Kana Kacha are the new industrial hubs on the outskirts of Lahore which makes them ideal places for the manufacturers as them being near to the market. Majority of the manufacturers situated here have large/medium plants. The manufacturing units on Brandreth road, Band road and Bhagwanpura are relatively older plants, some of which are also planning on relocating towards the side of Shahdrah and Kot Lakhpat. The major reason for relocation is the small restricted size which hinders the new capital investment in the operating lines.

5.2 Current Scenario:

Number of Units

Total number of units = 250

Break-up is as follows:

Large units: 10-15 units (5+ production lines)

Medium units: 50 units (3-4 production lines)

Small units: 180-185 units (1-2 production lines)

Technology Base

Large & medium units = refurbished western European machines *or*
Chinese/ Korean machines – Twin screw extruder

Small units = Local assembled single screw extruder

Dies & spare parts = imported from China, Korea or Germany

Typical Set of Machinery Required

Machinery Name	Description
High Speed Mixer & Cooler	Twin Screw Extruder
Die Heads and Sets	Calibration Sleeve Sets
Calibration & Cooling Bath	Spray Cooling Bath
Haul Off	Printer
Belling Machine with Dies	Crusher
High Tension Switch Gear	HT/LT Transformer
LT Distribution Board	Power Cables
Chiller System	Water Cooling System

Production Capacity

Twin screw extruder = 2,000-4,000 Kg/day

Single screw extruder * = 1,000-2,500 Kg/day

* is more problematic and has high wastage ratio

Machine Prices

Local single screw machine = Rs. 15-17 Lac
Chinese/Korean twin screw machinery = Rs. 40+ Lac
Refurbished twin screw machine = Rs. 30-40 Lac
Dies = Rs. 5-10 Lac (imported from China or Korea)

Capital Requirement

Fixed capital = Rs. 20-50 mil (avg. unit setup)
Working capital = Rs. 1-10 mil (avg. unit setup)
Investment required for modernization = Rs. 5-10 mil
Setting up international standard laboratory = Rs. 10 mil

Cost of Production

Raw material = Rs. 80-100/Kg
Other Costs = Rs. 25/Kg

Product Line

Currently manufacturing pipe size = ½” – 16” Dia
Possible intervention in pipe size = up to 34” Dia, double corrugated pipe and pipe fittings

Number of People Employed

Large units = 40+ per unit
Medium units = 20-35 per unit
Small units = 5-15 per unit
Majority of the workforce is indirectly employed on daily wages.

Technical Skills/Education Level

Machine operators = Diploma holders or FSc/BA
Labor = Primary pass or no education
Accountants = BCom
Lab Operators = Chemical Engineers*
* Only employed by top end manufacturers

Testing laboratories

Independent private testing laboratories = 10-15 units with minimum testing facilities
Public sector laboratory = PSQCA/PSI

Certification

Standard Certification = P.S 3501, ASIM, DIN & ISO 9000
(ISO 9000 certified units = 10-15)

Classification of PVC Pipes

According to pressure ratings

- Class of pipe working pressure class B 6 Bar

- Class C 9 Bar
- Class D 12 Bar
- Class E 15 Bar
- Pakistan Standard P.S 3501 (1991)

6. Analysis of Business Operations

6.1 Raw Material

PVC Resin:

Vinyl (Polyvinyl Chloride or PVC) is composed of two simple building blocks: Chloride and ethylene. After going through the processes of cracking and polymerization a fine powder-vinyl resin is produced. The three most important characteristics which affect the processing and use of specific resins are molecular weight, particle size and particle configuration. Its commercial value results from these characteristics: Chemically inert; water, corrosion and weather resistant; high strength-to-weight ratio; tough, dent-resistant; an electrical and thermal insulator; and maintains properties over long periods of time.

PVC resin can be of various types: suspension grade, paste resin and the synthetic resin. The main raw material used in PVC pipes manufacturing is the suspension grade used in the extrusion process. Normally certain additives are also used in PVC pipes manufacturing to facilitate production process and quality concerns. The additives like lubricant, stabilizer, antioxidant, plasticizers and colorants are added according to the requirement to increase the mechanical impact strength and easy processing. Raw material for PVC Pipes constitutes 95% of PVC resin while other agents are only used as 5% of total mixture. Common agents used in the production of PVC pipes are as follows:

- Filler: Calcium Carbonate
- Color: LT Black
- Color Fading Agent: Titanium
- Stabilizer

PVC Resin Manufacturers:

No.	Name	Investment (\$ US)	Capacity (tons)	Remarks
1	Engro Asahi Polymer & Chemical Ltd, Karachi	83 million	100, 000	In Operation
2	Pakistan PVC Limited Karachi	1 million		Closed
3	Sitara Chemicals Industries Limited	65 million		To start operation by end of 2006

Engro Asahi Polymer & Chemicals Limited Pakistan (EAPCL), in a Joint Venture with Asahi Glass Company and Mitsubishi Corporation of Japan set up a PVC Plant in Karachi. The plant went into full production in the year 1999 and since then it is producing about 100,000 metric tons. Present domestic PVC requirement is about 70,000 metric tons annually. Its head office and plant are located in Karachi. However for the convenience of the manufacturers there is a branch office in Lahore.

Earlier on PVC demand was catered by importing resin directly from a number of countries. But in recent years i.e. during 1996-2000, Pakistan imports of PVC resin have drastically shrunk from a value of US\$ 41 million to US\$ 15 million. This imported PVC resin is used for injection molding. The surplus resin (30,000 metric tons) is being exported to Australia, Dubai, Bangladesh and other Middle East countries.

