

## Khewra Salt Mines Project

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## **ACKNOWLEDGEMENT**

First and foremost, we would like to thank Allah Almighty who has given us an opportunity to not only work on this project, but also to complete MSPM program. We would also like to thank our parents, whose support has always been with us throughout the journey.

For this particular project, we would like to thank Mr. Shahzad Ahmed (Cluster Head MSPM), who has arranged such an information and knowledge boosting study trip to Khwera Salt Mines project. He has also mentored us in the learning of Primavera P6 software and helped us grow both personally and professionally. He is a great mentor and we have enjoyed working and learning with him.

## **PREFACE**

As per the requirement of degree MS Project Management at Bahria University (Lahore Campus), a number of tools and techniques have been studied and brought into practical implementation through working on case studies and real-time projects. This comprehensive report is based on the working on Primavera P6 software using the data obtained from site visit at Khewra Salt Mines.

Primavera P6 is an Enterprise Project Portfolio Management software, owned by Oracle Corporation, which is used to prioritize, plan, manage and control projects, programs and portfolios. This report comprises of three sections. In the very first section, a detailed introduction and background of Khewra Salt Mines is discussed. The benefits that Pakistan enjoys by the production and export of salt and tourist-attraction are also discussed. The next section elaborates Bahria University's study trip to Khewra Salt Mines. In the third and last section, the Khewra Salt Mines Project is run on Primavera P6, based on the data and information obtained by the study tour. The major activities involved in salt extraction including salt exploration, drilling mines and salt extraction, salt crushing, transportation, and warehousing and marketing and selling are all discussed one by one. The budgeted total costs for the planned project are also obtained along with gantt chart, resource and activity histograms and s curve.

The reports generated by the software are graphically displayed in the third section. We have also come up with a total budgeted cost for the project.

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# **1 Background of Khewra Salt Mines**

## **1.1 Introduction**

Khewra Salt mine is one of the greatest pride of Pakistan. Khewra Salt Mines are the world's second largest salt mines, the first being in Canada. The Khewra Salt Mines cover an area of 110 sq. kilometers. The salt mines are 228 meters deep. The Khewra Salt Mines area a great attraction for tourists. The salt mines attract nearly 250,000 tourists each year. The salt mines are not only an attraction to the locals, but foreigners, bloggers and vloggers are also attracted to this place. The mines are famous for producing pink Khewra Salt. The tourists take with them illuminating salt lamps and a vast knowledge of salt mines.

Huge salt reserves are present at Khewra, which not only serve the domestic needs, but a huge amount of salt is also exported which is used by people worldwide. It is reported, that annually about 300,000 tons of salt is mined from the Khewra Mines and still a lot of reserves of salt are unexplored.

## **1.2 Location of Khewra Salt Mines**

The salt mines are located in Khewra, north of Pind Dadan Khan, a subdivision of Jhelum District, Punjab, Pakistan. The mines are located in the Salt Range, at the outer range of Himalaya Mountains. The mines are located in the North of Punjab. The mines are about 245 km from Lahore, and 180 km from Islamabad. For tourists, the fastest and easiest way to commute to Khewra Salt Mines is through Motorway M2. The approximate travel time by car from Islamabad to salt mines is 2 hours 20 minutes and from Lahore to the mines is 3 hours and 20 minutes.



*Figure 1 Map showing location of Khewra Salt Mines with respect to Lahore and Islamabad (taken by Google Maps)*

### 1.3 Background and History of Khewra Salt Mines

In 326 B.C., during the battle between Alexander the Great and Raja Porus, the armies of Alexander settled for rest at the right bank of River Jhelum near Pind Dadan Khan Village. The salt mines were not discovered by Alexander or his soldiers, but by his horses. The horses started licking the ground at the place and the soldiers noticed this. Then one of the soldiers licked the ground himself to find out what was going on and this led to the discovery of the salt mines.

The salt mines were explored by Alexander's horses and in the Mughal era, proper salt mining had begun and the salt was also being exported to far off places by that time. When the Mughal era came to downfall, the salt mines were taken over by the Sikhs. The salt from the salt mines, by that time was being used both for consumption and also for exporting and earning revenue.

After Sikhs, came the British rule. During this time, major importance was given to the salt mines development. A lot of technical advancements came during the British period. They found out that the tunnels were not built properly which led to loss of lives of many labor who worked in the tunnels for extraction of salt. Also another issue was noted that the ways for extraction and mining of salt from the salt mines were very old fashioned and inefficient. There was no proper ventilation system and no proper place to store the extracted salt safely. Also, the area was very inaccessible at that time. There were either no roads, or the quality of roads was so poor that it took long hours to reach the salt mines.

To address these issues, the British government did many steps. They:

- Constructed new roads
- Levelled and asphalted existing roads
- Provided water supply
- Provided new warehouses for storage of extracted salt
- Provided water supply system
- Improved structure of tunnels
- Improved entrances of tunnels
- Introduced a better and safe system for excavation and extraction of salt
- Provided a proper ventilation system inside the tunnels for labors
- Prohibited smuggling of salt
- Increased wages of labors working inside the tunnels
- Ensured a proper safety system for the labor

These steps taken definitely improved the overall salt extraction process. It helped workers at sight as well and the mineral was given importance and it also increased revenue.



After the independence of Pakistan, great importance was given to the development of the salt mines. The natural resource was fully utilized and its benefits were enhanced as well by giving special importance to it. The salt mine structure was made more strong and it was opened for tourists as well. A number of mesmerizing models and other wonders were built to attract the tourists. A special clinic to treat asthma patients was also inaugurated. The Khewra Salt Mines are a great attraction to the local people and also to the foreigners. The revenue gained by exporting salt has also helped Pakistan in its GDP. [1]

## **1.4 The Salt Mine Structure**

The salt mine is saved from collapsing by using its own salt. The reason only fifty percent of the salt is mined is because it saves the mine itself from falling down. Half the salt discovered serves as supporting columns to save the mine from collapsing. [2]

## **1.5 Inside the Khewra Salt Mines**

### **1.5.1 Electric Tram**

The mines have an electric tram. This tram system was installed back in 1936. The tram was previously used to transport the salt but now it is used to serve the tourists. The tourists can travel in the tram for about 1 km inside the mines. The reason an electric tram is installed here is because the vibrations on the ground and underground are minimal in case of electric trams and trains. This tram has least vibrations and hence almost no disturbance to the underground strata. The electric engine of the tram pulls almost 12 trollies. Which means it provides sufficient seating capacity to cater a large number of tourists visiting the mines.

### **1.5.2 Sheesh Mahal**

Inside the mines is also Sheesh Mahal. This Mahal depicts the beauty of different colors of salt. The salt here is present in different colors and different layers naturally. This area is decorated with lights as well which makes it a very attractive point for the tourists. Two hanging bridges of salt are present here. Here, a natural portrait of Allama Muhammad Iqbal is also made on a plain wall of Rock Salt.

### 1.5.3 Angoori Bagh

The word bagh, depicting garden, Angoori Bagh is like a garden as beautiful salt cones hang down from the ceiling of the mines. These hanging cones look like a bunch of grapes. The scientific name of these hanging cones is Stalactites. The drops that come down from the cones or Stalactites are like tears of salt and in Urdu, called as Ashak-e-Namak. The small mountain that is formed by the accumulation of this dropping salt is called Sigh of Salt, in Urdu called as Aah-e-Namak. The area between the Ashak-e-Namak dripping cones and the small mountain, Aah-e-Namak is called Firaq-e-Namak.



*Figure 2 Angoori Bagh at Khewra Salt Mines (Source: <https://touristresortkhewra.blogspot.com/> [3])*

### 1.5.4 BadShahi Mosque

A mosque is also built in the mines and it is named BadShahi Mosque. It is the only underground mosque which is built with bricks of salt of various colors. This mosque was built about 50 years ago and has a capacity of about 25 people to pray here at a time.

The walls of this mosque are very mesmerizing and unique in the sense that they are made of salt brick of different colors and some of the bricks are translucent because of

the properties of that particular salt. Taking advantage of the translucency, lights are installed in these walls to enhance the beauty. Overall, these walls give a very shining effect. It is a very eye-catching sight for the tourists.



*Figure 3 Shahi Mosque inside Khewra Salt Mine (Source:www.dawn.com)*

### **1.5.5 Model of Minar-e-Pakistan**

Inside the mines, is made a model of Minar-e-Pakistan. This model is made using salts of different types and colors. For adding beauty to it, the model is lighted with bulbs to make it more glowing and attract more tourists.

### **1.5.6 Crystal Valley**

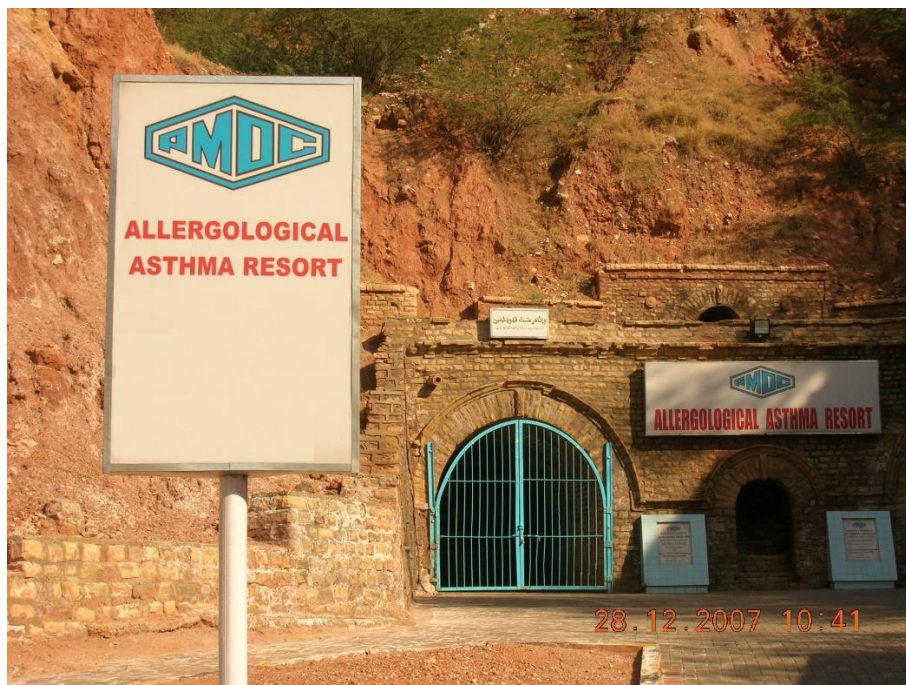
Crystal valley is another wonder of the salt mines. This area remained a pond of water for more than 20 years. This valley came into formation by the Crystallization of brine (salt solution). This is a very eye-catching area as it looks like pearls fixed on a sheet. There are two types of crystals present here. Cubic crystals which have resulted from sodium chloride salt, and needle crystals which are formed by gypsum. More fine crystals, such as diamond crystals can also be obtained from these already existing crystals by the pumping of water.

