



Un-plasticized Polyvinyl Chloride (UPVC) Profiles Production in Nepal

A Feasibility Study

Suman Kunwar

Degree Thesis

Plastics Technology

2012

DEGREE THESIS	
Arcada	
Degree Programme:	Plastics Technology
Identification number:	9374
Author:	Suman Kunwar
Title:	UPVC profiles production in Nepal
Supervisor (Arcada):	Marko Voho
Commissioned by:	Unique Profiles Pvt. Ltd.
Abstract:	
<p>The goal of the study was to concentrate on the production of UPVC profiles in Nepal, which otherwise has been imported from China. Importing has various sort of challenges associated with it and has been an issue of concern for Unique Profiles Pvt. Ltd. In order to eradicate all these adversities, they are keen to produce the UPVC profiles in their own premises. This may also turn out be a very profitable idea as the demand of UPVC profiles in the country has been growing immensely. The theory part concentrates on the feasibility of the production of UPVC profiles in Nepal. The thesis covers the study of raw materials needed and the machinery needed. The thesis covers the production capacity and the output of the plant thus established. The thesis analyses different suppliers and also calculates the financial aspects of the production. In Nepal where the use of UPVC as constructing material is very infant, the thesis and its outcome when materialized seems to be a noble idea. It is hoped that Unique Profiles benefits immensely from the effort.</p>	
Keywords:	Unique Profiles Pvt. Ltd, UPVC profiles, Profile production line, Sales Revenue, ROI.
Number of pages:	50
Language:	English
Date of acceptance:	15 th May, 2012

Table of Content

Contents

1. Introduction	9
1.1 Background.....	9
1.2 Objectives	9
1.3 Challenges and Limitations.....	10
1.4 Scope.....	10
1.5 Products and Requirements.....	10
2. Literature Review	12
2.1 “UPVC” The Material.....	12
2.2 Benefits of UPVC	12
2.3 Plastics Extrusion.....	14
2.4 Production Line for UPVC Profiles Production	15
2.5. Types of Extruders.....	17
2.6 Die Flows	19
3. Method	21
3.1 UPVC Production Line Models	21
3.1.1 Qingdao Xinquan UPVC Profile Production Line SJSZ65 /132.....	22
3.1.1.1 Technical Guidelines, Quality Assurance and Terms from Qingdao Xinquan Plastic Machinery Co. Ltd.	25
3.1.1.2 Rough Financial Detail of the Production Line	25
3.1.2. Qingdao Weier Profile Production Line SJSZ-65/132.....	27
3.1.2.1 Technical Guidelines, Quality Assurance and Terms from Qingdao Weier Machinery Co. Ltd.	29
3.1.2.2 Rough Financial Detail of the Production Line	30
3.1.3 Xinxing SJSZ 65/132-YF240 Profile Production Line.....	31
3.1.3.1 Technical Guidelines, Quality Assurance and Terms from Shanghai Xinxing Twin Screw Machinery Co. Ltd.....	33
3.1.3.2 Rough Financial Detail of the Production Line	33
3.2 Acquainting the Raw Material	34

3.2.1 Efficient Growth Sdn. Bhd. White PVC Granules	35
3.2.2 Linyi Hao Yuan Plastic Industry Co.Ltd. UPVC Powder	36
3.3 Financial Aspects of the Production	38
3.3.1 Fixed Capital Investment	38
3.3.2. Installation and Working Capital	39
3.3.3. Annual Operating Cost.....	40
3.3.3.1 Fixed Operating Cost	40
3.3.3.2 The Variable Operating Expenses	43
4. Results	45
4.1 Sales Revenue & the Return on Investment (ROI).....	45
4.2. Final Overview.....	46
5. Conclusion and discussion.....	47
6. References	48
7. Appendices	50

Figures:

Fig 1 Required Profiles drawing with dimension.....	11
Fig 2 Sectional View of a simple plastic extruder.....	14
Fig 3 Schematic figure of Profiles production line.....	16
Fig 4 Simple Plastic extrusion screw.....	18
Fig 5 A typical annular die.....	19
Fig 6 UPVC profile production line (Qingdao Xinquan Plastic Machinery Co, Ltd)	22
Fig 7 Block diagram of production process.....	23
Fig 8 UPVC Profile production line (Qingdao Weier Machinery Co. Ltd)	27
Fig 9 UPVC Profile Production line (Xinxing Twin Screw Machinery Co. Ltd).....	31
Fig 10 PVC granules and their profile.....	35

Tables

Table 1. Rough Calculation of expenses for the production line (Qingdao Xinquan Plastic Machinery Co, Ltd)	26
Table 2. Rough Calculation of the expenses for the production line (Qingdao Weier Machinery Co. Ltd).....	30
Table 3. Rough expenditure for the production line (Shanghai Xinxing Twin Screw Machinery Co. Ltd.).....	34
Table 4. Fixed Capital Investment.....	38
Table 5. Installation and Working Capital.....	39
Table 6. Fixed operating Cost.....	41
Table 7. Variable Operating expenses	43
Table 8. Sales Revenue and ROI.....	44
Table 9. Financial Detail of the project.....	45

Foreword

The thesis “UPVC profiles production in Nepal, a feasibility study” is an overview on the possibility of UPVC production in Nepal itself. The aim of the thesis is to provide the company with a basic idea about the different production lines of UPVC profiles and also analyze if it is going to be lucrative or not to start extruding the profiles.

I would like to express my sincere gratitude to Mr. Sabin Silwal the plant engineer at Unique Profiles Pvt. Ltd. for encouraging me to study in such a topic and guiding me through my works. In addition, I am also grateful to Mr. Subash Joshi the project manager at Unique Profiles Pvt. Ltd. for his valuable comments and guidelines about the topic. I would also like to express my warm regards to Mr. Om Praksh Subedi, the general manager at Panchakanya for his generous briefings about the technical and financial aspects of business in the context of Nepalese market. Mr. Iswor Raj Pandey the executive director at Unique Profiles also deserves a humble appreciation for his encouragement and support.

I hope the thesis will prove to be very helpful for the production of UPVC profiles. At the same time, it is also expected that Unique Profiles benefits immensely from this effort.

Helsinki, May 2012.

Suman Kunwar

Glossary:

UPVC: Un-plasticized Polyvinyl Chloride

ROI: Return on Investment

Amortization: It is the process of allocating an amount particularly for loans and other forms of finance which reduces the principal amount.

Modulus of elasticity: It is the ratio of the stress applied to a body to the resulting strain.

UV stabilizers: They are the substances used for absorbing UV radiation and not letting them turn into heat.

T/T payment: Telegraphic transfer, a mode of payment.

L/C payment: Letter of credit.

FOB: Free on Board price.

1. Introduction

1.1 Background

Panchakanya is an esteemed business house in Nepal which has been one of the leading business houses since decades. The newest feather in Panchakanya Group's cap is Unique Profiles Pvt. Ltd established in January 2010 and is located in Patan Industrial Estate. It produces doors, window, partitions and roof panels out of UPVC profiles. Pachakanya [1].

Presently wood has become difficult to get access of and aluminum is not good enough, there is no denying to the fact that UPVC profiles are the next big thing. Although the concept of production of UPVC profiles is rather new in Nepal, Unique Profiles seems very keen to make it popular in the market, which surely will be a huge success. There are few challenges in the path of Unique Profiles and one of them is to produce UPVC profile locally and lower the cost of production.