A new resin manufacturing plant in Faisalabad by Sitara chemicals will start operating in 2007 and will help in stabilizing the price level in domestic market. The said plant is said to be based on Chinese technology which incorporates the wastage into account and is therefore more efficient as a result its expected raw material price is anticipated to be cheaper.

Price Trend, Local and Imported:

The imported price of PVC resin at an average is around US\$ 700-780/ton – around Rs 1,650 per bag of 25 Kg which after inclusion of taxes (custom 25% and other duties - with holding tax 6% and sales tax 15%) is Rs. 2,300-2,500. The manufacturers however buy their raw material from Engro due to the high custom duty on PVC pipes resin (Rs. 1,750) which is subject to the change in crude oil prices.

The import and use of PVC scrap by small units has also increased over the last years due to it being far cheaper. The annual import of scrap a couple of years back was 5,000 tons. However this volume of imports has increased to 30-35,000 tons, and is increasing every year.

Supply Dynamics:

There is a branch office of Engro Asahi in Lahore, which deals with all the resin purchases. There is no facilitation provided by this raw material supplier not even in the area of credit buying. The purchase of the resin is possible only on cash basis. However the raw materials are not delivered on time. This is the usual practice of Engro Asahi especially in case when they are expecting to increase the price of resin. Additives and other chemicals required for pipes manufacturing are currently being imported and can be easily purchased by any plastic resin whole sellers.

6.2 Production Operations

PVC pipes are produced by the conventional extrusion process. Depending on its end use application, PVC resin is compounded with several additives, stabilizers, lubricant, and filler in a high-speed mixer. This compound is fed into a twin screw extruder, where it is plasticized and forced through a die to form a pipe. The sizing of pipe is done through calibration equipment. The pipe is then cooled off by passing it through a water bath. The Haul off unit is responsible for pulling the pipe. A rotary cutter can be employed to cut the pipe into standard predetermined lengths.

Typically manufacturing process consists of the following steps:

Raw Material Preparation:

This is the process where PVC is initially mixed with additives. Additives are essential in PVC processing in order to take care of adverse reaction during heat application in extrusion process. During the process of mixing the polypropylene is mixed with dyes and other additives for a fixed time over heat. This causes the raw materials to infuse into each other and form a clumpy product that is further granulized.

Recommended machinery for raw material preparation is high-speed mixer and cooler combination. Majority of the manufacturers are using such machineries to blend the additives and resin together. PVC powder is weighted quantity is discharged batch wise into the high-speed mixer. Before starting the mixer additives are added into the batch.

Typically a batch of the material for PVC pipe would consist of:

PVC	100.0 Kgs	K – Values 65 to 67
Stabilizer	2.0 to 2.5 Kgs	
Filler	0 to 2.0 Kgs	
Color	0.5 Kgs	

Stabilizer protects PVC from heat degradation during extrusion and consists of metal co-precipitates. Quality filler may be added to reduce some cost but not at the expense of physical strength. It consists of coated calcium carbonate now available locally.

Color is essentially titanium dioxide and carbon black to give the PVC Pipe its traditional grey shade and also some protection against visible light, which causes growth of fungus.

High-speed mixer is started and by friction the temperature is raised to 110°C after which the mixed batch is discharged to cooler where it is cooled to 50°C. This mixture is called dry blend and is ready for extrusion process.

Extrusion Process:

These granules are fed into twin screw extruder through a hopper and a dosage feeder, are heated in different stages between the ranges of 150°-230° C. Dosage feeder controls the feed rate to extruder. Material is heated, compressed, air vented by vacuum and metered in the extruder barrel (containing twin screws) before entering into die.

The two types of extruders used in PVC pipes manufacturing are single screw and double screw. The use of twin screw extruders is recommended for a number of reasons:

- Their segmented screw design gives flexibility in screw and barrel layout and enables changes for future processes.
- The variable screw speed gives process flexibility.
- The co-rotating twin screw; mixes the raw materials horizontally and vertically simultaneously.
- The self-cleaning effect of the intermeshing screws.
- Large numbers of components can be incorporated, including powders.
- Up to 20 per cent of blowing agent can be incorporated, including non- or partly soluble blowing agents.

PVC Pipe dies have many parts/die sets, which can be changed to produce different dia pipes with, desired wall thickness. For example one die would have die sets or parts to produce pipes from ½” to 4” dia pipes. Die has thickness control bolts for control of circumferential thickness of pipes. The resulted molted paste is passed through the dye to obtain a very unstable hot end product. At this point the product is viable to damage due to unsuitability for which it needs cooling down.

Calibration and Hauling Off:

Exact diameter of pipe is formed in the water bath where calibration bush is installed. Cooling water and vacuum is applied for exact control of pipe diameter according to standards. The pipe is continuously balanced by the haul off speed through which minimum thickness of pipe is controlled.

The obtained product needs to be cooled down immediately to strengthen it. For this purpose the pipe/product is passed through the room temperature water. The cooling provides strength and toughness to the product.

Printing:

After the product has been prepared as per the requirements the brand name, size, density is printed on to the pipe. In normal practices the text is printed three times on a single pipe. Sometimes the printing is done after the product has been prepared and tested per the customer’s requirements.

Cutting:

The pipes need to be cut into appropriate sizes. Cutting is done either manually or automatically. The cutter cuts the pipe at pre determined lengths usually 5 meter in Pakistan. Furthermore it also typically chamfers one end for ease of joining.