### 1.5.7 Allergological Asthma Resort

It has been proven scientifically that micro climatic atmosphere, like the one present in the salt mines, is very beneficial for people suffering from allergic asthma. The patients of allergic asthma can be cured by the salt mines air, which has huge properties of curing asthma patients.

Previously, only two asthma clinics in salt mines were functioning. One was present in the salt mines of Poland, and the other in Ukrainian salt mines. MD of PMDC looked into the matter and came up with the idea of starting a separate asthma clinic in Pakistan, taking advantage of Khewra Salt Mines. Help was taken from Polish Ambassador to make an asthma clinic in Pakistan, on the same grounds as the one already functioning in Poland.

In 2007, an Asthma Clinic at Khewra Salt Mines was inaugurated. This clinic is one-of-its-kind in Pakistan. This clinic helps cure asthma patients by taking benefit from the properties of salts.



*Figure 4 Allergological Asthma Resort at Khewra (Source:www.pmdc.gov.pk)*

## **1.6 Khewra Tourist Resort**

Khewra Salt Mines are a great attraction for the tourists. It is recorded that the salt mines attract around 250,000 tourists annually, including all age groups. Visitors are very fascinated by this place. Salt cones everywhere and the items made of salt like lamps and other souvenirs attract people a lot. Not only local people come to visit this mesmerizing wonder, but it is also a great attraction for foreigners as well.

Another added benefit is that the roads to Khewra are now very well-developed, making the salt mines easily accessible. The salt mines are accessible by Motorway M2 and thus the travel time to Khewra Salt Mines is now significantly reduced from both Lahore and Islamabad.

A number of facilities to tourists are also provided at the salt mines which include:

- Refreshment area
- Walkway
- Souvenir shop
- Electric tram
- Reception/briefing hall

## **1.7 Uses of Salt**

The salt is not only used for human consumption. Other than the human consumption, there are multiple other uses of salt as well. Less than 5% of the total salt production is used for eating purposes. The salt is also used for food seasoning, for the manufacturing of different chemicals for making glass and other airplane parts, for preparing different soap brands, growing of crops and for killing weeds.

The salt is also a great antiseptic. It is used to soothe any insect bites. The salt is also a great preservative. It is also used for color fixing in the dyeing of clothes. Salt is also used around the world to treat asthma patients because of the curing properties of this mineral. Despite being extremely useful, salt is not given the importance it deserves due to its high availability.

## **1.8 Benefits for Locals**

Although the whole nation feels pride in having the world's second largest salt mines in Pakistan, the salt mines offer pride to the locals as well. The locals are happy that people from around the world come to visit this wonder. The locals treat the tourists with respect and treat them very nice. The locals nearby having gift shops, transporters, owners of restaurants, shopkeepers, people who sell salt-made souvenirs, all get benefit from the salt mines financially as well. Other than that, around 1000 workers are involved in the extraction of salt from Khewra Salt Mines. [4]

Due to peace of the country, the number of international tourists has also increased in the recent years.

## **1.9 Production of Salt**

The Khewra Salt Mines are a huge reserve of salt. The recorded salt reserves in Pakistan are about 10 billion ton in three mines. The salt reserves in the Khewra Salt Mine alone are more than 6.687 billion tons. The other two mines are located in Warcha and Kalabagh.

Other than the high production rate at Khewra Salt Mines, the salt produced from these mines is of great quality and is very fine. It is stated as one of the best quality salts of the world. Salt from Khewra is being mined from a long time but the reserves seem like never-ending. Currently, the Khewra Salt Mine is under Pakistan Mineral Development Corporation (PMDC).

It is stated that despite huge quantity of salt is being mined from a large number of years, but still a lot of reserves are undiscovered. Each year, about 300,000 tons is mined from the Khewra Mines.

According to a survey, there are still enough salt reserves in Khewra which can be used for coming 400 years. [5] Till 1850, 0.5 million tons of salt had been mined and the production of salt obtained till March 1923 was 4.9 million tons. [6]

The salt extracted from Khewra mines is very pure and refined. It requires minimal processing and refining. The Halite content in the salt extracted is very high, making the salt very pure and edible.

Pure, cleaned and refined salt is used for eating purposes. The salt mines supply its salt to a number of industries as well. It means that the salt mined is also used for other needs. The unrefined form of salt or the salt that is not good enough for eating, is used by industries and it also minimizes waste. PMDC supplies unrefined salt to **Imperial Chemical Industries (ICI)**. ICI has its Soda Ash Plant which utilizes this salt.

Other than ICI, the salt from Khewra is also supplied to other chemical industries as well which include:

- Ittehad Chemicals Ltd.
- Sitara Chemicals Industries Ltd.
- Olympia Chemicals
- and other small industries

Ice factories and tanneries also receive salt from Khewra. The salt is also used to make decoration pieces like lamps, vases, ashtrays, candle stands, pen holders, etc.

Pakistan does not only meet its salt requirements by the salt mined from the Khewra Mines, but it also exports a large amount worldwide. India also imports its salt from Pakistan. In this way Pakistan generates a large revenue by exporting its salt. India imports 10 to 18 thousand tons of salt from Pakistan annually. Pakistan does get a huge financial benefit by this.

### **1.10 PMDC (Pakistan Mineral Development Corporation)**

PMDC is an autonomous corporation. PMDC is under the control of Ministry of Petroleum and Natural Resources, Govt. of Pakistan. PMDC was established in 1974.

The main aim of PMDC is to best utilize the mineral resources of Pakistan and enhance them as far as possible. This is to get the most out of the present god-gifted resources.

PMDC has an objective to explore the natural resources throughout Pakistan and help to best utilize the resources. PMDC works in preparing techno-economic feasibility reports, exploring new mineral resources, evaluation of mineral deposits, mining and marketing.

PMDC currently is operating:

- 4 coal mines
- 4 salt mines/quarries
- 1 silica sand quarry

PMDC at present shares 17% of coal and 58% of total salt production of Pakistan. [7]

The organogram of PMDC is shown on the next page. The organization is headed by the Board of Directors and Managing Director. Four Project Managers work under General Manager Salt which include:

- PM Khewra Salt Mines
- PM Warcha Salt Mines
- PM Kalabagh Salt Mines
- PM Jatta/B. Khel Salt Quarries



1.10.1 PMDC Organogram

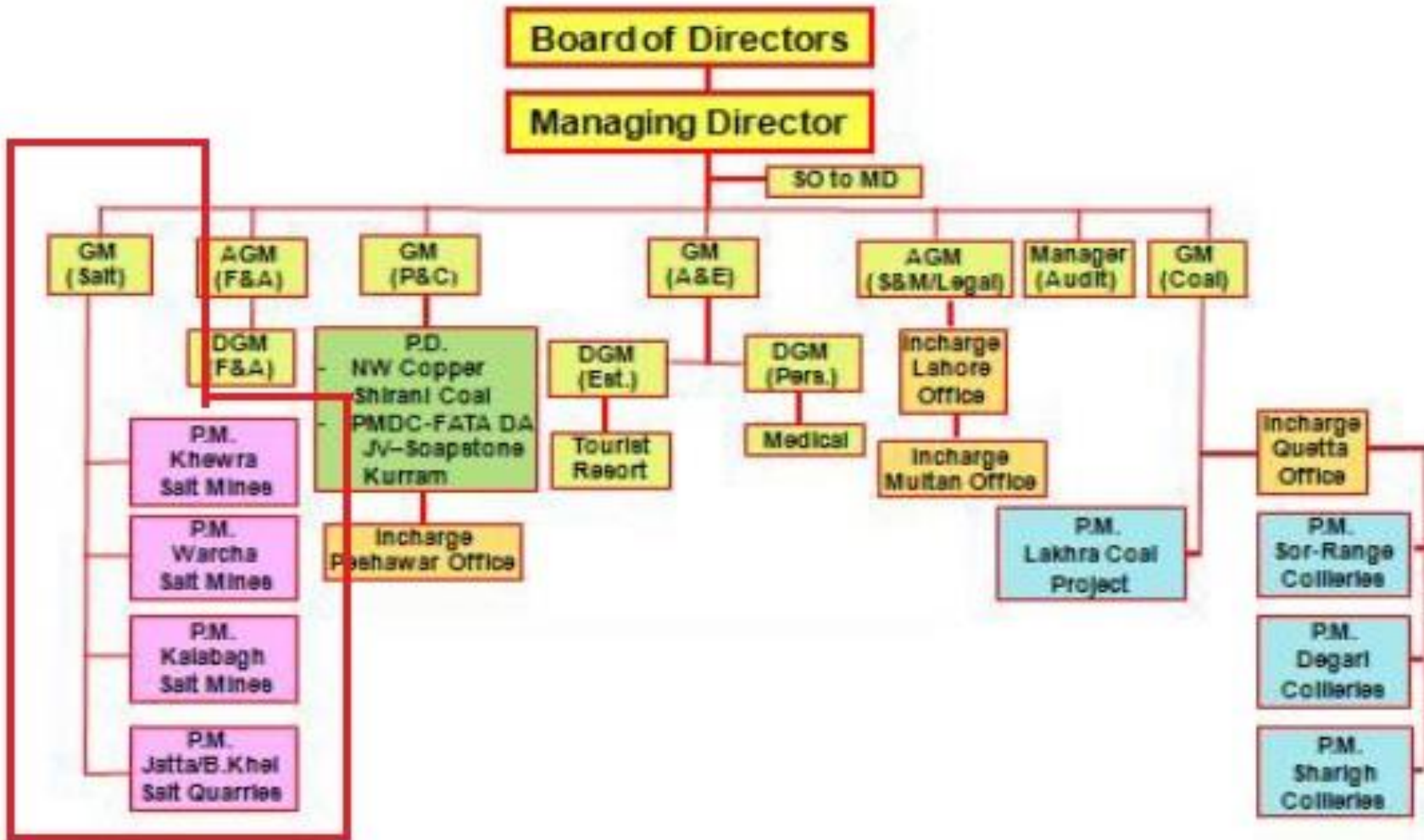


Figure 5 PMDC Organogram (Source: [www.pmdc.gov.pk](http://www.pmdc.gov.pk))

## 1.11 Rock Salt Composition

The strata of the rocks of Khewra consist of Halite. Halite is a form of salt, usually known as an unrefined form of sodium chloride (NaCl). Halite makes isometric crystals. The color of Halite is normally white or is colorless.