Nowadays, it is a constant challenge to find ways to cut some of production expenses and be more productive. One of the ways out is to find cheaper raw material and in our case the company wants to produce UPVC profiles locally so that they can get rid of importing the profiles. The effort will help the company not only to bring down the cost of production but also combat the hassles of importing. Such hassles generally include the impatience until the arrival of the import, various custom procedures and so on.

1.2 Objectives

The main objectives of the thesis are as follows:

1. To source for machinery for extruding the UPVC profiles.
2. To find suppliers in order to purchase the raw material.
3. Finally, all the financial aspects of the production are to be scrutinized. This includes all the fixed capital, installations and working capital, and the sales

revenue. Then, the Return on Investment (ROI) is to be calculated and hence the idea of production is manipulated according to the ROI.

1.3 Challenges and Limitations

Panchakanya Group being a much esteemed company in Nepal, it makes a point not to compromise with quality. The challenge in looking such machine is that not only should they be of optimum cost but also should yield a high quality product. The mantra is as simple as getting the best one out of the limited resources available. The capacity of the plant can be on the higher side and the production may be adjusted according to the market demand.

1.4 Scope

Among the various obstacles, the company is very concerned about the UPVC profiles it imports from China. It is a constant challenge that the inventories of all the profiles are maintained well. The duration of the consignment that leaves China takes something like 50 days to enter the premises of the company. In addition, the tax on importing is 25%, it skyrockets the cost of production. The tax and the duration of shipment complicate the idea of importing. It would be a divine boon if the UPVC profiles can be produced in Nepal itself. It is obvious that if the idea of producing the UPVC profiles is materialized, the company will be able to out shadow the market competitors as well.

1.5 Products and Requirements

Basically, the company requires thirty four different types of profiles. Among them some are frequently used and some are scarcely used but at the end of the day we need to produce all these for the smooth running of the company. Some of the profile's drawings and dimensions are shown as below.


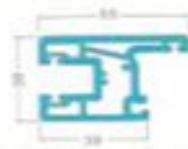





S. N	PROFILES	Dimension
1		width 80mm, height 50mm, thickness 30mm
2		up width 55mm, down width 39mm height 38mm
3		width 80mm, height 46mm. thickness 30
4		height 80, and width 65
5		width 80mm, height 15mm
6		width 40mm, height 28mm
7		width 20mm, height 22mm

Fig 1: Required Profiles drawing with dimension. Foshan Yatai plastic profile Co.Ltd [2]

2. Literature Review

2.1 “UPVC” The Material

UPVC stands for un-plasticized poly vinyl chloride. It is said to be un-plasticized because no additive is added to make the material flexible instead of being rigid. It is a thermoplastic material with high rigidity and high modulus of elasticity. Thanks to modern science and many years of research and development that UPVC has become the most sophisticated substances available for windows, doors, shutters, automobile body parts, building material and even credit cards. They are also often referred as rigid PVC. Osswald [3].

Traditionally, wood has been the constructing material for the doors and window panels. It dates back to centuries since the wood has found its use as a constructing material. In recent times, UPVC has been used as a substitute of wood, which is a very positive step. The importance of UPVC over wood in the present scenario cannot be denied nor can be neglected. Let aside all the technical benefits, the environmental aspect of UPVC can single-handedly dethrone wood as a constructing material.

Public awareness towards constructing material such as UPVC which is an excellent substitute to wood is the need of the hour. Since UPVC is recyclable there is no hazard associated with it and following qualities make it an excellent substitute of wood as far as the constructing panels is concerned.

2.2 Benefits of UPVC

- High impact strength
- Relatively lower cost
- Sustainable and recyclable

- Beautiful and stylish with standard-sized holes for locks and knobs
- Wide variety of finishes
- Energy-saving and heat-reflective
- Easy to clean
- Sound proof
- Furthermore, unlike wooden or metal doors, windows and frames made from UPVC exhibits following stand out features:
 - Termite resistant
 - Corrosion-free
 - Fire-resistant
 - Moisture resistant
 - Lower Maintenance Cost. Unique Profiles [4].

Moreover, deforestation has been a serious problem in Nepal for quite some time now.

There are various reasons for deforestation but the use of timbers as a construction material is also one of them. Basically, the use of UPVC as a construction material minimizes the use of timber and can be significant in controlling deforestation to some extent.

2.3 Plastics Extrusion

Extrusion is a manufacturing process where a material is drawn through a die of required cross section. The main advantage of extrusion over other processes is that it can create very complex sections and also can be used for brittle objects since shear and compressive are the only stresses that are acting on the material. Additionally, the process also provides excellent surface finishes.

Various types of plastic material can be extruded e.g. PVC, UPVC, ABC, PE, PP, PC, etc. In plastic extrusion generally the pellets are fed to the hopper and they are heated by heating elements and the shear heating is done by the screw. Then, the molten resin is forced through the die by the screw giving it the required shape. The extruded plastic solidifies as it is pulled through the die or water tanks.

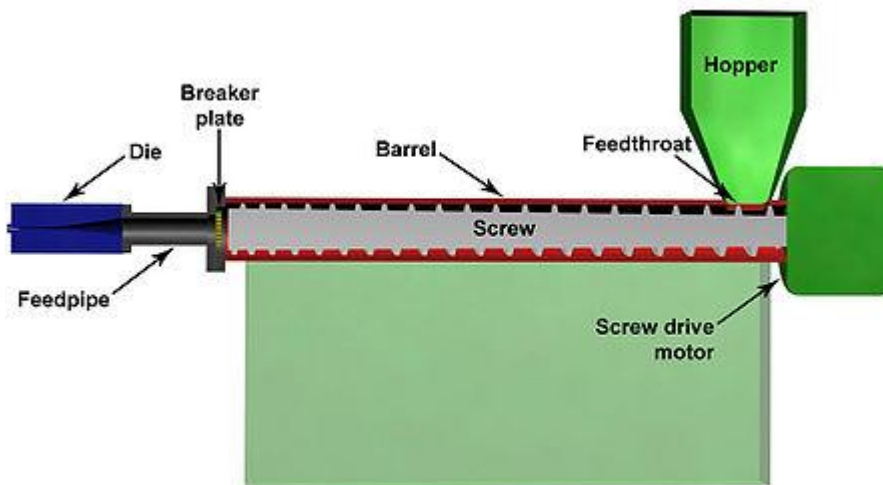


Fig 2: Sectional View of a simple plastic extruder. Wikimedia Foundation [5].

If required various additives can be added to the pellets and dried before inflicting them to the hopper. After the hopper is passed through, the pellets enter the screw through feed throat and are pushed through the barrel by the rotating screw. The melting of the pellets is

done by the heating elements in such a way that the temperature increases gradually from the hopper end to the other end of the barrel allowing the pellets to melt gradually too. Some heat is also generated by the intense pressure and friction inside the barrel as well.

Then the melted pellet passes from the end of the barrel to the screen pack where any contamination in the melt is removed. The screen pack is reinforced with breakers plate and this assembly plays an important role to create a back pressure to the barrel which facilitates to melt and mix the polymers uniformly.

Then onwards the melt is subjected to the die where the melt gets its final shape but care should be taken that the design would let the molten plastic flow evenly and let the cylindrical profile take the final shape. Any uneven flow at the stage can lead to uneven stresses over the profile. Using an appropriate die any continuous profiles may be produced.