Bell Ending/Socketing:

As per the requirements these pipes are reheated and then molded (expanded, bent, sealing etc) into the final product. Two types of socket ends are produced in PVC pipe length. At the requirement of the buyer plain ends can also be supplied. Two types of socket ends are;

- Solvent weld joints: These are plain bell end joints usually popular from ½” to 4” dia. However on customer’s requirement bigger dia also are sometimes produced for some industrial and tube well applications.
- Z joint: This is a rubber ring method joints and is produced with grooved socket where the rubber ring Z cross section is placed. This is a popular joint for pipes in dia 3” to 24” ranges for pressure water supply and distribution.

PVC Pipe Testing:

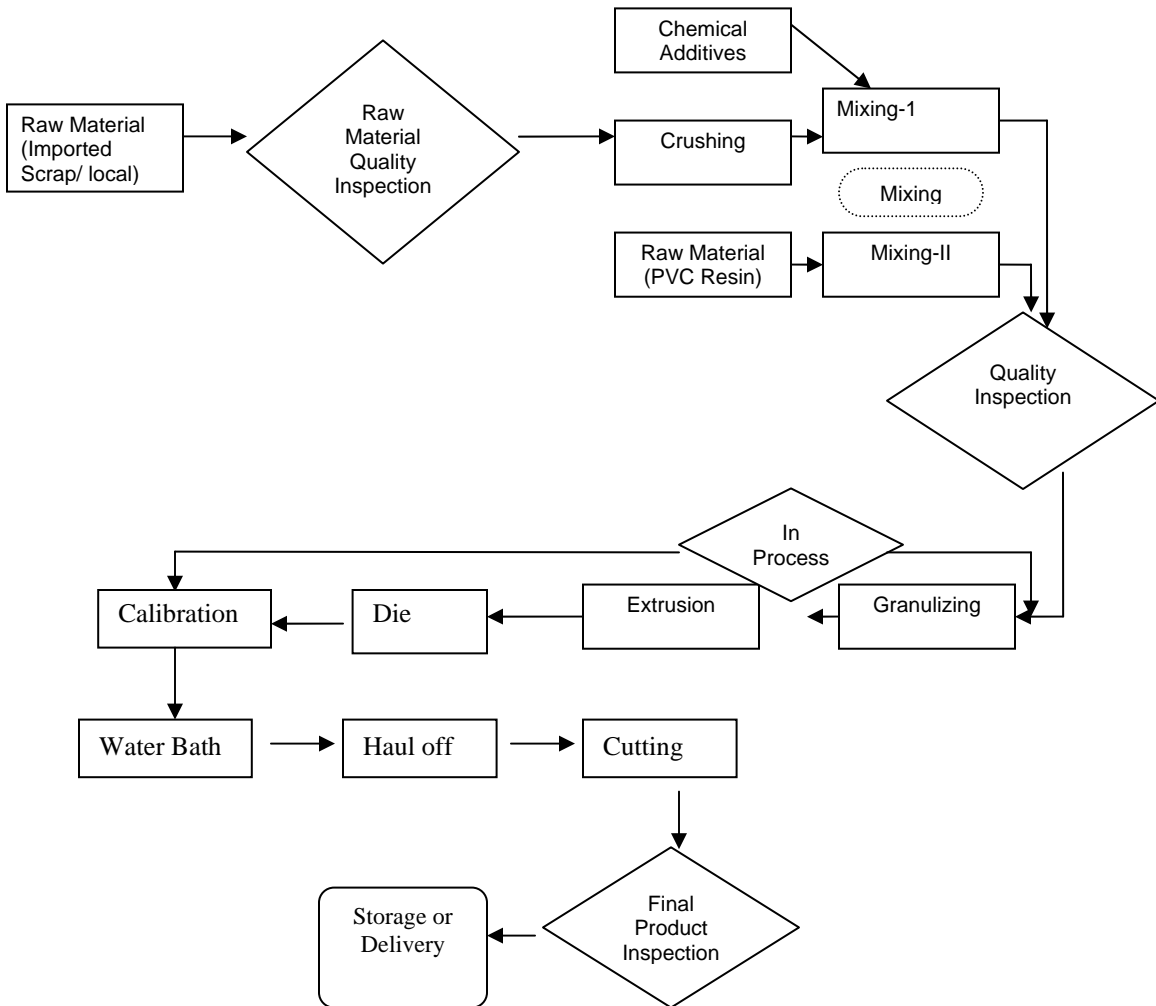
A sample of each batch is tested for Opacity, Gravity, Fracture toughness, Heat reversion and Hydrostaticity. However at this point in Pakistan only limited factories are testing their products. Typically following tests are carried out during production of PVC Pipes for basic quality control.