Depending on the addition of impurities, Halite crystals can be any of the following colors:

- Light blue
- Purple
- Pink
- Red
- Orange
- Yellow
- Gray

The color variation can also be a result of isotropic or structural abnormalities.

Halite is formed by the drying of sedimentary minerals present in lakes or seas through evaporation. The salt beds can be hundreds of meters thick and they spread very large areas. These salt beds are the dried form of sea beds many thousand years ago. The Khewra Salt Mines are a massive deposit of Halite in the North of Punjab. Other than Halite, gypsum and sulfur are also deposited in the region.

## 1.12 Salt Export

Pakistan does not only meet its salt needs, but it also exports its salt. After meeting the domestic needs, there is still enough salt left to export. The salt for export is of both the qualities:

- ✓ Edible salt
- ✓ Commercial/Industrial salt

The countries who import salt from Pakistan include, but not limited to:

- India
- Japan
- Afghanistan
- Iran
- Malaysia

The salt exported by Pakistan is mostly obtained from Khewra Salt Mines. Pakistan earns foreign exchange by the export of salt. Thus Khewra Salt Mines help Pakistan earn foreign exchange as well. This not only happens by the export of salt, but the Khewra Mines also attract tourists from around the world, which also helps Pakistan economically.

## **2 Review on Bahria University Trip to Khewra Salt Mines**

### **2.1 Introduction**

Bahria University Lahore Campus arranged a study tour to Khewra Salt Mines on 7 December, 2019. The main purpose of this tour was the site visiting at Khewra and making the students aware of this mesmerizing wonder our country has. The students visited the mines and gained a lot of information by this. One of the biggest natural resources of Pakistan is found here. The salt mine was full of beautiful and amazing sights.

The salt mine has its floor, walls and roof, all made of salt. The students learned how salt from these mines is extracted and transported throughout the country. Not only does this salt mine serve Pakistan, but a large amount of salt is also exported to earn foreign exchange.

The complete salt mining process was studied. The students got a chance to observe the whole process real-time. the on-site experience is far better than the book knowledge so this trip helped a lot in the learning of students.

The complete process of mining starting from salt exploration to final supply of salt to customers was observed. The detail about the extraction of salt from salt mines was looked into with great detail. It was a source of immense knowledge and new learnings for the students.

### **2.2 Mining of Salt Process**

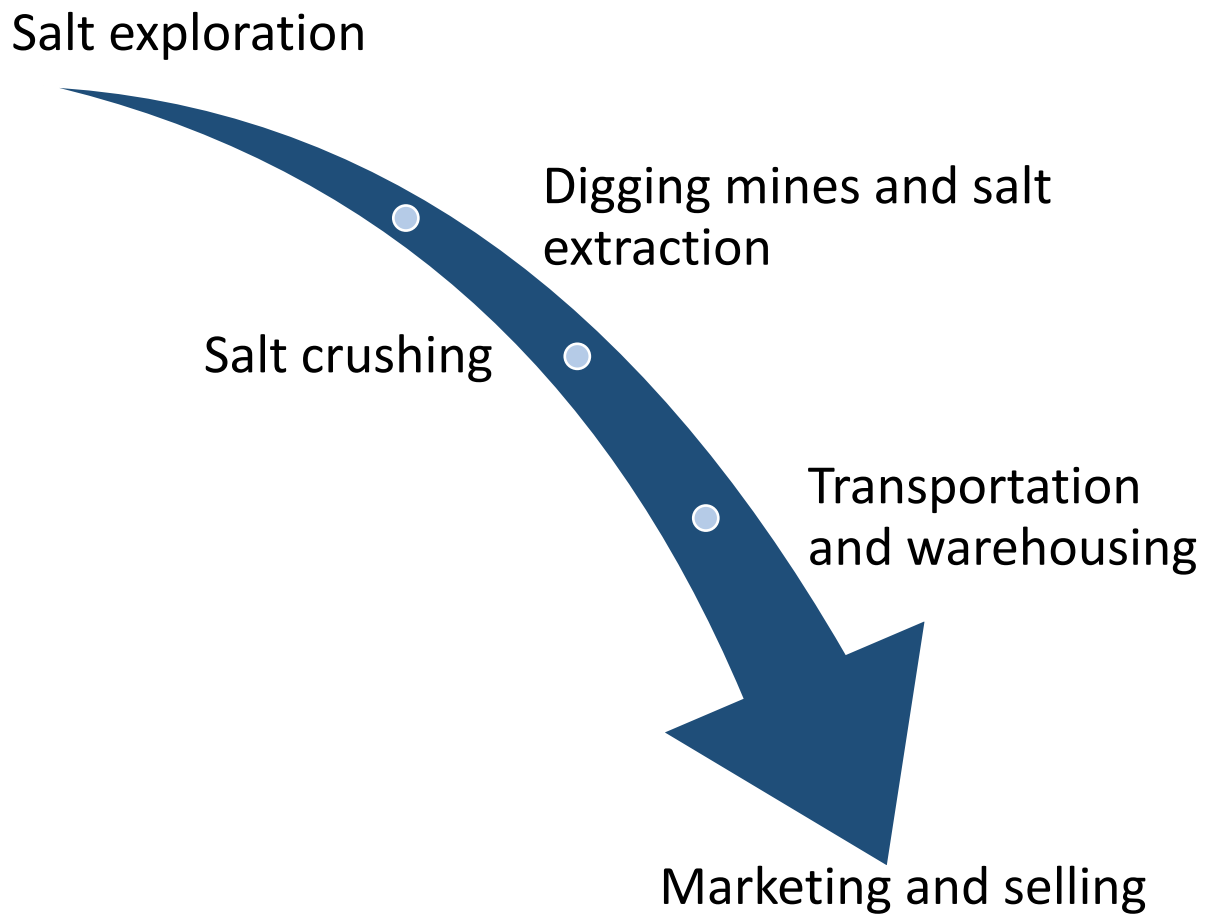
Mining/extraction of salt from salt mines is a whole system that involves a number of systematic processes. Starting from the exploration/discovery of salt site to excavating the tunnel and then extracting salt from mines are the major steps to be performed.

The students learned about the mining process at Khewra in detail. The salt mining involves five major steps as under:

- I. Salt exploration
- II. Digging mines and salt extraction
- III. Salt crushing

- IV. Transportation and warehousing
- V. Marketing and selling

These five major steps also involve a number of sub-processes within as well.



*Figure 6 Major steps involved in salt mining*

## **2.3 Activities performed at Khewra**

At Khewra Salt Mines Trip, the students learned that the following activities are performed at the Khewra Salt Mines project starting from salt exploration to transporting the finished product.

### **I. Salt exploration**

Satellite imaging for study of rock strata

Study of rock strata at Khewra site

Development of 3D model of rock deposits

Sampling and drilling of rock

Estimates and calculation of salt content in sample

Preparation of pre-feasibility report

Feasibility report preparation

Feasibility report verification

Feasibility report approval

Selecting a site to start from first

### **II. Digging Mines and salt extraction**

Testing a small sample from site

Salt mine digging 0.5km using Tunnel Boring Machine (TBM)

Digging the total length of 10km using TBM

Cleaning the dug mine for labors work

Installing ventilation system in mine

Installing first aid medical facility in mine

Training of workers and labors on safety

Installation of lights in mine

Selecting a site for blasting  
Analyzing soil/rock strength at site  
Selecting type of dynamite to be used  
Dynamite installation at site  
Blasting  
Drilling of rock left behind after blasting  
Collecting the extracted rock pieces  
Cleaning of rock pieces  
Loading extracted salt on loader  
Transportation of extracted salt to crushing area

### **III. Salt Crushing**

Extracted salt receiving at crushing area  
Segregation of large and small salt pieces  
Crushing of large pieces of rock salt  
Crushing of small pieces of rock salt  
Collection of finely ground salt  
Analysis of edible and non-edible salt  
Quality check of salt  
Segregation of edible and non-edible salt  
Packing of edible salt  
Packing of non-edible salt/waste for commercial use

### **IV. Transportation and warehousing**

Transportation of edible salt in small packs to warehouse

Transportation of commercial salt in large bags to warehouse

Receiving of salt at inventory

Making record of salt received at inventory

Storing edible salt

Storing commercial salt

## **V. Marketing and selling**

Order for salt received

Transporting edible salt to retailers

Transporting commercial salt to industries

Keeping record of edible salt dispatched

Keeping record of commercial salt dispatched

Recording overall salt demand data

Showing salt quality reports and salt demand data to PM

Decision for new site extraction or continuing same site

Recording lessons learnt

### **2.4 Segregation of edible and commercial salt**

After the salt has been extracted and crushed, a test is performed on the extracted salt to check if the salt is edible one or will it be used for commercial/industrial purposes.