Normally, after all these processes the substance is cooled pulling it through a water tub. Pullers are also often used to pull it uniformly from the die. Since plastics are good thermal insulators it takes some time to cool the extruded material. Crawford [6].

2.4 Production Line for UPVC Profiles Production

Profile Production lines for UPVC involves a complex extrusion process. This process has some more stages than the normal extrusion process. Here is the general schematic figure of the whole profile production line.

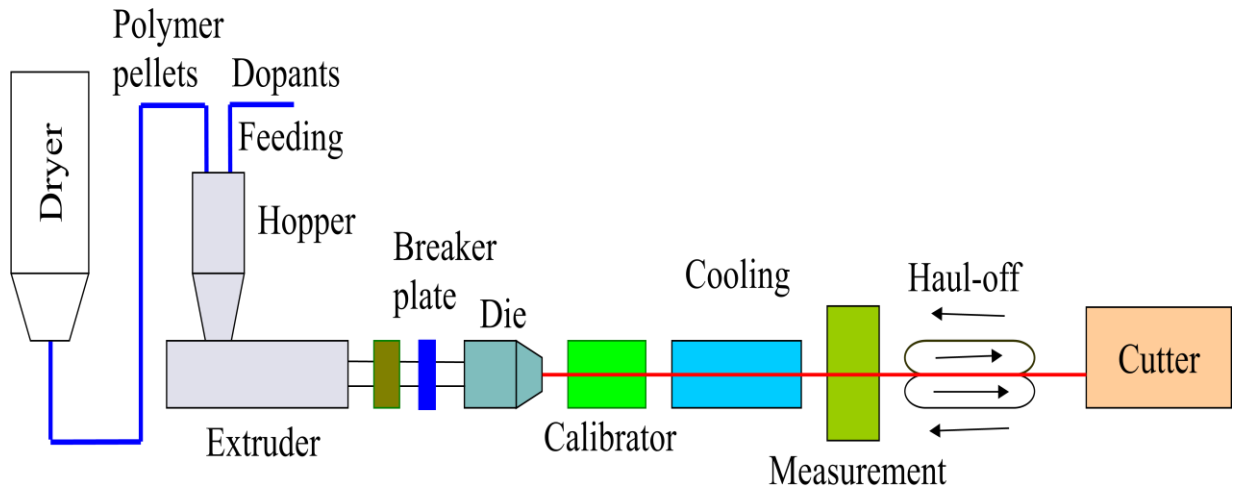


Fig 3: Schematic figure of Profiles production line. Vaddiraju R S [7].

Firstly, polymer pellets are fed in the hopper and prior to it they are dried and the dopants are fed as well. Then, the process in the extruder is the same as already stated in the normal extrusion process. Here, in the extruder there is a screw and a barrel. The screw is coupled with a motor and it moves within the barrel. The pellets that are fed through the hopper is what the screw acts upon on. Then, the pellets are distributed across the barrel by the screw and are heated by the process of conduction from the heaters present in the barrel and the shear heating is done by the movement of the screw. The extruder can be single screwed or twin screwed. The design of the barrel and the screw can be parallel or even conical and the screw can co-rotate or counter-rotate. The design of the screw is such that it has three different zones labeled as feed, compressing and metering. These zones have their own significance and feed heats the pellets and send it to the compression zone. In the compression zone where the depth decreases due to the tapering screw helps to compact the resin and also helps to squeeze any trapped air pockets. This is the zone where most of the resin is melted. The resin then heads to the metering zone from where molten pellets are fed to the die at a uniform rate.

The molten plastic then enters the breaker plate and screen pack assembly which functions as the contamination filter and also creates the back pressure needed to uniformly melt the substance. The gear pump located in between the extruder and the die finds its function to pump the molten plastic through the die. The advantage of using such a gear pump is that it allows an even flow of materials and improves thickness control thus saving the material. In addition to that the gear pump also takes the load off the extruder allowing it to run in low pressure thus generating lower frictional heat. Griff [8].

The die gives the final shape to the molten plastic. A significant amount goes in the manufacture of the die that gives the uniform flow to produce a quality extrusion. Calibrator is used to hold the molten plastic that comes out of the die in the dimensional specification until it cools down. They are normally used to control dimensional tolerance and increase production. Plastics are excellent insulators making them very hard to cool and even during cooling it tends to shrink and distort. In order to prevent these fluctuations profiles are pulled through calibrator. Omega Plastics Corporation [9].

Cooling unit is where the molten plastic is cooled and since plastics are good insulators it takes significant time to cool down. Haul off unit is used for extracting the profile at uniform speed through the water tub. They consist of two sets of electric motor driven tracks which are set on top of one another and has an adjustable gap between them from which the plastic passes. Cutting Unit cuts the profiles in desirable lengths once they pass the haul off.

2.5. Types of Extruders

In the extrusion process two types of plastic extruders, single screw and twin screw extruders are generally used.

Single screw extruder:



Fig 4: Simple Plastic single screw extruder. Wikimedia Foundation [5].

Single screw extruder is used whenever some pure form of polymer has to be extruded. It basically has three zones, feed zone, compression zone and the metering zone. In addition to that they may have additional zones to improve the quality of output. Mixing zones may be introduced which makes sure that the melt is uniform. In addition to that venting zone can also be made to combat hygroscopic plastics.

Twin Screw Extruder:

Twin screw extruder is used in compound production whenever two or more compound is to be mixed and extruded to form a pellet. Rigid PVC is produced using a twin screw extruder. While having two screws rotating in the heated barrel they provide a wider range of possibilities regarding the output rates, mixing efficiency and the heat generation. The output of a twin screw extruder can be thrice than that of single screw extruder of same diameter and speed. It is to be noted that the combinations of screw in a twin screw extruder need not be identical. Moreover, the screws can be conjugated or non- conjugated, a conjugated screw being the one with no gap between the screw flights and vice versa. This gives an opportunity for the material to move around in a non- conjugated arrangement of screw due to the presence of space between the screw flights. Similarly in a

counter rotating twin screw extruder the material is squeezed between the screws and in co-rotating system the material is passed from one screw to the other. Crawford [6].

2.6 Die Flows



Fig 5: A typical profile extrusion die. World Technology Machinery [10].

Dies are passes or blocks that are created to give the required shape to a melted polymer. Basically there are three zones in a die, the manifold, the approach channel and the die lips. The manifold circulates the polymer melt over an area which is similar to that of the finished product. The approach channel drives the polymer towards the final opening of the die. Finally, the die lips give the product its desired shape. It is to be noted that the gap between the die lips can be adjusted for a specific use. Grulke [11].

3. Method

Complying with the objectives of the thesis, a UPVC production line was sought after. Price, capacity and quality were the main parameters to be considered. Accordingly various manufacturers and suppliers were contacted as long as their production line seemed to be within the range. Soon a quotation that included the technical detail of the production line and the total price was obtained. Three of those had to be scrutinized as desired by the company. After the issue of the production line got done and dusted, a search for the raw material was conducted. Consequently, a quotation and the detail of the PVC raw material were obtained. Among those, two suppliers with moderate retail price and high quality had to be looked into, which was the prime interest of the company.

Then it came to financial aspects of production in which a general overview of the production was tried to calculate. Various aspects such as fixed capital investment, installation and working capital, annual operational cost, sales revenue and then the ROI were calculated. Result was manipulated and the conclusion was also drawn through these calculations. The calculated amount has been shown in various currencies, regarding the convenience and relevance.