Falling ball impact test at 20°C	(Impact strength)
Glycerin Test at 150°C	(Homogeneity of PVC material)
Hydrostatic pressure test at 20°C	(Short term requirement)
Hydrostatic pressure test at 60°C	(Long term requirement)
Methylene chloride test	(Related to fracture toughness)

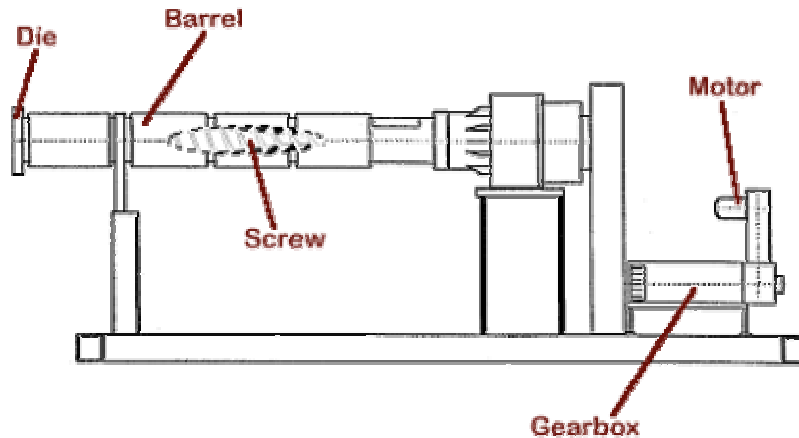
Storage:

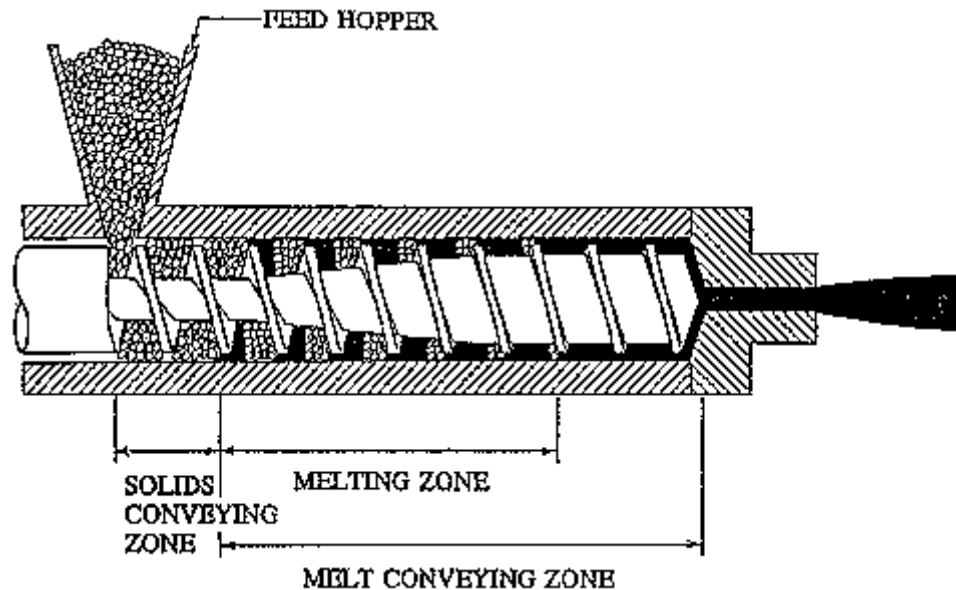
These pipes are packed and stored in warehouses, and are subject to their delivery in the market.

Process flow chart of PVC pipes manufacturing is depicted in the figure given below:



Figures below shows a typical extruder machine used in PVC pipes manufacturing and the detailed version of the screw.





6.3 Quality Assurance

The top line manufacturing units have their own laboratory setup and are ISO 9000 certified. The other basic standards followed by the industry are P.S 3501, ASIM and DIN. It is estimated that around 50% of the products are made in accordance with the quality products and remaining 50% are non-standard products. The issue of sub-standard product quality is by and large pertaining to the unorganized sector which uses scarp material, excessive additives and filler materials.

Only the top industry players are in a position to use new or second hand imported machinery which manufacturers a better quality produce. Extrusion dies/screws are nitrided and re-nitrided several times to extend their die life. Nitriding is a surface-hardening heat treatment that introduces nitrogen into the surface of steel at a temperature range (500 to 550°C, or 930 to 1020°F), while it is in the ferrite condition. Nitriding parameters are adjusted to the expected die duty cycle resulting in significant cost reductions and virtual elimination of unscheduled press shutdowns. It produces a high surface hardness for excellent wear resistance, improved fatigue strength, increased corrosion resistance, and a surface that is resistant to softening from elevated temperatures up to 1000°F. Currently the locally produced machinery does not go through this process, and as a result the screws are not that effective and loose their productivity within a year's time. The substandard replicated machinery is prone to screw slippage and stalling, which affects the quality of the products.

PSI/PSQCA is not successful in providing adequate testing equipment as well as trained human resources to provide confirmation of the quality of the PVC pipes.

6.4 Machinery

PVC pipes industry has an obsolete technology base majority units equipped with local single screw-extrusion machines. Only medium and large size units are using twin-screw type refurbished old machinery of 80's imported Western Europe. Few of top line units are also using modern machines imported from China, Korea and Germany. There are only 3 machine manufacturers which are working in the local market (Lahore cluster). These manufacturers are replicating the single-screw imported machines and are offering these services at a much lower price than the imported second-hand machinery. Their main customers are small size units in unorganized sector. The downstream plastic processing industry is highly fragmented essentially due to low technology and capital investment barriers. Incentives to small-scale industry have also encouraged this kind of fragmentation. An immediate consolidation of such capacities is not seen. However, in the future as margins gets squeezed, when scale of production and cost of manufacturing become relevant, consolidation will be the inevitable result.

Extruders and dies are critical component of the machinery. The import of these parts is very costly and the local industry is incapable of providing quality spare parts or repairing.