#### **2.4.1 Edible Salt**

The extracted salt is categorized as edible salt if the sodium chloride (NaCl) content in the extracted rock salts is equal to or more than 97%. That salt is free from impurities i.e., it is usually colorless or very near to colorless.



### **2.4.2 Commercial/Industrial Salt**

The salt that does not fit the edible salt requirements (sodium chloride in the extracted salt is less than 97%) is used in the industries for commercial purposes. Such a salt is usually having a light pink or purple shade in it. It is generally not colorless.

## **3 Primavera P6 and Khewra Salt Mines Project**

### **3.1 Introduction**

Primavera P6 software is not a software that needs an introduction now. Because of its vast use in the construction, planning, IT and many other industries, the benefits of this software are not hidden. Primavera P6 is mainly a planning tool. Any project related to any industry, big or small, involving minimum costs to engaging huge budgets, all can be planned and scheduled using this tool.

Primavera is also used to compare the actual and planned schedules, costs and resource usage. It is also used in making Gantt chart for activity scheduling. For showing the planned data to senior management, usually a Gantt chart is used. The software also generates histograms and an S curve for the cumulative activity and resource usage. Other than that there are multiple other uses of the software as well.

The Khewra Salt Mines project was run on Primavera P6 software for scheduling the project and checking if the planned and actual costs meet or not. The activities discussed under Heading 2.3 were scheduled using the primavera software. Planned start and finish dates were also incorporated in the software along with the resources and the budgeted costs associated with them.

The project details of Khewra Salt Mines project were incorporated in primavera and scheduling was done. The next sections will one by one define what inputs were put in the software and what outputs were generated by Primavera.

But prior to this, an overview of the project is shown by the table below.

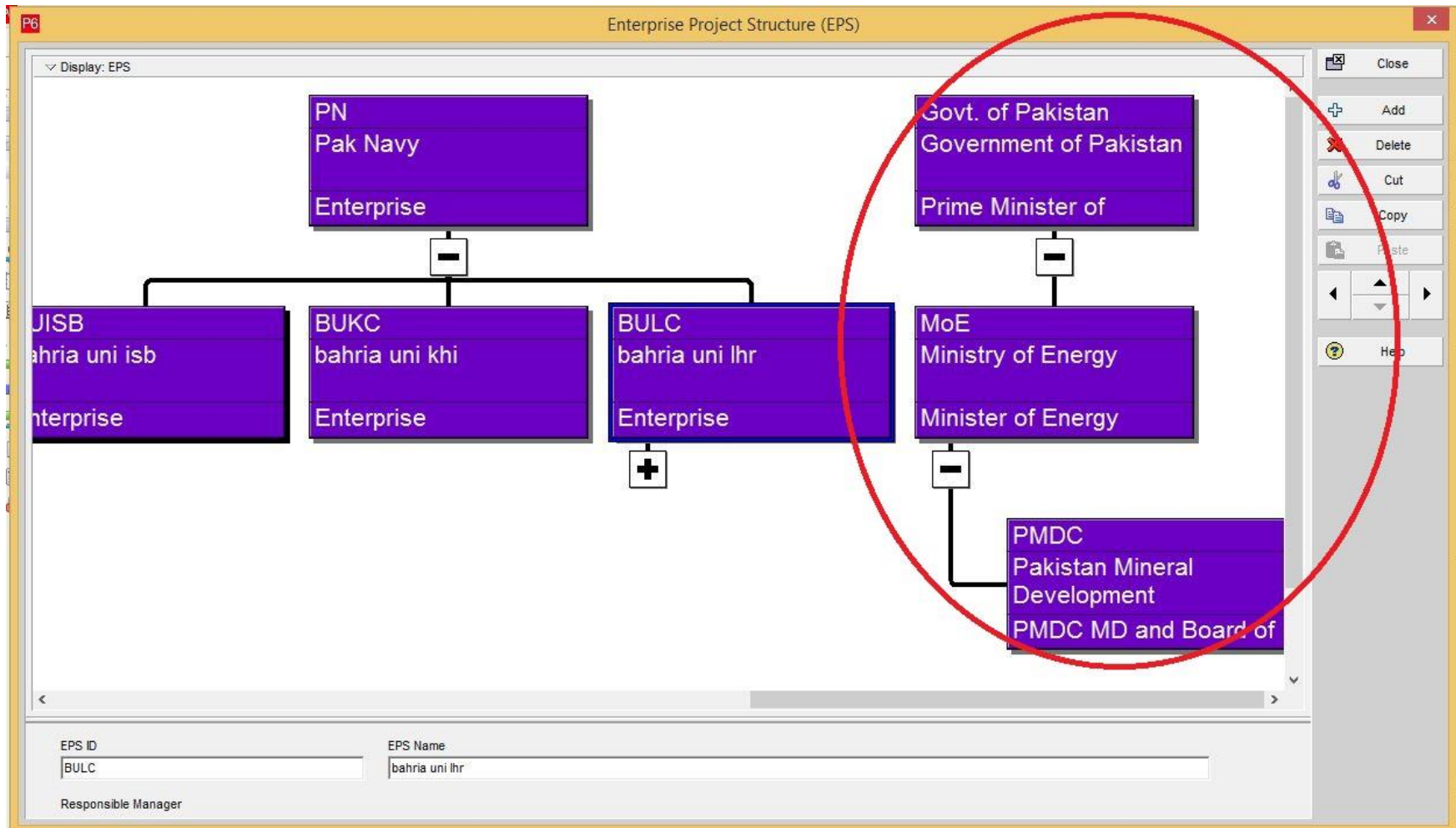
### 3.2 Project Summary

<b>Project Name</b>	Khewra Salt Mines Project
<b>Project Start Date</b>	1 <sup>st</sup> August, 2019
<b>Project Finish Date</b>	23 <sup>rd</sup> December, 2019
<b>Project Duration</b>	120 days 5 hours
<b>Total Project Activities</b>	53
<b>Budgeted Total Cost</b>	Rs. 2,504,456.00
<b>Milestones in the project</b>	2 (start and finish)

The inputs given in the software and the generated outputs are discussed one by one in the coming sections.

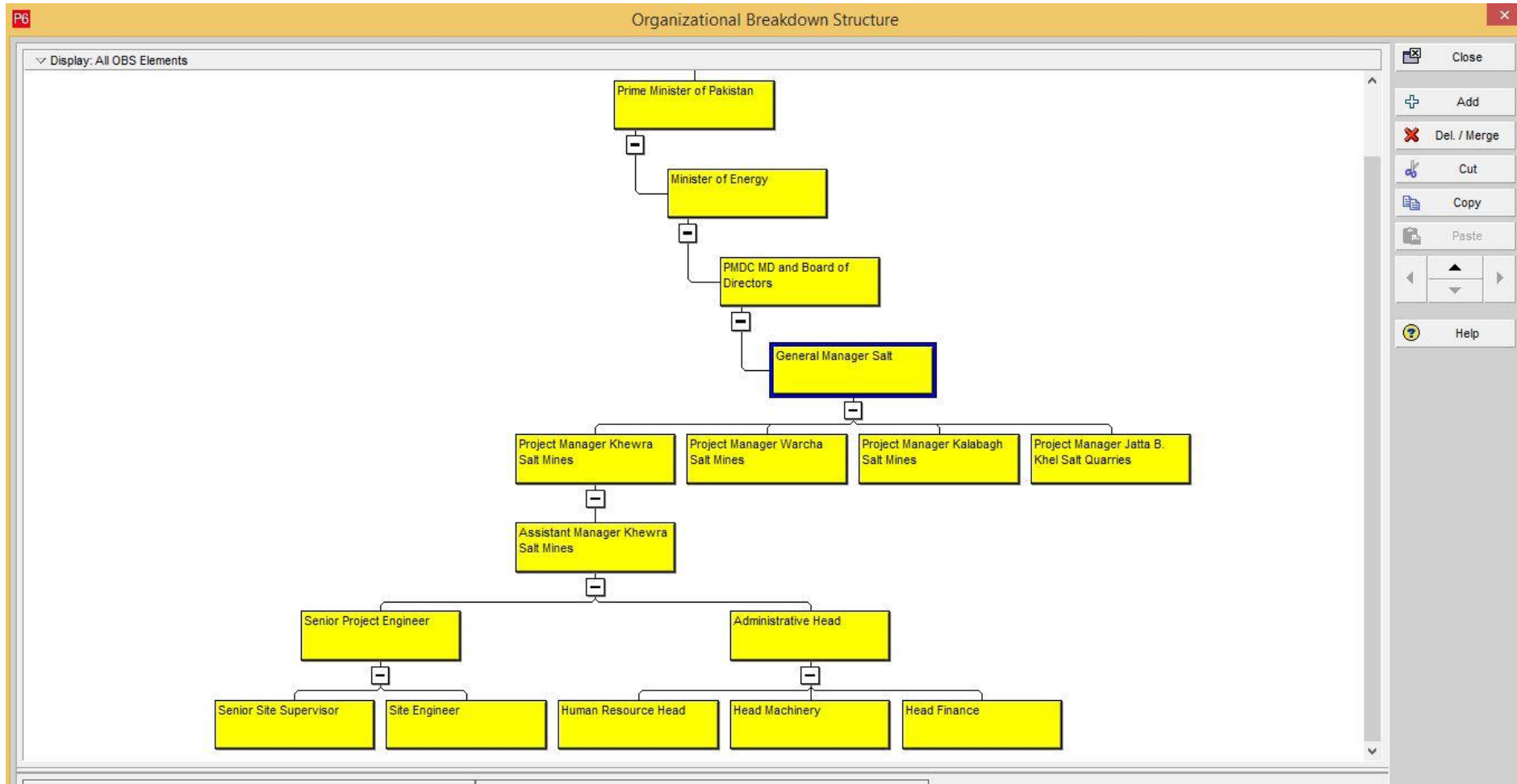
### 3.3 EPS (Enterprise Project Structure)

EPS in this project consists of three levels (two sub-levels under the main EPS).