3.1 UPVC Production Line Models

Various profile line can be used for the production of UPVC profiles. The real challenge of selecting the profile line for the company is that not only should it be optimally productive but also should be cost effective. Thus, the solution of bringing the consignment from an esteemed company where the quality comes with a high price tag becomes unlikely. So, as far as possible the Chinese market which has a big reputation in Nepal for both being cost friendly as well as for quality seems to be the right path to follow.

Considering those consideration, finally some models of the profiles production line considered for study which are as follows.

3.1.1 Qingdao Xinquan UPVC Profile Production Line SJSZ65 /132



Fig 6: UPVC profile production line. Qingdao Xinquan Plastic Machinery Co, Ltd. [12].

The model SJSZ65 /132, a product of Qingdao Xinquan Plastic Machinery Co. Ltd. looks very impressive and is expected to fulfill the requirement of Unique Profiles. It has a twin screw extruder of the model SJSZ65/132 which is equipped with automatic loader and is driven by main motor of 37 kW and a max capacity of 240kg/ h. The Electric controlling system consists of a set each of ABB frequency inverter, Schneider contactor and an Omron temperature controlling meter. The temperature controlling meter has the function of achieving the temperature adjustment precision. Thus helping to enhance the efficiency of production and also giving a gloss and stability to the profiles. Die head, mould would be designed as per the requirement. One set of Vacuum calibrating stand of the model SJP-5000 mm is also associated with the production line that consists of the vacuum pump of power 5.5 kW and the water pump of power 2.2 kW. Haul off block is of the model SLQ-240 having a haul off of 5.5 kW. There is also an ABB frequency inverter present in the unit that has the function of changing the single phase or three phase ac voltage into ac voltage of different frequency or even phases number. Cutting machine of the model SQG-240 comes with the production line which is automatic and has the cutting power of 2.2 kW. Tilter stacker SFZ-6000 is present in the line for stacking the profile that is cut by the

cutter. Further, the production line has the dimension of 24000 * 1200 * 1300mm and weighs 8T. The production capacity is of 160 -180 kg/h.

Block Diagram of the production

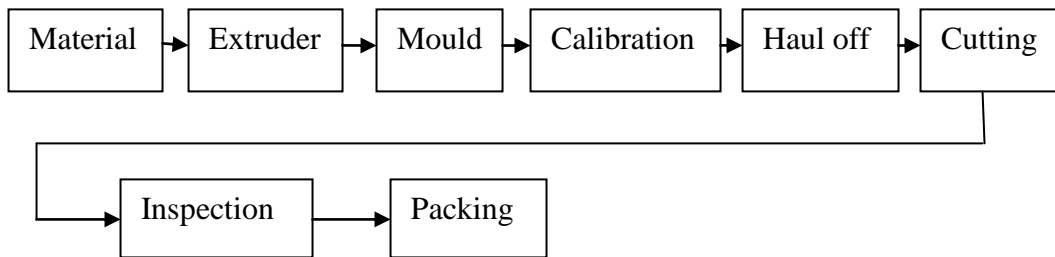


Fig 7: Block diagram of the production process

Twin screw extruder SJSZ65/132

Type:	SJSZ-65/132
Screw diameter:	65/ 132mm
Screw number:	2 pcs
Barrel heating	Cast aluminium heater
Barrel cooling:	3 zones, per zone 250 W
Base structure:	horizontal installment

The Electric system of the production line consists of Schneider contactors and ABB temperature controlling meter.

Die Moulding: The material is goes through forging (shaping metals with compression), surface quenching treatment (rapid cooling to obtain certain properties) and tempering (heat treatment to increase toughness). These processes make the material abrasion-resistance and corrosion-resistance, high intensity and high precision, making sure it has long service life.

SZD-2400 vacuum calibrating stand

Vacuum pump power:	5.5 kW
Water nozzle material:	copper
Stand surface material:	stainless steel
Calibrating stand length:	2400mm

SQY-240 haul-off

Hauling power:	5.5 kW
Clamping mode:	pneumatic clamping
Frequency control:	ABB 5.5 kW
Pneumatic clamping length:	2350mm

SQG-160 cutting machine

Cutting mode:	automatic length set cutting
Cutting power:	2.2 kW
Controlling mode:	pneumatic controlling

SFZ-6000 Tilt stacker

Length:	6000mm
Stand surface material	stainless steel

Discharging mode: pneumatic discharging, with products collecting system

3.1.1.1 Technical Guidelines, Quality Assurance and Terms from Qingdao Xinquan Plastic Machinery Co. Ltd.

The company has a policy that assures their customer in such a way that for the first 12 months, except the human made damages the faulty parts are replaced. Even after the 12 months period the sellers promises a long term preferential services.

Regarding the installation and the technical training, Qingdao Xinquan Co. Ltd provides the man power to train 3 person of the buying company, one being the manager himself. The technical training content would be all about the production procedures, technology, equipment structure and repair, electric principle, main operating points and method, incorrect operating prediction and solutions. All these processes will be conducted in the premises of the buyer. The man power that comes from Qingdao is responsible for installation and also makes sure that the production line produces the desired quality of profiles. The production line requires two containers of 40 feet and 20 feet to be carried away. Qingdao Xinquan Plastic Machinery Co. Ltd. Quotation [13].

3.1.1.2 Rough Financial Detail of the Production Line

The company has quoted that all the production line equipment would cost \$53,000 (FOB, Qingdao Port) which does not include the moulds. Since 34 different profiles are needed the total cost of the mould was quoted as \$147,000 - \$149,600. The range is offered with the option that in some mould there is the provision of using different number of cavities. Higher the number of cavities presents in the mould, higher the price of the mould.

Harmonized System code suggests that the production line has to be subjected to 5% tax and the die has 10% tax. The company has the policy that the man power sent for training and the installation has to be paid the round-trip tickets fee from Qingdao to the buyer's factory, and his food and lodging fees have to be taken care of. In addition to that a pocket

money of \$50 per day has to be given as well. It may take like 15 days for the man power to get the production line installed and give the necessary technical training. The whole process may sum up to approximately \$ 4, 000. The insurance and the fleet and the transportation in such big consignment normally cost 2% of the FOB, thus the total rockets up to \$204,000 - 206,652. Thus, adding the tax \$ 2,650 for the production line and \$14,700 -14, 960 for the die, this takes the total to \$22,1350 – 224,262 and adding the installation charge of \$4,000 makes the total \$225, 350 - 228, 262. So, we can conclude that the whole production can be set up with the budget of \$229, 000. Here is the whole calculation summed up in the excel sheet.

	A	B	C
1	Description of Expenditure	Cost in \$ (P1)	Cost in \$ (P2)
2	Production Line (FOB)	53000	53000
3	Die head, moulds (FOB)	147000	149600
4	Taxes 5 % for Production line	2650	2650
5	Taxes 10% for die and moulds	14700	14960
6	Installation & Technical	4000	4000
7	Insurance, Freight & Transportation (2% FOB) for PL	1060	1060
8	Insurance, Freight & Transportation (2% FOB) forD & M	2940	2992
9	Total Cost	225350	228262

Table 1: Rough Calculation of expenses for the production line

Regarding the terms of payment, the seller has such a policy that 30% has to be paid as down payment by T/T and the remaining 70% balance should be paid off before delivery by T/T again. The delivery period is of 55 working days from the date of receiving the total payment.