6.5 Selling and Distribution

Almost 40-50% of the total industry production was purchased by institutional buyers including government departments and remaining 50-55% was sold through conventional market channels. Manufacturers generally distribute pipes using a network of wholesalers who then sell to retailers and large customers. The higher quality manufacturers usually appoint two or three well-reputed entities with past experience and sound financial position as their wholesalers in larger cities, who also serve adjacent rural areas. However, these top tier manufacturers service large volume orders from the public sector directly. The unorganized sector manufacturers on the other hand appoint a host of relatively small dealers. Wholesalers generally operate on a manufacturer margin calculated as a percentage of gross prices. Margins are pegged to the off take volumes and larger orders attract higher margins.

Most of the small units tend to be established close to the market to reduce freight costs. In an endeavor to boost sales in a non-differentiation market, manufacturers generally resort to credit sale. This phenomenon is especially very common in the unorganized sector. The organized sector manufacturers are more selective while forwarding credit and limit this facility for larger orders and selective customers. Due to restricted quality product being available in the market, higher quality producers can place their pipes without offering significant credit terms and cash on delivery basis. 40% of all sales are on payment on delivery basis while 60% on some form of credit basis ranging from 7 – 30 days. Some producers may also move product on order basis, where product is pre-

sold at the time of being manufactured, but these types of sales exists in high turnover periods only.

Pricing of PVC pipes is on the basis of resin content and a distinct pattern emerges when higher quality product prices are studied closely - across all dia ranges, the price per kilogram will remain constant for any one producer. As the cost of resin increases or decreases, the price per kilogram of pipe also moves accordingly, showing that manufacturers are content with such pricing basis and are not sensitive to actual production processes.

6.6 Financing

Currently there is no cluster specific financing scheme available to the manufacturers. On personal terms financing from banks is easily available at very competitive rates. Apart from this leasing facilities are also being offered by banks and leasing companies for purchase of machinery and equipment. Manufacturers avoid entering into any lengthy paperwork and processing, therefore informal credit is a more popular source of loans. All the units are therefore equity based.

7. All Pakistan PVC Pipe Manufacturers Association (APPMA)

There is only one association of PVC pipes manufacturers in Pakistan which enjoys the support of its 250 members. This association is fairly new and is engaged in various activities pertaining to the development of the industry. However, due to the existing crisis in this industry its credibility is very subjective. The Chairman of the association is elected through elections, which are held at regular intervals. The main office of the association is based in Lahore.

Following table identifies the cities with large number of PVC units (Note: These figures represent only the registered members of association):

Sr.	Location/City	Number of units
1	Lahore	61
2	Gujrat	17
3	Karachi	16
4	Faisalabad	9
5	Rawalpindi	6
6	Gujranwala	13
7	Peshawar	5
9	Multan	20

Over the past years association has tried to involve various business service providers and technical institutions to initiate different development programs for this industry. However, even after pursuance no positive results have been produced. The association has also arranged training workshops/seminars during its tenure.

8. Support Institutions

There are few institutions which can provide assistance to this cluster. However there is little or no linkage between these institutes and the APPMA.

Small & Medium Enterprise Development Authority SMEDA was established in October 1998 to take on the challenge of developing Small & Medium Enterprises (SMEs) in Pakistan by providing the necessary services to help SMEs overcome the weaknesses that are endogenous to their very nature. It is an autonomous body working under the umbrella of the Ministry of Industries & Production and contributes towards the growth and development of SMEs in Pakistan through:

- (i) the creation of a conducive and enabling regulatory environment;
- (ii) development of industrial clusters;
- (iii) and the provision of Business Development Services to SMEs in all areas of business management.

SMEDA carries out comprehensive analyses of international trends, national policies and other macroeconomic factors affecting SMEs in Pakistan for a gradual progress towards the creation of a favorable business environment for its key clients – the SMEs of Pakistan. This interaction takes place at the individual as well as collective level to provide proactive and responsive financial, technical, management and marketing services to SMEs. At the collective level SMEDA addresses the problems and needs of SMEs in the form of an industrial cluster – a concentration of largely homogenous enterprises within a certain geographical area. SMEDA interacts with the stakeholders operating in such clusters on a regular basis and collects first hand information about their problems and needs. During this interaction, the issues are prioritized and the important problems are selected for detailed working through which the projects/programs are identified. SME support through cluster development program is provided on two fronts:

1. Regulations and policy level support
2. Institutional & networking support

SMEDA has conducted a number of training workshops on the request of APPMA for the development of this industry and is in touch with association to work on future areas of facilitation.

Pakistan Council for Scientific and Industrial Research (PCSIR) is the largest research organization in Pakistan, which was established in 1953. Objectives of PCSIR include systematic evaluation, development, value addition, and utilization of the indigenous raw materials; conduct research and development work on problems that are being faced by the industrial sector in order to adopt measures for the application and utilization of research results and indigenization of technical development through adaptation, modification, and improvement of existing technologies appropriate to the local conditions. Over the years, the primary target of PCSIR has been to develop low cost technologies attracting the

attention of small and medium level entrepreneurs (SMEs) recognized as the backbone of economies in developing countries.

Over the past couple of years APPMA has tried to organize training workshops with PCSIR in areas of technical up-gradation, as PCSIR has the mandate as well as capacity and required finance available to procure new twin-screw extruders and replicate this technology. For this purpose the members of association have held couple of meetings with the officials of PCSIR but so far this has not resulted in any positive activity.