### 3.4 OBS (Organizational Breakdown Structure)

The organizational breakdown structure of the project is shown below.



### 3.5 Currency conversion

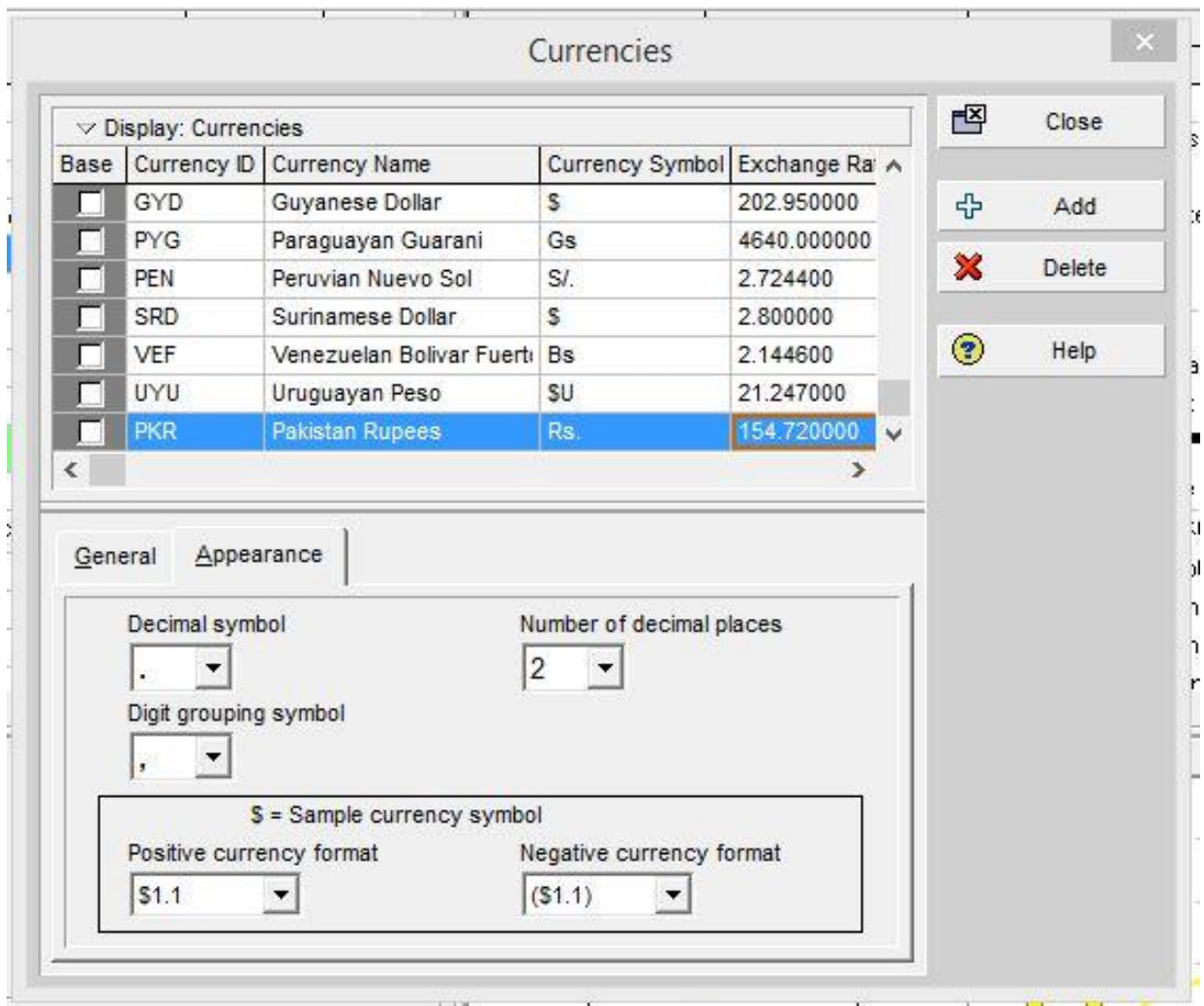
PKR is by default not included in Primavera P6 software.

PKR was added as a new currency in the tool.

The base unit is USD (dollars)

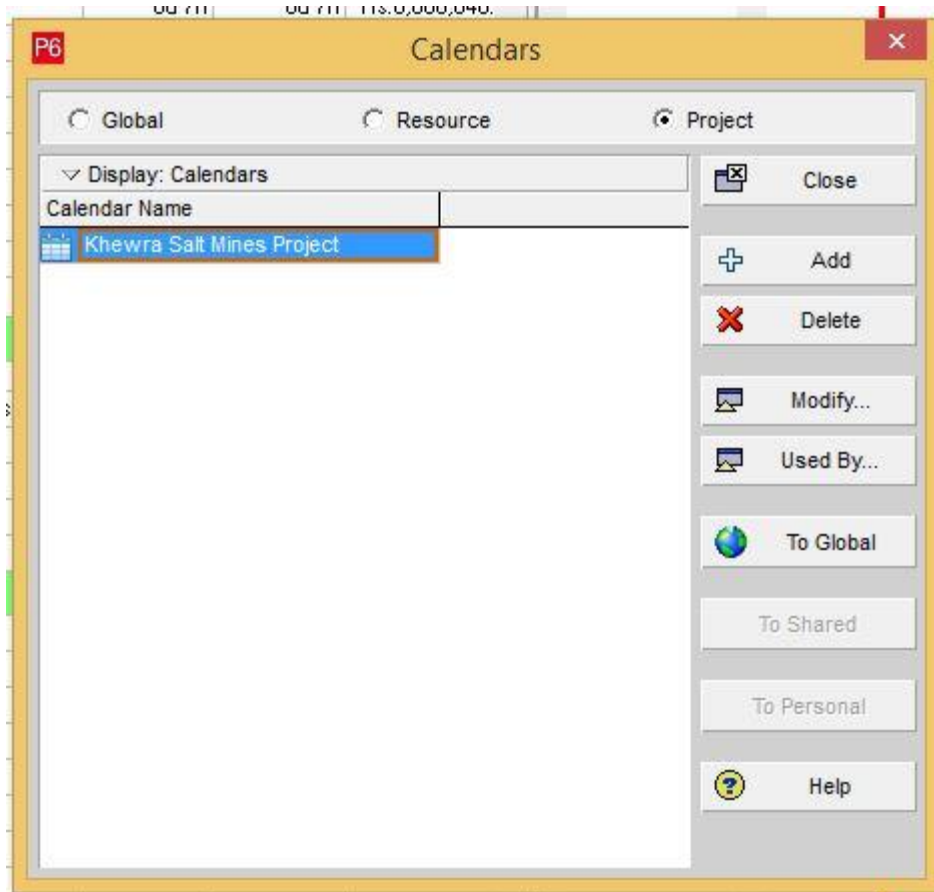
A conversion rate of 154.72 was applied

As, 1 USD = 154.72 PKR



### 3.6 Project calendar

A project calendar named “Khewra Salt Mines Project” was added.



The project starts on 1<sup>st</sup> August, 2019.

Five working days were marked on the calendar i.e., Monday to Friday).

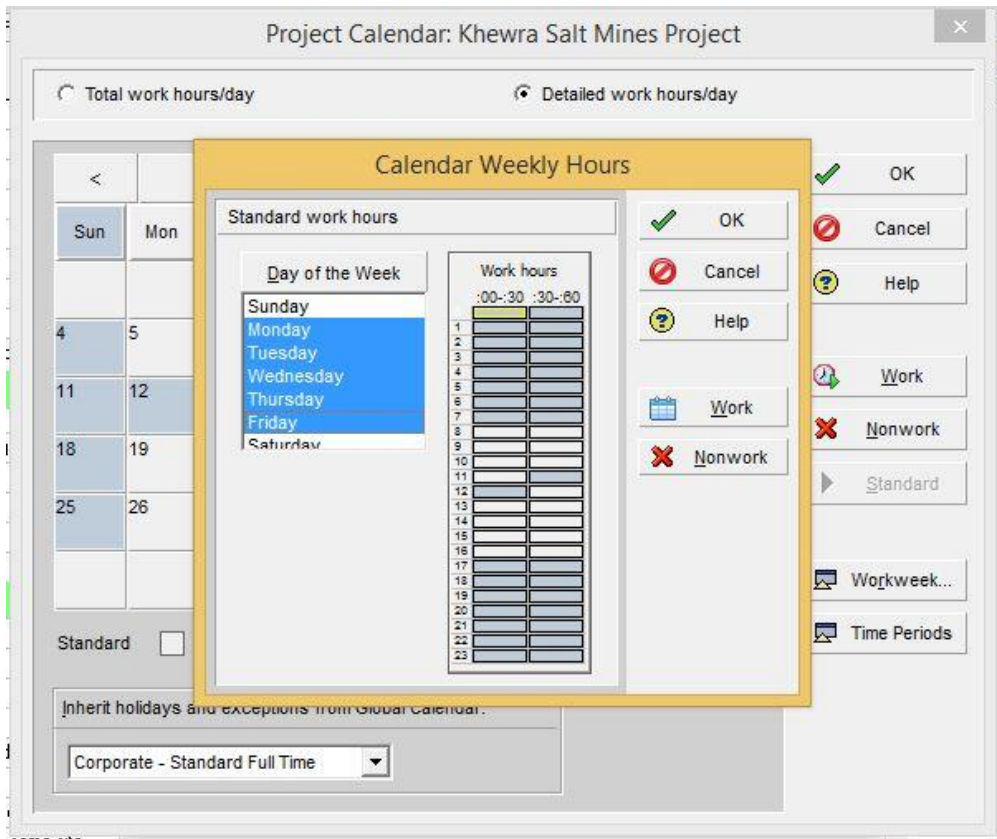
Each working day is an eight-hour work day.

The day starts at 8 a.m.