3.1.2. Qingdao Weier Profile Production Line SJSZ-65/132



Fig 8: UPVC Profile production machine. Qingdao Weier Machinery Co. Ltd. [14]

The next model of UPVC profile production line that was observed is of Qingdao Weier Plastic Machinery Co. Ltd and the model being SJSZ-65/132 twin conical screw extrusion. It is a very impressive as it provides a complete solution for producing the UPVC profiles. The part list of the production line includes twin conical screw extruder SJSZ 65/ 132 and a vacuum fixed stand. There is also haul-off unit present, cutting machine and the tilter table. The dimension of the production line is 24000* 1500* 2600 mm and weighs approximately 11T. The maximum production capacity is 200kg/h.

Detail technical Parameter of the production Line

The extruder SJSZ-65/132

Type: SJSZ-65/132
Screw diameter: 65/ 132 mm
Screw number: 2 pcs
Max. Capacity: 200kg/h

Vacuum fixed stand

Type: Vacuum Sop water and cooling system
Cooling type: water cooling
Drive: Manual
Steel stand: gear motor front back movement
Motor power: 1.1 kW.

Haul off

Type: Caterpillar
Haul off speed: 4m/ min
Motor: 3 kW
Max haul off: 120 mm
Pneumatic clamping length: 2200 mm

Automatic cutting machine

Type: Cross saw cutting
Cutting type: Pneumatic
Cutting power: 2.2 kW
Controlling mode: pneumatic controlling

Tilting Table

Type:	Inclined
Length:	6000mm
Stand surface material:	stainless steel

The Electric system of the production line consists of different branded products. The temperature controlling meter is a Japanese Omron product. The buttons and low voltage electric appliance are French TE product and the breakers and contactors are German Siemens. Finally, the inverter used is that of Fuji, Japanese.

Die Moulding: The general method of manufacturing the mould is quite the same. The material undergoes forging, surface quenching treatment and tempering making the material abrasion-resistance and corrosion-resistance. This leads to very long service life of the mould.

In addition to all these, the company provides Crushing machine which recycles the scrap produced during the production. Power grinder also comes with the set which turns the profiles into powder helping the recycling process.

3.1.2.1 Technical Guidelines, Quality Assurance and Terms from Qingdao Weier Machinery Co. Ltd.

Regarding the warranty the company will give full support for mending for the whole life of machine. In addition to that they will help with designing the layout of the factory. The company will send technical engineers to the factory to install and test the machines and train the workers as well. Last but not the least, they will also be giving the technology and formulation support.

The terms and condition of the payment to the company is that 30% has to be paid as down payment when the contract takes effect and the remaining 70% has to be paid before

delivery by T/T. They claim that 55 days is the total time of delivery. Qingdao Weier Machinery Co. Ltd. [15].

3.1.2.2 Rough Financial Detail of the Production Line

The production line has been quoted to be of \$54,500 (FOB, Qingdao Port) which does not include the moulds. Since 34 different profiles are needed the total cost of the mould was quoted as \$113,000. Harmonized System code suggests that the production line has to be subjected to 5% tax and the mould has 10% tax. The company has the policy that the man power sent for training and the installation has to be paid the round-trip tickets fee from Qingdao to the buyer's factory, and his food and lodging fees have to be taken care of. In addition to that a pocket money of \$40 per day has to be given as well. It may take like 20 days for the man power to get the production line installed and give the necessary technical training. The whole process may sum up to approximately \$4,000. The insurance and the fleet and the transportation in such big consignment normally cost 2% of the FOB. Thus we can conclude that the whole production can be set up with the budget of around \$188,900. Here is the whole calculation summed up in the excel sheet.

	A	B
1	Description of Expenditure	Cost in \$ (P1)
2	Production Line (FOB)	54500
3	Die and moulds (FOB)	113000
4	Taxes 5 % for Production line	2725
5	Taxes 10% for die and moulds	11300
6	Installation & Technical	4000
7	Insurance, Freight & Tansportation (2% FOB) for PL	1090
8	Insurance, Freight & Tansportation (2% FOB) forD & M	2260
9	Total Cost	188875
10		

Table 2.Rough estimation of the expenses

3.1.3 Xinxing SJSZ 65/132-YF240 Profile Production Line



Fig 9: UPVC Profile Production line. Shanghai Xinxing Twin Screw Machinery Co.Ltd.[16].

The next model we are concentrating is of Shanghai Xinxing twin screw machinery Co. Ltd. and the model being SJSZ65/132-YF240 UPVC profile production line. Basically, the production line consist of Conical twin screw extruder, vacuum forming table, traction cutting machine and the stirring up rack. The dimension of the production line is 43000* 1650* 2300mm. The maximum production capacity is 180kg/h.

65/132 Conical Twin Screw Extruder

Here the screw is designed specifically for PVC powder.

Screw Diameter: 65mm, 132mm.

Output: 180 kg /h.

Rotational Speed: 1-30 rpm.

Screw & Barrel Material: High quality alloy steel

Electric control Systems

Japan RKC temperature controller control system

Siemens AC contactors

Emergency stop devices and alarm systems

Alarm System Detection range

Over-current protection alarm

Loose Screw off protection

Vacuum Forming Table

Setting table length:	6000mm
Setting table width:	1000mm
Traction belt length	2200mm
Traction width:	240mm
Traction Speed:	0.5 to 4.6 m / min
Pneumatic working pressure:	0.5 to 0.7 MPa.

OYQG240 Saw Cutting Machine

Cutting motor power:	1.5 kW
Maximum cutting width:	240mm
Maximum cutting height:	130mm.
Sucking fan power:	1.5kW
Cutting process controlled:	Mitsubishi PLC
Cutting blade:	high quality alloy
Blade diameter:	400mm

Moreover, there is the use of cutting rubber block in the clamping device to provide accurate cutting precision.

Type 240 Stirring up Rack

Stirring up rack length: 6m (minimum cutting length of four meters, moving the range to be able to meet the precise requirement).

Stirring with PLC controlled, matched stroke control device.

Stirring up rack type: Removable, nylon panels attached to prevent the product surface scratches.

3.1.3.1 Technical Guidelines, Quality Assurance and Terms from Shanghai Xinxing Twin Screw Machinery Co. Ltd.

The payment procedure is almost the same as the other above mentioned companies. They have a provision that 30% of the payment has to be made as the contract takes in effect. Then the remaining 70% of the payment has to be made pre delivery. The delivery time they have stated is of 50 days.

There is a guarantee a three years on the production line. The supplier is responsible for testing and installing of the production line, and training the man power at the buyer's premises. It is to be noted that the buyer is liable to the all the cost that comes with the installations and the training. Shanghai Xinxing Twin Screw Machinery Co. Ltd. [17].

3.1.3.2 Rough Financial Detail of the Production Line

The production line has quoted USD \$39, 000 (FOB, Shanghai Port) which doesn't include the moulds. Since 34 different profiles are needed the total cost of the mould was quoted as \$ 127, 000. Harmonized System code suggests that the production line has to be subjected to 5% tax and the mould has 10% tax. The company has the policy that the man power sent

for training and the installation has to be paid the round-trip tickets fee from Shanghai to the buyer's factory, and his food and lodging fees have to be taken care of. In addition to that a pocket money of \$50 per day has to be given as well. It may take like 15 days for the technician to get the production line installed and give the necessary technical training. The whole process may sum up to approximately \$5, 000. The insurance and the fleet and the transportation in such big consignment normally cost 2% of the FOB. Thus we can conclude that the whole production can be set up with the budget of around \$189, 000. Here is the whole calculation summed up in the excel sheet.