The Pakistan Industrial Technical Assistance Centre PITAC established in July 1962, is an autonomous organization is working under the administrative control of the Federal Ministry of Industries & Production. Workshop facilities were established at Lahore, to provide in-plant advisory and consultancy services and keep liaison with the industries in this region. Its aim is to meet the acute shortage of skilled labor force in the country, increase productivity and ultimately accelerate economic development through mutual cooperation. For the realization of these aims and objectives it was decided that the Centre should have an excellent workshop with the purpose of training industrial workers in latest metal working engineering techniques and handling of precision equipment. The objectives are set forth as under:

- Training and upgrading of the skills of industrial personnel in the technical and managerial fields.
- Assistance in the design and manufacturing of Jigs, Fixtures, Gauges, Moulds, Dies, Tools and Products (Prototype) for industries.
- Extend the advisory services to industrial organizations, primarily in the private sector to solve their individual in-plant production problems including installation and maintenance techniques.
- Helping the industries in improving the quality of their products, increasing production, reducing costs and expanding the scope of indigenous manufacture.
- To disseminate modern technical know-how among industrial personnel through Seminars, Group Discussions, Demonstrations, Publications and Audio Visual Aids.

Currently it is not providing any assistance to this PVC pipes cluster. However, recently it has setup a modern injection molding unit to train other plastic product manufacturers.

National Productivity Organization (NPO), Ministry of Industries, Production and Special Initiatives, Government of Pakistan, was repositioned in the year 2001, to undertake Productivity Movement in Pakistan. NPO serves as the Secretariat and the Implementing Arm of National Productivity Council of Cabinet Division, and the Liaison Office of Asian Productivity Organization (APO). NPO is a skill-development and research organization, having a national mandate to

address and promote productivity in all the economic sectors of Pakistan. Its objectives are:

- To inculcate productivity consciousness through national and international training courses;
- To establish databases and dissemination systems covering all productivity issues of economy;
- To carry out research in Productivity and Quality (P&Q) and establish productivity indices for industries;
- To provide and disseminate information on P&Q indicators and case studies at sectoral and national level of industry;
- To develop an in-depth understanding and promotion of benchmarking in industry and hereby developing comparative data in order to encourage the implementation of best practices;
- To act as an integrated focal point of all organizations engaged in productivity drives

APPMA along with NPO have conducted training over the years.

Lahore Chamber of Commerce and Industry LCCI was established by the businessmen and industrialists of Northern India in 1923 under the name of "Northern India Chamber of Commerce and Industry". In 1947, on creation of Pakistan, its name was changed to "West Pakistan Chamber of Commerce and Industry" and to present name "Lahore Chamber of Commerce of Commerce and Industry" in 1960.

LCCI's prime objective is to serve its members to their utmost satisfaction. It is committed to make an effective contribution to the nation's economic development through the promotion of trade and industry. LCCI can act as a facilitator in creating awareness in the local market about the advantages of PVC pipes.

Plastics Technology Centre (PTC) was established by Federal Chemical & Ceramics Corporation Limited (FCCCL) with the assistance of UNIDO. The Centre is aimed to develop technical know-how and competence of technical workforce involved in the manufacture of plastic products and for better utilization of manpower, material and machinery. The Centre started its operations in October 1988. Since then number of academic & short courses training programs, seminars and industrial clinics have been conducted for the local Plastics industry. It also provides testing, advisory and technical services to the Plastics processors and end-users. At present PTC is the only training institution on Plastics in Pakistan. PTC is the pioneer in the field of teaching polymer engineering in Pakistan and is still the only institution in the country offering Polymer Engineering qualifications like BTEC National Diploma, UNL Certificate and Diploma in Polymer Technology and Bachelor of Engineering in Polymer Engineering.

Export Promotion Bureau EPB is headed by the Chairman who is usually from the private sector with the status of the Minister of State. With a view to make Export Promotion Bureau an effective trade promotion and development body of the country, it has recently been expanded, restructured, and reinforced with employment of experts from the private sector.