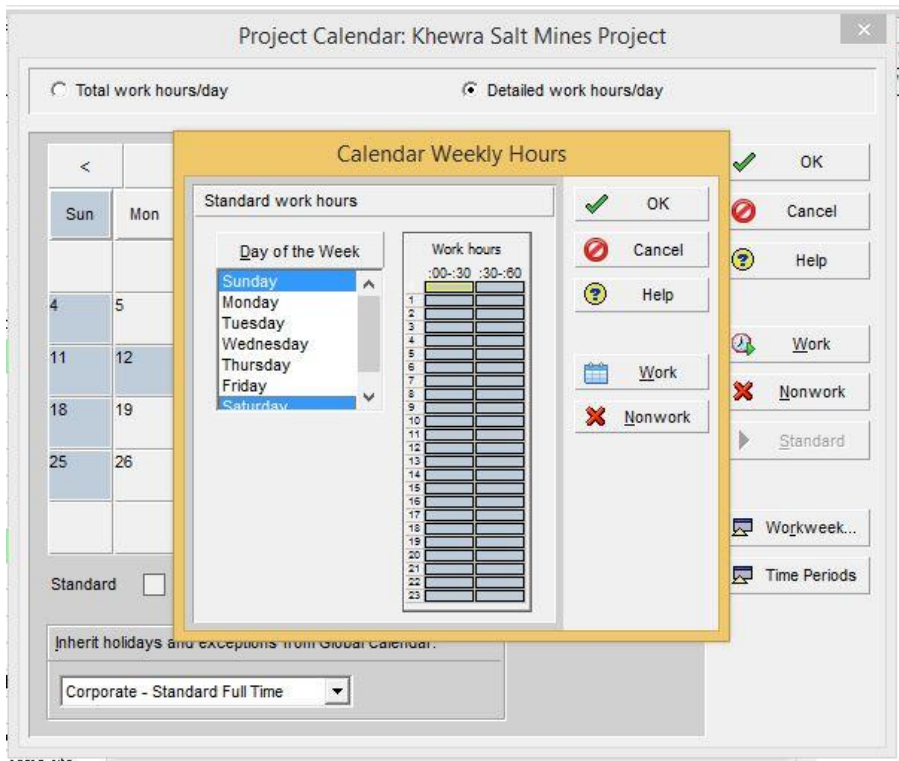
5 p.m. is off time.

Between these hours, a break of 1 hour is given (from 11:30 a.m. to 12:30 p.m.).

The lunch break is made non-work.



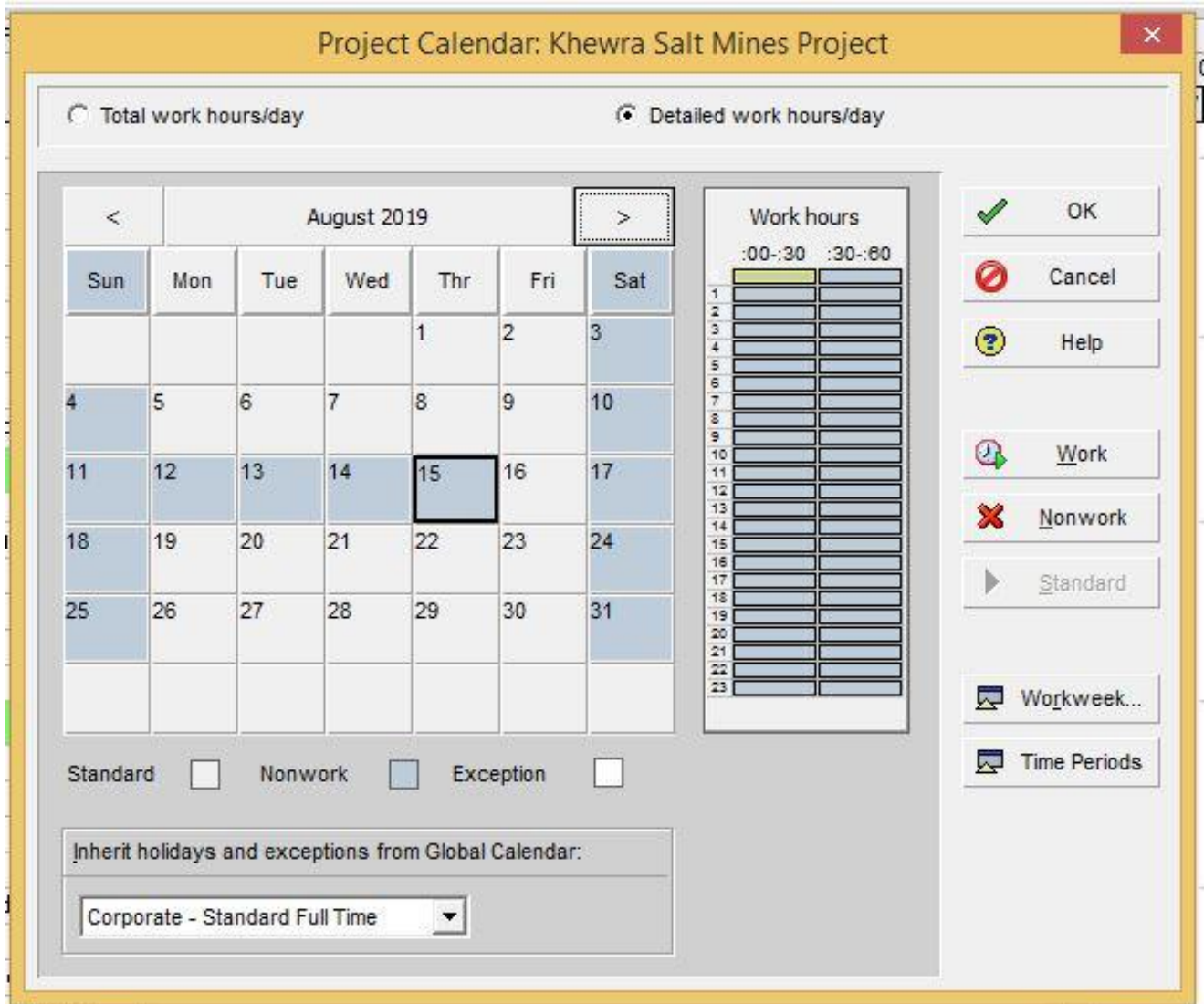
Saturday and Sunday are made Non-work.



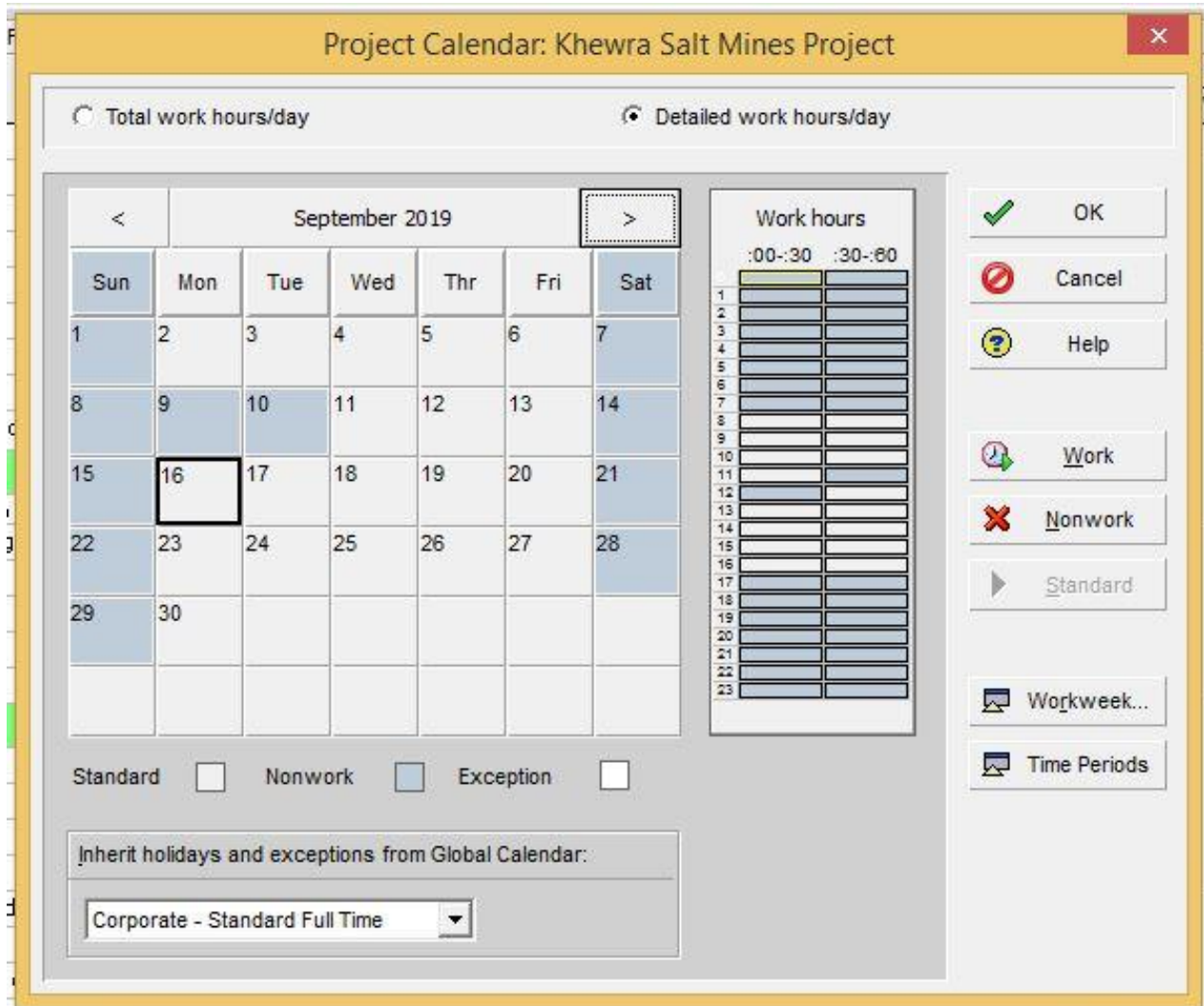


The national holidays are also marked non-work on the calendar.