	A	B
1	Description of Expenditure	Cost in \$ (P1)
2	Production Line (FOB)	39000
3	Die and moulds (FOB)	127000
4	Taxes 5 % for Production line	1950
5	Taxes 10% for die and moulds	12700
6	Installation & Technical	5000
7	Insurance, Freight & Tansportation (2% FOB) for PL	780
8	Insurance, Freight & Tansportation (2% FOB) forD & M	2540
9	Total Cost	188970

Table 3: Rough expenditure for the production line

3.2 Acquainting the Raw Material

After all these processes, the raw material which is the UPVC pellets needs to be imported. Various suppliers of the raw materials were pin pointed and finally two suppliers were taken into account. Basically, while considering those suppliers their claim, price and quality had to be kept in mind. The suppliers that were considered are as follows.

1. Efficient Growth Sdn Bhd.
52 Persiaran Wangsa Baiduri 2
47500 Subang Jaya Selangor, Malaysia
2. Linyi Yuan Plastic Industry Co.Ltd.
Linyi, Shandong, China.

3.2.1 Efficient Growth Sdn. Bhd. White PVC Granules

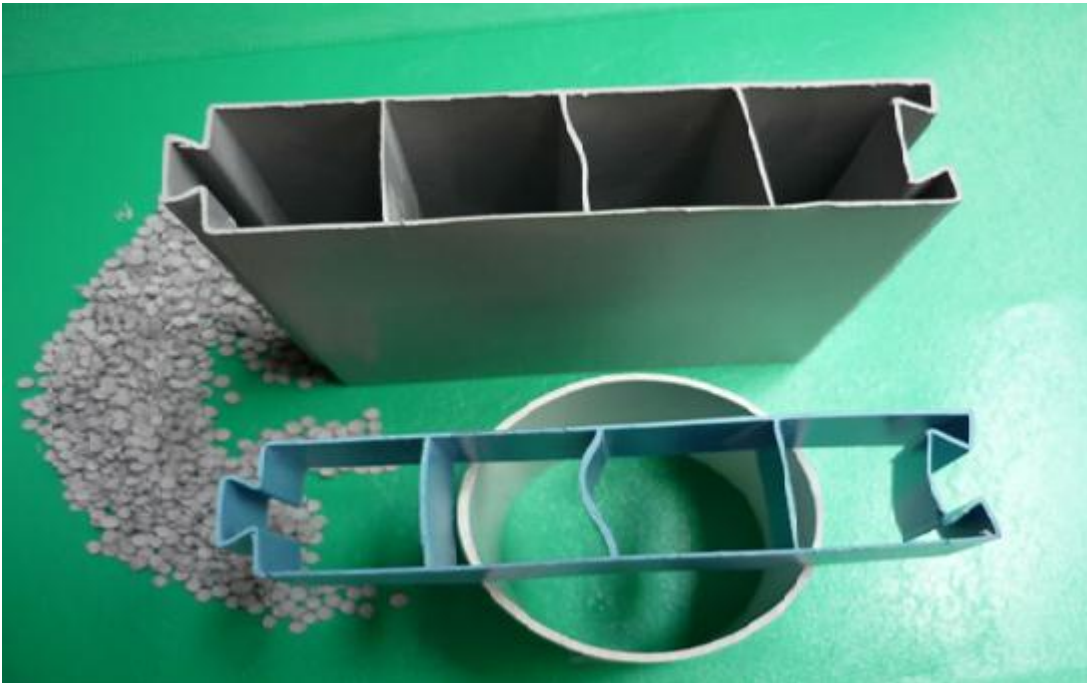


Fig 10: PVC granules and the profile. Efficient Growth Sdn Bhd[18].

UPVC pellets: Grey or white

Material: PVC compound granules

It is suitable for both twin and single screw extruders.

Minimum order: 22, 000kg

Rate: \$1, 200/MT (FOB Malaysia).

Packing: Varies from 25kg/ bag to 1000kg/ bag (bulk bag).

Payment method: L/C & TT

Delivery Time: Approximately 3 weeks.

It is specified that the PVC resin are treated with some additives and turned into UPVC and can be extruded directly without any complications. The additives and their description weren't disclosed stating that those details were company's secret.

It is to be noted that per kg price of the UPVC pellets thus imported would be as follows.

Per kg price of the pellets = USD \$1, 200/ 1000 + 5% tax + 5% transportation, insurance and freight.

$$= \$1.29 * 80 \text{ (USD } \$1 = \text{NRs.80)}$$

$$= \text{NRs. } 105.60$$

3.2.2 Linyi Hao Yuan Plastic Industry Co.Ltd. UPVC Powder

The above company supplies UPVC dry powder for the profiles production. The powder has all the required additives and is ready to be extruded. Basically the company claims to have passed the ISO testing assuring very high quality. Taking about the material it has following features.

Material: UPVC dry powder

Special Feature: Aging resistant

(This is the feature Unique profiles is very keen about. The profile which they have been using is of supreme quality but only thing that concerns them is the gloss of the profile. Although there hasn't been any complain as such but as the time passes, those profiles which have been used in rather hot areas of Nepal, where the day temperature exceeds 30°C for 8 months a year may show some aging. By the use of the above pellets, they hope to rectify such possible defect).

Certification: ISO 9001

It is suitable for both twin and single screw extruders.

Minimum order: 1000kg

Rate: \$1, 339.75 /MT (FOB Qingdao).

Packing: Varies from 25kg/ bag to 1000kg/ bag (bulk bag).

Payment method: L/C & TT or even money transfers.

Delivery Time: Approximately 3 weeks. Linyi Hao Yuan Plastic Industry Co. Ltd. [19].

It is to be noted that per kg price of the UPVC pellets thus imported would be as follows.

Per kg price of the powder = \$1, 339.75/ 1000 + 5% tax + 5% transportation, insurance and freight.

$$= \$1.48 * 80 \text{ (USD } \$1 = \text{NRs.80)}$$

$$= \text{NRs.118.4}$$

3.3 Financial Aspects of the Production

Finally, the company was keen to set the Qingdao Weier Profile Production Line SJSZ-65/132 as it also provides the crushing machine to recycle the scrap. Recycling the scrap is handy as there will be considerable amount of it produced. The raw material would be the dry UPVC powder that the Linyi HaoYuan Plastic Industry Co. Ltd supplies. Thus, a detail financial estimation was traced out which is as follows. Here all the calculations show the amount in Nepalese Rupees (NRs.).

3.3.1 Fixed Capital Investment

	A	B	C	D	E
1	FIXED CAPITAL INVESTMENT				
2					
3	Buildings				800000
4	Factory building enlargement			500000	
5	Office Building enrichment			100000	
6	Additional Electrifications			150000	
7	Misc. and Unforeseen			50000	
8					
9	Plant and Machineries				1500000
10					
11	Furniture and fixtures			100000	100000
12	Pre-operating Exp			500000	500000
13					
14	TOTAL FIXED CAPITAL				<u>16400000</u>

Table 4. Fixed Capital Investment

Fixed capital refers to the expenses that are carried out for physical assets of the company. It was assumed that the production would carry on over the same premises that is being used now but with some renovation. In our case, Rs.800, 000 is to be spent for renovation of the existing building. Plant and machineries would be costing Rs.15, 000,000. Similarly, furniture and fixtures would be of Rs.100, 000. Likewise, pre-operating cost is set to be Rs. 500, 000. Hence the total fixed capital investment sums up to Rs.16, 400, 000.