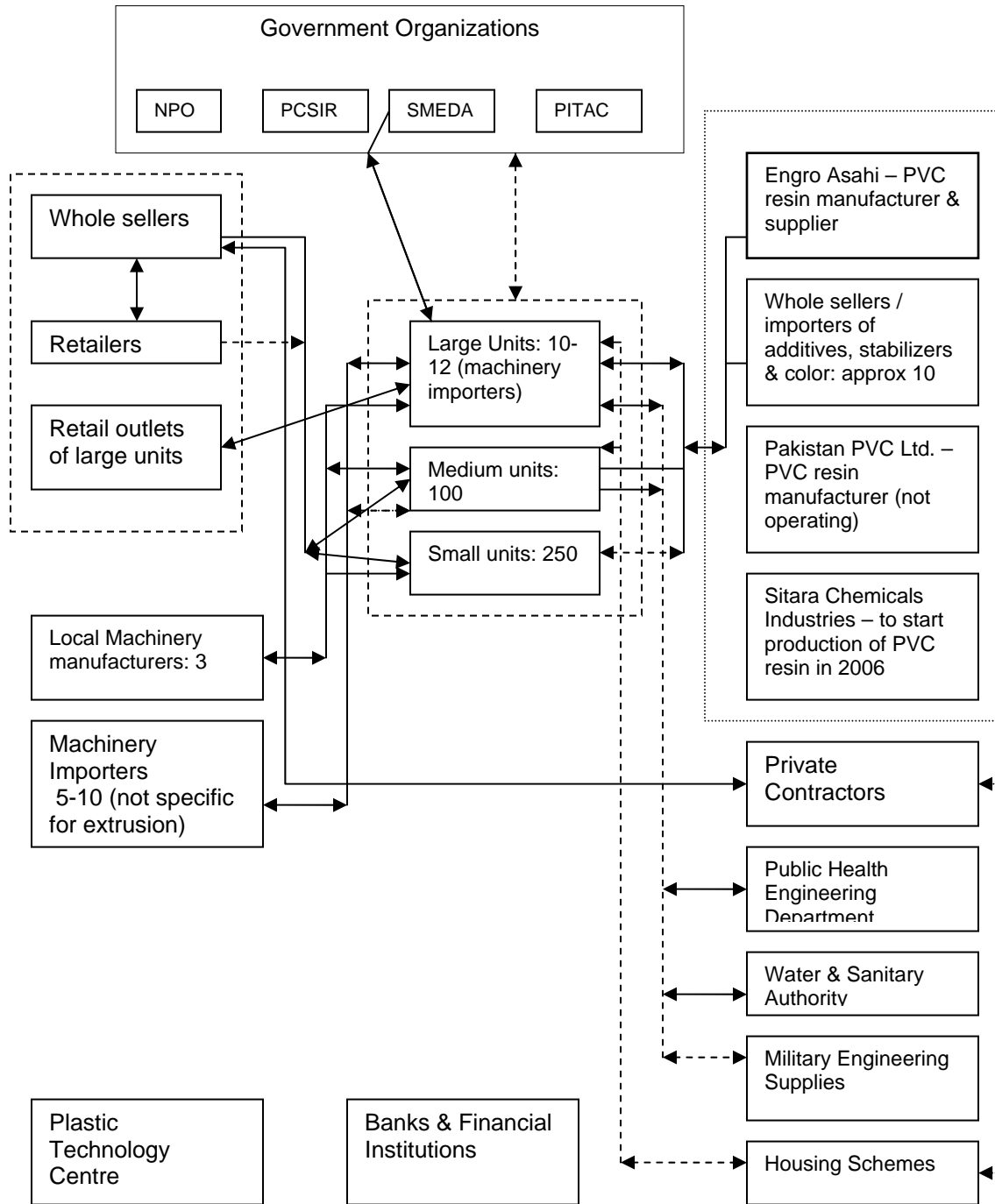
Now EPB has 9 Divisions with following nomenclature:

1. Geographic and Regional Trade Alliances
2. Export Supply Management (Textiles and Agriculture)
3. Export Supply Management -II (Other than Textile)
4. Quota & Regulatory Management
5. Planning, Policies and International
6. Communications
7. Human Resource, Finance & Administration
8. Information Technology
9. Skill Development

Academia circle can be involved into various developmental activities for this industry by using technical universities to develop and run courses and degrees concerning machinery design & development and Chemical & material engineering. Thus contributing in the development of technical experts or master trainers.

Punjab Small Industries Corporation PSIC was established in July 1972 under PSIC Act to serve the depressed small industrial sector in the province. To promote sustained development through provision of market driven credit, infrastructure and technological support, contributing to employment generation, poverty alleviation and socio-economic uplift of the province. To promote sustained development through provision of market driven credit, infrastructure and technological support, contributing to employment generation, poverty alleviation and socio-economic uplift of the province.

9. CLUSTER MAP OF LAHORE CLUSTER



10. SWOT ANALYSIS

Strength:

1. Most of the large units are engaged in further up-grading
2. The raw material supplier (Engro Asahi) assists in different issues relating to pipe production. Its Lahore branch office manager meets with the manufacturers on regular basis to understand their issues and come up with appropriate solutions
3. The local machine manufacturers are located near the cluster within Lahore, and also assist the manufacturing units in setting up new lines
4. Cooperation exists between the local machinery suppliers and the small manufacturing units
5. Basic knowledge and technology involved in manufacturing of PVC pipes is present in the cluster
6. Availability of basic infrastructure/network
7. Easy access to nearby cities via G.T. Road and national highway
8. Have a dry port facility in Lahore to cater for potential exports
9. Presence of few recognized brands from top-end manufacturers
10. These manufacturers are willing to diversify into further products

Weaknesses:

1. Volatility of raw material prices
2. Constants break down in local made machines or obsolete machines and irregular supplies of electricity and water etc leading to high level of wastage
3. Unchecked use of scrap material in pipes production which leads to inferior and hazardous pipes
4. Extreme price pressures and low margins at all levels of market leading to continuous price wars among stakeholders to catch new customers
5. Lack of design guides and standards
6. Products only manufactured by large and medium units are according to safety and quality standards
7. There is no pressure or demand from consumers to uplift and maintain quality of products
8. Unskilled labor and machine operators
9. No technical expert in the field of PVC extrusion to help with machine fabrication
10. Weak linkages with government agencies to help in technical up-gradation
11. No research and development in areas of development of competitive technologies. Understanding of new technology is low.
12. Supply of products is limited to small local market with limited purchasing power, leading to manufacturing below full capacity
13. Unawareness regarding modern manufacturing and marketing of products
14. No pooling of efforts to obtain orders on collective basis

15. No capital investment available on large scale in the sector
16. No linkages with banks to help with working capital and long term investment
17. Unawareness among the manufacturers regarding Islamic mode of obtaining finance from the financial institutions

Opportunities:

1. Diversified product range
2. Strong future domestic market demand for quality products
3. Scope of increased penetration in other sectors as a result of awareness about its advantages and different uses
4. Possibility of market penetration (export) to neighboring countries
5. Increasing interest of foreign and local investors
6. Joint ventures with international training institutes
7. Benchmarking of market leaders for small units to up-grade their technology base
8. Expansion/modernization of infrastructure/networking for the sector for collective development
9. Establishment of an information sharing/dissemination mechanism among industry to keep them updated on international trends

Threats:

1. The market of PVC remains under pressure from high energy and feed stock costs
2. Irregular availability of high quality raw materials especially before a price hike
3. According to the current budget the custom duty on the PVC resin is 20%. However the plastic items/raw materials have 5% custom duty. The PVC pipes manufacturers have no choice but to use scrap. Industry may get more fragmented if duty is not reduced
4. Pakistan products do not have a good quality image
5. Increasing availability of international brands in local market - aggressive competition especially from China, Malaysia, Indonesia and India
6. Environmental legislation and other restrictions concerning the proper way to recycle and dispose PVC products
7. Non-availability of master trainers for training
8. No training institutes at national level to guide the industry towards new technology and product line

11. VISION

To uplift the status of Lahore PVC Pipes industry by its capacity building to manufacture diversified quality products, to induce the process of import substitution resulting in decline of PVC Pipes imports to US\$ 10 million in next five years.

12. STRATEGY

Objective: To develop the competency of domestic PVC Pipes industry to sustain the domestic market share through enhancing quality image and introducing new product line which is possible only through technology up-gradation and strengthening of local linkages in upcoming years.

Marketing:

- Awareness campaign for retailers/whole sellers/contractors for advantages on using quality PVC pipes
- Advantages of networking to obtain joint orders
- Diversified product range and its application in various fields
- Issuing of regular newspaper to bridge information gap

Quality Output:

- Production process standardization and optimization to maintain quality to curtail substandard production
- Up-grading of PSQCA testing facility
- Introducing/establish model testing facility through PCSIR and Plastic technology centre

Technology Up-gradation:

- Customized lending scheme for up-gradation of local units
- Transfer of technology through replication of modern machines
- Benchmarking local unit as an example for small setups

Skills development:

- Training of machine operators with PITAC
- Conduct training for local machine manufacturers with PITAC
- Training on batch making with PITAC to reduce wastage and break downs
- Developing linkages with training institutes (local & international)

13. ACTION PLAN

Short Term: Till July 2007

Sr	Target	Activity	Approx. Cost Rs.					Time Frame	Implementer
			APPMA	UNIDO	PITAC	PCSIR	SMEDA		
1.	Marketing: Sustain the local market share which is declining over years	<ul style="list-style-type: none"> Holding seminars for enhancing awareness on using quality PVC pipes Seminars on networking to obtain joint orders Seminars on diversified product range & applications Issuing of regular newspaper to bridge information gap * 	5,000	50,000	-	-	100,000	March to July 2006	APPMA & SMEDA
2.	Skill Development: Develop pool of skilled workforce & trainers	<ul style="list-style-type: none"> Developing linkages with local & international training institutes* Training workshops of machine operators Training workshop for local machine manufacturers Training on batch making 	10,000 – 50,000	-	25,000	100,000	50,000	May to Dec. 2006	SMEDA, PCSIR & PITAC
3.	Technology Up-gradation: Develop a better technological base	<ul style="list-style-type: none"> Customized lending scheme Benchmarking of local unit as example for small units^ Technology transfer through replication of modern machines* 	-	-	-	-	50,000	Feb. to Dec. 2006	SMEDA, PCSIR & financial institutes

4.	Quality Output: Enhancing quality image	<ul style="list-style-type: none"> • Up-grading of PSQCA testing facility • Introducing/establish model testing facility • Production process standardization & optimization* 					100,000	July 2006 to July 2007	PSQCA, PTC & Technical institutes
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* All such activities are subject to other partners' approval & would be accomplished in long term. Associated costs are not included, as require further working.

^ Subject to the manufacturer's approval.

14. Current Institutional Matrix:

	APPMA	Machinery suppliers	Raw Mat. Suppliers	EAPCL	PSIC	PCSIR	PITAC	PTC	NPO	SMEDA	LCCI	EPB	Academia circle	Financial inst.
APPMA	x	5	4	5	1	2	3	2	4	5	4	1	1	3
Machinery suppliers	5	x	2	3	1	2	1	2	0	1	0	0	0	0
Raw Mat. Suppliers	5	2	x	2	0	0	0	0	0	0	0	0	0	0
EAPCL	5	4	2	x	0	1	1	1	1	0	0	0	0	5
PSIC	1	0	0	1	x	1	2	1	1	4	4	2	1	4
PCSIR	1	0	0	2	2	x	2	1	1	2	1	1	1	1
PITAC	1	2	0	1	2	1	x	1	1	3	1	1	1	1
PTC	1	2	2	4	1	1	1	x	1	1	0	0	4	0
NPO	3	0	0	1	0	3	3	1	x	3	2	1	1	1
SMEDA	4	1	1	2	4	3	4	2	4	x	5	2	3	4
LCCI	3	0	0	0	3	1	1	0	0	4	x	2	4	3
EPB	0	0	0	0	0	0	0	0	0	1	2	x	1	2
Academia circle	0	0	0	0	0	0	0	0	0	2	3	1	x	3
Financial inst.	0	1	0	2	2	1	1	1	1	3	3	3	1	x

0 = Do not know each other
 1 = Know but never interacted
 2 = Just interacted
 3 = Formal correspondence
 4 = Few joint projects
 5 = Formal relationships