12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup>, 15<sup>th</sup> August, 2019 are marked non-work due to Eid-ul-Azha holidays.



Similarly, 9<sup>th</sup> and 10<sup>th</sup> of September, 2019 are also marked non-work on account of Muharram.



### 3.7 Project WBS (Work Breakdown Structure)

WBS			
Activities	WBS	Projects	Resources
Layout: WBS			
WBS Code	WBS Name	Total Activities	
[-] Khewra Salt Mines Project	Khewra Salt Mines Project	55	
[-] Khewra Salt Mines Project.1	Salt Exploration	11	
[-] Khewra Salt Mines Project.2	Digging Mines and Salt Extrac	18	
[-] Khewra Salt Mines Project.3	Salt Crushing	10	
[-] Khewra Salt Mines Project.4	Transportation and Warehouse	6	
[-] Khewra Salt Mines Project.5	Marketing and Selling	10	

### 3.8 Activities of the project

Primavera offers to add any of the six types of activities:

- Finish milestone
- Level of effort
- Resource dependent
- Start milestone
- Task dependent
- WBS Summary

The project starts with the salt exploration. After approval off feasibility report, the digging of tunnel begins. A total of 10 k length of tunnel is dug using Tunnel Boing Machine. Special safety measures in the tunnel are adopted. The staff and labors are given training on self-safety. Subsequently, a medical doctor also gives training to the workers about health and safety.

After that, site blasting is done by installation of dynamites at the dug tunnel. The rock salt is collected and transported to crushing site. After salt crushing, a quality test is performed to check is the salt will be used for eating purposes or it will be used commercially. After this, the salt is sent to inventory. The salt is stored here and sent to retailers and industries as per demand.

The project activities are added in the software along with the following data:

- ✓ Activity planned duration
- ✓ Remaining duration
- ✓ budgeted total cost
- ✓ actual total cost
- ✓ activity start date
- ✓ activity finish date
- ✓ total float per activity

This activity data is shown in the following table generated by Primavera:

## Salt exploration

Activity ID	Activity Name	Original Duration	Remaining Duration	Predecessors	Successors	Budgeted Total Cost	Start	Finish	Total Float
<b>Khewra Salt Mines Project</b>		120d 5h	120d 5h			Rs.2,504,456.00	Aug-01-2019 A	Dec-23-2019	0d
<b>Salt Exploration</b>		23d 6h	23d 6h			Rs.104,288.00	Aug-01-2019 A	Aug-29-2019	0d
A1000	Project Start	0d	0d		A1001	Rs.0.00	Aug-01-2019		0d
A1001	Satellite imaging for study of rock strata	2d	2d	A1000	A1002	Rs.9,600.00	Aug-01-2019 A	Aug-02-2019	0d
A1002	Study of rock strata at Khewra site	5d	5d	A1001	A1003	Rs.8,800.00	Aug-05-2019 A	Aug-09-2019	0d
A1003	Development of 3D model of rock deposits	2d 4h	2d 4h	A1002	A1004	Rs.6,000.00	Aug-04-2019 A	Aug-06-2019	0d
A1004	Sampling and drilling of rock	2d 3h	2d 3h	A1003	A1005	Rs.10,850.00	Aug-06-2019 A	Aug-08-2019	0d
A1005	Estimates and calculation of salt content in sample	2d 4h	2d 4h	A1004	A1006	Rs.4,200.00	Aug-09-2019 A	Aug-12-2019	0d
A1006	Preparation of pre-feasibility report	4d 4h	4d 4h	A1005	A1007	Rs.15,120.00	Aug-07-2019 A	Aug-12-2019	0d
A1007	Feasibility report preparation	7d 5h	7d 5h	A1006	A1008	Rs.16,470.00	Aug-12-2019 A	Aug-21-2019	0d
A1008	Feasibility report verification	2d	2d	A1007	A1009	Rs.3,200.00	Aug-21-2019 A	Aug-23-2019	0d
A1009	Feasibility report approval	3d	3d	A1008	A1010	Rs.24,000.00	Aug-23-2019 A	Aug-27-2019	0d
A1010	Selecting a stie to start from first	1d 6h	1d 6h	A1009	A1011	Rs.6,048.00	Aug-27-2019 A	Aug-29-2019	0d

The total budgeted cost, project start date and finish date are shown in the first row of the table.

Start milestone of Project Start is added in the start.

## Digging mines and salt exploration

Activity ID	Activity Name	Original Duration	Remaining Duration	Predecessors	Successors	Budgeted Total Cost	Start	Finish	Total Float
<b>Digging Mines and Salt Extraction</b>		45d 0h	45d 0h			Rs.1,827,256.00	Aug-29-2019 A	Oct-22-2019	0d
A1011	Testing a small sample from site	0d 6h	0d 6h	A1010	A1012	Rs.2,040.00	Aug-29-2019 A	Aug-29-2019	0d
A1012	Salt mine digging 0.5km using Tunnel Boring Machine (TBM)	0d 4h	0d 4h	A1011	A1013	Rs.21,680.00	Aug-30-2019 A	Aug-30-2019	0d
A1013	Digging the total length of 10km using TBM	5d	7d	A1012	A1014	Rs.128,800.00	Aug-30-2019 A	Sep-08-2019	0d
A1014	Cleaning the dug mine for labors work	3d 6h	3d 6h	A1013	A1015	Rs.109,440.00	Sep-08-2019 A	Sep-12-2019	0d
A1015	Installing ventilation sytem in mine	8d 4h	8d 4h	A1014	A1016, A1019	Rs.520,200.00	Sep-12-2019 A	Sep-23-2019	0d
A1016	Installing first aid medical facility in mine	4d	4d	A1015	A1017	Rs.78,960.00	Sep-12-2019 A	Sep-17-2019	5d 4h
A1017	Training of workers and labors on safety	2d 6h	2d 6h	A1016	A1018	Rs.96,656.00	Sep-12-2019 A	Sep-16-2019	5d 4h
A1018	Installation of lights in mine	3d	3d	A1017	A1019	Rs.346,640.00	Sep-12-2019 A	Sep-16-2019	5d 4h
A1019	Selecting a site for blasting	0d 3h	0d 3h	A1018, A1015	A1020	Rs.420.00	Sep-23-2019 A	Sep-23-2019	0d
A1020	Aanalyzing soil/rock strength at site	1d 6h	1d 6h	A1019	A1021	Rs.6,720.00	Sep-23-2019 A	Sep-25-2019	0d
A1021	Selecting type of dynamite to be used	0d 6h	0d 6h	A1020	A1022	Rs.1,260.00	Sep-24-2019 A	Sep-25-2019	0d
A1022	Dynamite installation at site	2d 6h	2d 6h	A1021	A1023	Rs.152,200.00	Sep-25-2019 A	Sep-29-2019	0d
A1023	Blasting	6d	6d	A1022	A1024	Rs.158,640.00	Sep-29-2019 A	Oct-06-2019	0d
A1024	Drilling of rock left behind after blasting	5d	5d	A1023	A1025	Rs.84,000.00	Oct-06-2019 A	Oct-11-2019	0d
A1025	Collecting the extracted rock pieces	4d	4d	A1024	A1026	Rs.3,200.00	Oct-11-2019 A	Oct-16-2019	0d
A1026	Cleaning of rock pieces	7d	7d	A1025	A1027	Rs.5,600.00	Oct-11-2019 A	Oct-20-2019	0d
A1027	Loading extracted salt on loader	8d	8d	A1026	A1028	Rs.102,400.00	Oct-11-2019 A	Oct-21-2019	0d
A1028	Transportation of extracted salt to crushing area	0d 5h	0d 5h	A1027	A1029	Rs.8,400.00	Oct-21-2019 A	Oct-22-2019	0d

The activities A1016, A1017 and A1018 are non-critical activities and have a float of 5 days and 4 hours.

## Salt crushing

Activity ID	Activity Name	Original Duration	Remaining Duration	Predecessors	Successors	Budgeted Total Cost	Start	Finish	Total Float
<b>Salt Crushing</b>		25d 1h	25d 1h			Rs.297,022.00	Oct-22-2019 A	Nov-20-2019	0d
A1029	Extracted salt receiving at crushing area	2d	2d	A1028	A1030	Rs.1,600.00	Oct-22-2019 A	Oct-24-2019	0d
A1030	Segregation of large and small salt pieces	0d 7h	0d 7h	A1029	A1031	Rs.350.00	Oct-24-2019 A	Oct-25-2019	0d
A1031	Crushing of large pieces of rock salt	5d 4h	5d 4h	A1030	A1032	Rs.136,400.00	Oct-25-2019 A	Oct-31-2019	0d
A1032	Crushing of small pieces of rock salt	5d 4h	5d 4h	A1031	A1033	Rs.136,400.00	Oct-25-2019 A	Oct-31-2019	0d
A1033	Collection of finely ground salt	2d	2d	A1032	A1034	Rs.1,600.00	Oct-31-2019 A	Nov-03-2019	0d
A1034	Analysis of edible and non-edible salt	2d 4h	2d 4h	A1033	A1035	Rs.5,200.00	Nov-03-2019 A	Nov-06-2019	0d
A1035	Quality check of salt	4d 6h	4d 6h	A1034	A1036	Rs.6,912.00	Nov-06-2019 A	Nov-12-2019	0d
A1036	Segregation of edible and non-edible salt	4d	4d	A1035	A1037	Rs.5,760.00	Nov-12-2019 A	Nov-17-2019	0d
A1037	Packing of edible salt	1d 4h	1d 4h	A1036	A1038	Rs.1,200.00	Nov-17-2019 A	Nov-18-2019	0d
A1038	Packing of non-edible salt/waste for commercial use	2d	2d	A1037	A1039	Rs.1,600.00	Nov-19-2019 A	Nov-20-2019	0d