3.3.2. Installation and Working Capital

	A	B	C	D	E
1	Installation & Working Capital				
2	Description	for month	Cost (Rs)		Amount
3	Raw Materials	1	120 Per Kg		2160000
4	Direct Labor	1	60000		60000
5	Factory Overheads	1	20000		20000
6	Electricity Fix charge	1	12000		12000
7	Office overheads	1	30000		30000
8	Indirect labor	1	50000		50000
9	Land rent	1	20000		20000
10	Advertisement	1	100000		100000
11	insurance	1	164000		164000
12					
13	Total Working Capital				<u>2616000</u>
14					
15	Total Project cost	<u>19016000</u>			
16	Fixed Capital	16400000			
17	Working Capital	2616000			

Table 5. Installation and Working Capital

Installation and the working capital calculation scrutinize the expenditure that is to be put in during installation and the running charge of a month.

Raw material = Unit Cost of the raw material * Monthly Working days * daily production*
No of months.

Here, Monthly working days is assumed as 25 days a month (common practice in Nepal) and the daily production is assumed as 720 kg that is 45% of the total capacity, working 8 hours a day.

Various other working expenses can be seen from the table, thus the total installation and the working capital adds up to Rs.2, 616, 000. These rockets up the total project cost (fixed capital + working capital) to Rs.19, 016, 000. 70% of the total project cost is intended to be financial loans i.e. Rs.13, 311, 200. The financial loan is again categorized as long term loan which constitutes 60% of the total loan and the rest 40% is the short term loan. It is to be noted that the interest rate of the long term loan and the short term loan is 14% and 18% respectively. The discrepancy between the financial loan and the total project cost is the total equity of the company i.e. Rs.5, 704, 800.

3.3.3. Annual Operating Cost

Now the stage is set up for calculating the annual operating cost. Basically it is the sum of the fixed operating expenses and variable operating expenses.

3.3.3.1 Fixed Operating Cost

Fixed operating cost is summarized as following. While calculating the fixed operating expenses depreciation is one of the prime factors. In our case the building, plant and machinery and furniture and fixtures are categorized as depreciating elements. Although they are categorized in depreciating elements they tend to have different depreciating rates, the building 5%, the plant and machinery 10% and the furniture and fixtures 20%.

Generally, the insurance costs about 1% of the fixed capital. The maintenance is estimated to cost 5% of the total cost of the plant and the machineries. The interest on long term loan is 14% per annum. Regarding the indirect labor there will be two persons in the management and their annual salary including the perks will be Rs.720, 000. In the fixed operating cost there is a holding stock expense and here it is assumed that the holding of the raw material is for 2 months. The general purpose of holding the stock is to for balancing the stock.

Holding Cost = Production / day * Working days /month* No. of months* material cost/
unit

$$= 720 * 25 * 2 * 120$$

$$= \text{Rs.}4, 320, 000.$$

Similarly, the office overhead sums up to Rs.708, 000. Amortization which is the allocation of an amount particularly for loans and other forms of finance which reduces the principal amount is also added in the fixed operating cost. Generally, amortization is set as 10% of the pre operating cost which sums up to be Rs.50, 000. All these factors make the total annual fixed operating cost to be Rs.9, 630, 141. It is shown in the excel sheet as following.

1	ANNUAL OPERATING EXPENSES					
2	A. Fixed operating expenses					Amount
3	1. Depreciation		Amt			1560000
4	Building		800000	5%	40000	
5	Plant & Machinery		15,000,000	10%	1500000	
6	Furniture & fixture		100000	20%	20000	
7	2. Insurance					164000
8	Fixed Capital		16400000	1%	164000	
9	(exc. land & Pre-Opn. Cost)					
10	3. maintenance	(plant & M/C)	15,000,000	5%		750000
11	4. Interest on long term		7986720	14%		1118141
12	5. Land rent					240000
13	6. Indirect labour					720000
14		Designation			Per month	Per year
15		MGMT.		2	50000	600000
16						
17						<u>600000</u>
18		Add about	20%	Perks		120000
19						720000
20						
21	7. Holding Cost	2 months stock balance in terms of cost			4320000	4320000
22						
23	8 Office Overheads					708000
24		Stationery				30000
25		Advertisement				600000
26		Legal & Auditing				50000
27		Miscellaneous				28000
28	9. Amortization					50000
29		pre-expenses	500000	10%	50000	
30	Total Fixed Cost		<u>9630141</u>			

Table 6. Fixed Operating Expenses

3.3.3.2 The Variable Operating Expenses

Variable operating cost is the cost that is directly proportional to the activity during production. In our case raw material, labor, factory overheads and interest on short term loan are considered to be variable costs.

$$\begin{aligned}\text{Direct raw material} &= \text{working days/ year} * \text{production/ day} * \text{Unit cost of raw material} \\ &= 300 * 720 * 120 \\ &= \text{Rs. } 25,920,000.\end{aligned}$$

Five employees will be deployed with salary of Rs.12,000 each and a perk of 20% is also added. This takes the direct labor cost to Rs.864,000 per year. The Factory overhead that is set as facilities and miscellaneous are allocated to be Rs.60,000 and Rs.65,000 respectively, which adds up to Rs.125,000. Similarly the interest on the short term loan (Rs.5,324,480), which has the interest 18% pops out to be Rs.958,406.

Thus the total variable cost sums up to be Rs.27,867,406 which added with the fixed operating cost Rs.9,630,141 gives the total annual operating cost Rs.37,497,547 and is shown as below.

32	B. Variable Operating Expenses					Amount
33	Description					
34	<u>1. Direct Raw Materials</u>					25920000
35	particulars			cost		
36	upvc powder			120		
37	total			120		
38						
39						
40	<u>2. Direct labor</u>					864000
41		Designation	No.of emp.	Wages		per year
42		Factory staff	5	60000		720000
43						720000
44		Add about	20%	perks		144000
45						864000
46	Factory Overheads					125000
47		Facilities				60000
48		Miscellaneous				65000
49	Interest on Short term Loans		5324480	18%		958406
50						
51	Total variable cost		27867406			
52						
53	Total Annual Operating Expenses		<u>37497547</u>			
54		Fixed cost	9630141			
55		Vairable cost	27867406			

Table 7. Variable Operating Expenses

4. Results

4.1 Sales Revenue & the Return on Investment (ROI)

Here the total Sales revenue = Working day/ year * production/ day * Selling cost/unit

$$= 300 * 720 * 195$$

$$= \text{Rs.}42, 120, 000$$

There is an operating cost of Rs.37, 497, 547, thus the profit which is the difference between the sales revenue and operating cost is Rs.4, 622, 453.

The total interest on both the long term and the short term loan is Rs.2, 076, 547.

Similarly the total project cost is Rs 19, 016, 000.

Return on investment (ROI) is the term used for the profitable ratio which shows the return on the invested capital.

Now, calculating the ROI = (Profit + Interest) / Total Investment

$$= 35.23\%$$

These calculations are clearly shown as below.

	A	B	C	D	E
1		SALES REVENUE & ROI			
2					
3		Total Sales Revenue			42120000
4					
5		Total Profit per year			
6		Total Sales Revenue			42120000
7		Total operating expenses			37497547
8					4622453
9		Return on Investment			
10		R.O.I. =(Profit+Interests)/Total invest			
11					
12		Profit	Interests	Total investment	ROI
13		4622453	2076547	19016000	35.23

Table 8. Sales Revenue and ROI

4.2. Final Overview

Following snapshot show the final overview of the project that is to be established. It shows all the basic elements that were considered during the whole calculations. It is to be noted that the exchange rate of NRs.110 is assigned for €1.

	A	B	C
2	UPVC Profiles Pvt.ltd.		
3			
4	Location	Patan Industrial Estate	
5	Capacity	180	kg/ h
6	Working shift	single	
7	working Days/yr	300	
8	working days /month	25	
9	Production/day	720	kg
10	Per unit selling price	195	Rs.per kg
11		NRs.	Euro
12	Total Project Cost	19016000	172872.7273
13	Fixed Capital	16400000	149090.9091
14	Working Capital	2616000	23781.81818
15			
16	Total financial Loan	13311200	121010.9091
17	Long term loan	7986720	72606.54545
18	short term loan	5324480	48404.36364
19			
20	Total Equity	5704800	51861.81818
21			
22	Total sales Revenue	42120000	382909.0909
23	Profit per annum	4622453	42022.29818
24	Return on investment	35.23	
25	Interest per annum	2076547	18877.7
26	Manpower	7 persons	

Table 9. Financial Detail of the project

5. Conclusion and discussion

The goal of looking for a reliable production line was achieved by analyzing the technical description and the quotation of three different manufactures. It will provide the company with options to pick from. Regarding the raw material, two different suppliers were pointed out along with the prices and the description of their supply. These processes potentially address the objectives of producing the required UPVC profiles.

For the calculation, it was assumed that the production line of Qingdao Weier Machinery Co. Ltd will be used and the raw material of Linyi Yuan Plastic Co. Ltd will be preferred. The total cost of setting up the production line was noted to be USD \$188, 875 (Euro 137, 363.63). It was also noted that since thirty four different profiles are to be produced the price of the dies are rather high compared to the production line alone. The raw material will be costing USD \$ 1.48/kg (Euro 1.07).

The material cost per kg, which on importing is around Rs.240- 250 (Euro 2.18- 2.27) and varies according to the value of the American dollar. In the calculations, the selling unit material cost which the company produces is assigned to be Rs195. It can be seen that there is a discrepancy of at least Rs. 45 in the unit material cost while importing and when producing. Assigning that cost and getting a ROI (Return on Investment) of 35.23% simply highlights the scope of the production. Since the ROI here is 35.23%, the production of the UPVC profiles can be abruptly started. In this case, the ROI had to be more than 18% for the head start as the short term loan has an interest of 18%. Although for the calculation, particular raw material and the production line is chosen, production can be done with any of the above listed raw material or the production line according to the convenience and as long as the desired quality is obtained. As the ROI is high enough even some minor adjusted could be made to the parameters as well. Considering all the above factors, it can be concluded that the UPVC profiles production is very much feasible in Nepal.

It is also suggested that before starting the production, a sample of raw material is taken and a visit to the production line manufacturer is made to be absolutely sure about what the quality of the profiles would be.

6. References

1. Panchakanya Group, 2009. Company profile. Available: <http://www.panchakanya.org/company/index.php> [Accessed; 12.12.2011].
2. Foshan Yatai Plastics Profile Co. Ltd, 2010. UPVC Door and Window profile Catalogue.
3. Osswald T, Baur E, Brinkmann S, Oberbach K and Schmachtenberg E, 2006. *International Plastics Handbook*. Carl Hanser Verlag, Munich, 2006.
4. Unique Profiles Pvt. Ltd, 2010. UPVC profiles Catalogue.
5. Wiki media Foundation, Inc, 2011. Plastics Extrusion. Available: http://en.wikipedia.org/wiki/Plastics_extrusion [Accessed; 9.01. 2012].
6. Crawford R J, 1998. *Plastics engineering*, 3rd edition. Butterworth- Heinemann.
7. Vaddiraju S, 2003. Extrusion Simulation and optimization of profile die design. North Illinois Center for Accelerator and Detector Development, Illinois 2003.
8. A.L.Griff, 2007. Gear Pumps in Extrusion. SpecialChem-Omnexus. Available: <http://www.omnexus.com/resources/articles/article.aspx?id=15477> [Accessed; 16.03.2012].
9. Omega Plastics Corporation, 2004. Profile design. Available: <http://www.omegaplastics.com/profile%20design.htm> [Accessed: 9.02.2012].
10. World Technology Machinery Jiangsu Co. Ltd, 2008. Large section Profile extrusion die. Available: <http://www.china-extrusion-press.com/auxiliary-equipment/extrusion-mould.htm> [Accessed; 03.05.2012]
11. Grulke A E, 1994. *Polymer processing engineering*. Prentice-Hall Inc.

12. Qingdao Xinquan Plastic Machinery Co. Ltd. 2008. PVC Profile Production Line. Available: <http://www.qdxinquan.com/Html/200911/Product240.html> [Accessed: 20.12.2011].
13. Qingdao Xinquan Plastic Machinery Co. Ltd, 2008. Quotation and product detail of UPVC Profile Production Line SJSZ65 /132.
14. Qingdao Weier Machinery Co. Ltd, 2006. PVC Window Profile Production Machine. Available: <http://www.weiermachine.com/Html/200909/Product167.html> [Accessed: 15.01. 2012)
15. Qingdao Weier Machinery Co. Ltd, 2006. Quotation and the product detail of Qingdao Weier Profile Production Line SJSZ 65/132
16. Shanghai Xinxing Twin Screw Machinery Co.Ltd, 2010. Profile Bar Production line. Available: http://en.xxscREW.com/products_detail/&productId=f030e628-0084-42e2-ada4-73dcdcf4029&comp_stats=comp-FrontProducts_list01-1271227897396.html [Accessed: 4.3.2012].
17. Shanghai Xinxing Twin Screw Machinery Co.Ltd, 2010. Quotation and the product detail of Shanghai Xinxing SJSZ65/132 YF240 UPVC profile production line.
18. Efficient Growth SDN Bhd, 2010, White PVC granules for profile. Available : http://egrowth.trustpass.alibaba.com/product/112616917-101778270/White_PVC_Granules_for_profile.html?tracelog=ggsotherproduct1 [Accessed: 22.02.2012].
19. Linyi Hao Yuan Plastic Industry, 2004. PVC particles for Profiles. Available: http://www.sdhaoyuan.cn/product/422671420209422915/rigid_pvc_particles_for_pvc_profile.html [Accessed: 28.02.2012].

7. Appendices

1. Regarding the quality of the profiles that would be extruded, the gross can be improved by adding PE wax to the PVC pellets, which may constitute from 0.2% to 2%.
2. It is also to be noted that mostly powder PVC are to be used with twin screw extruders for bigger profiles and long production periods.
3. Titanium dioxide is used in profile extrusion for a better quality as it helps in weather resistance.
4. UV stabilizers can also be used to make the UPVC profiles more weather proof.
5. In the thesis, it has been assigned that USD \$1 = NRs.80 and €1= NRs.110. It is likely that the exchange rates can vary daily so proper adjustment has to be made.