## Transportation and warehousing

Activity ID	Activity Name	Original Duration	Remaining Duration	Predecessors	Successors	Budgeted Total Cost	Start	Finish	Total Float
<b>Transportation and Warehousing</b>		11d	11d			Rs.147,440.00	Nov-21-2019 A	Dec-04-2019	0d
A1039	Transportation of edible salt in small packs to warehouse	2d	2d	A1038	A1040	Rs.25,280.00	Nov-21-2019 A	Nov-22-2019	0d
A1040	Transportation of commercial salt in large bags to warehouse	4d	4d	A1039	A1041	Rs.50,560.00	Nov-21-2019 A	Nov-26-2019	0d
A1041	Receiving of salt at inventory	0d 5h	0d 5h	A1040	A1042	Rs.500.00	Nov-26-2019 A	Nov-26-2019	0d
A1042	Making record of salt received at inventory	0d 7h	0d 7h	A1041	A1043	Rs.700.00	Nov-26-2019 A	Nov-27-2019	0d
A1043	Storing edible salt	2d 4h	2d 4h	A1042	A1044	Rs.22,000.00	Nov-27-2019 A	Dec-01-2019	0d
A1044	Storing commercial salt	5d 4h	5d 4h	A1043	A1045	Rs.48,400.00	Nov-27-2019 A	Dec-04-2019	0d

## Marketing and selling

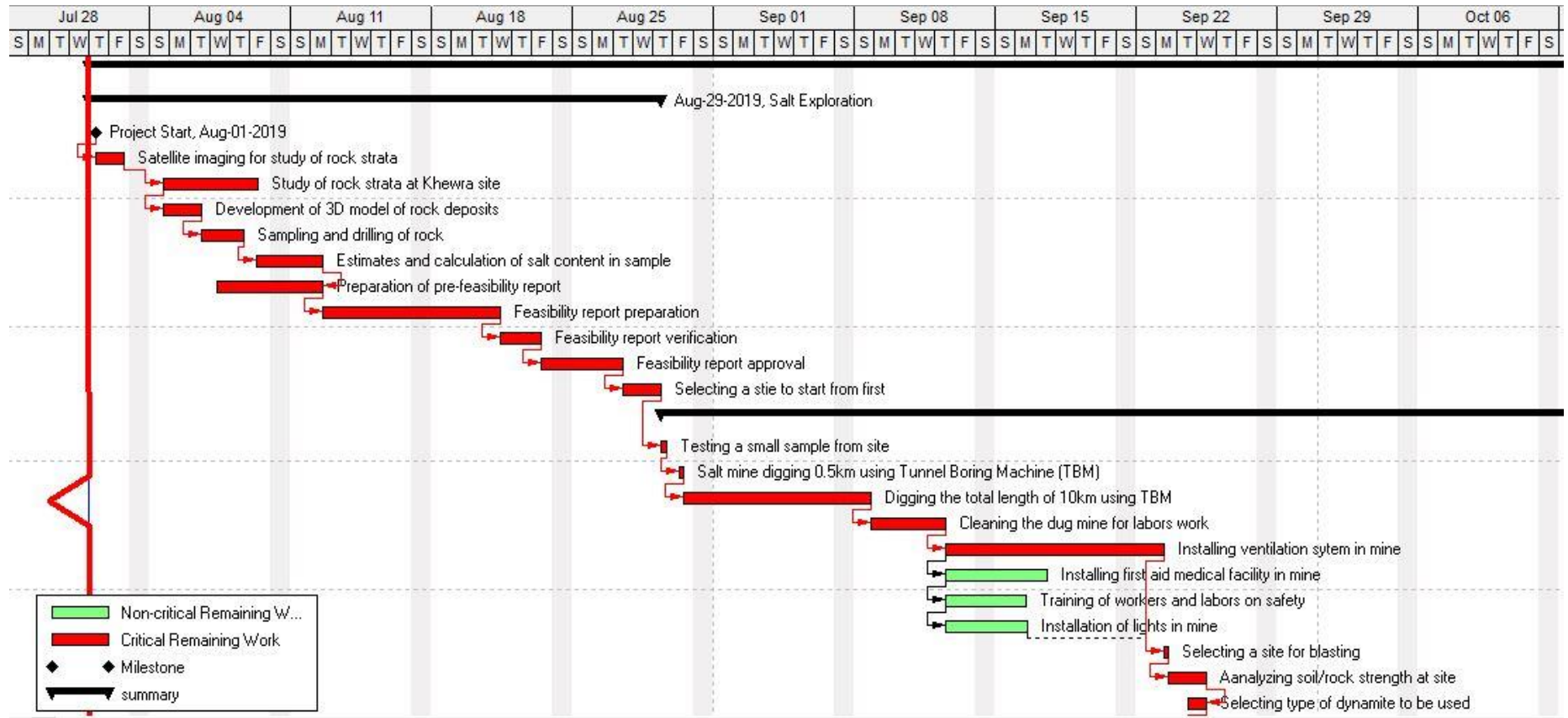
Activity ID	Activity Name	Original Duration	Remaining Duration	Predecessors	Successors	Budgeted Total Cost	Start	Finish	Total Float
<b>Marketing and Selling</b>		15d 5h	15d 5h			Rs.128,450.00	Dec-04-2019 A	Dec-23-2019	0d
A1045	Order for salt received	4d	4d	A1044	A1046	Rs.3,200.00	Dec-04-2019 A	Dec-09-2019	0d
A1046	Transporting edible salt to retailers	3d	3d	A1045	A1047	Rs.37,920.00	Dec-09-2019 A	Dec-12-2019	0d
A1047	Transporting commercial salt to industries	5d	5d	A1046	A1048	Rs.63,200.00	Dec-09-2019 A	Dec-15-2019	0d
A1048	Keeping record of edible salt dispatched	2d 4h	2d 4h	A1047	A1049	Rs.2,000.00	Dec-15-2019 A	Dec-17-2019	0d
A1049	Keeping record of commercial salt dispatched	3d 4h	3d 4h	A1048	A1050	Rs.2,800.00	Dec-15-2019 A	Dec-18-2019	0d
A1050	Recording overall salt demand data	5d 2h	5d 2h	A1049	A1051	Rs.4,200.00	Dec-15-2019 A	Dec-20-2019	0d
A1051	Showing salt quality reports and salt demand data to PM	4d	4d	A1050	A1052	Rs.9,600.00	Dec-16-2019 A	Dec-20-2019	0d
A1052	Decision for new site extraction or continuing same site	0d 5h	0d 5h	A1051	A1053	Rs.1,750.00	Dec-20-2019 A	Dec-22-2019	0d
A1053	Recording lessons learnt	0d 6h	0d 6h	A1052	A1054	Rs.3,780.00	Dec-22-2019 A	Dec-23-2019	0d
A1054	Project Finish	0d	0d	A1053		Rs.0.00		Dec-23-2019	0d

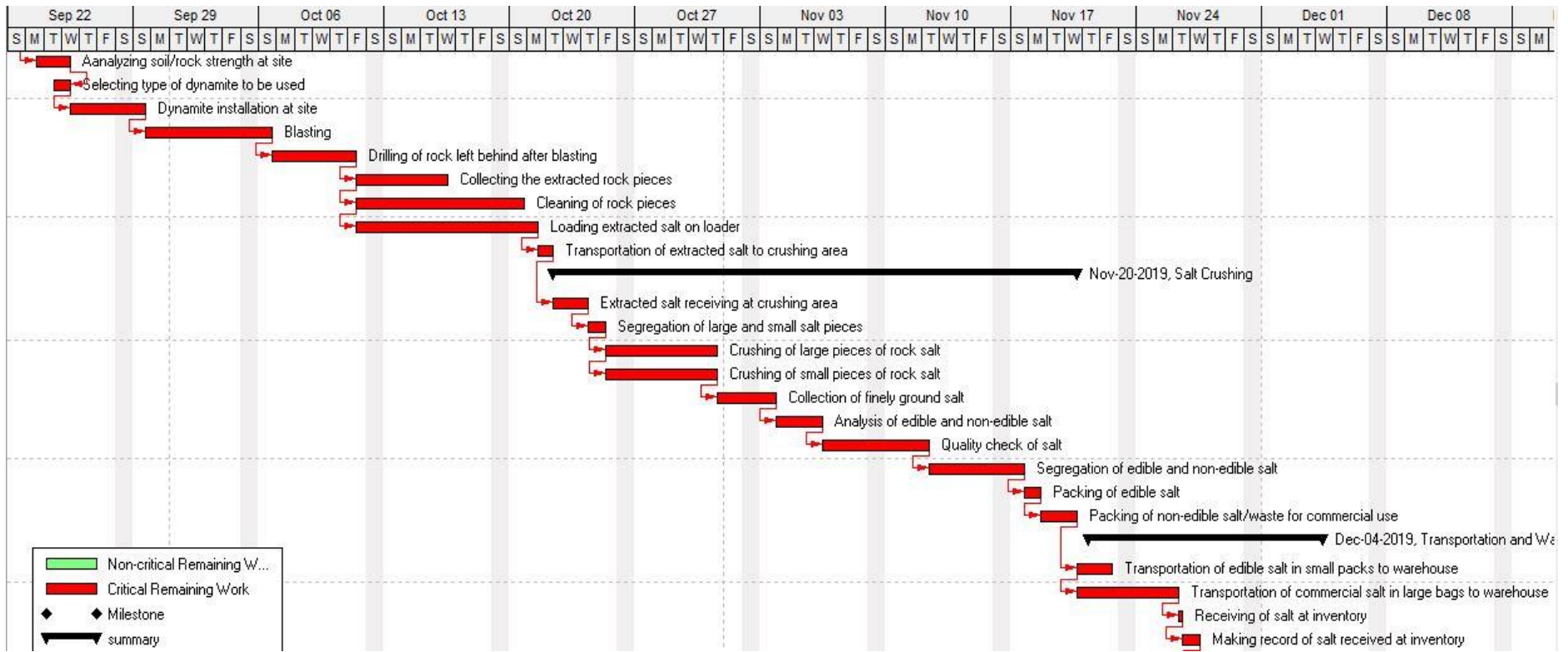
Finish milestone is added at the end, named Project Finish.

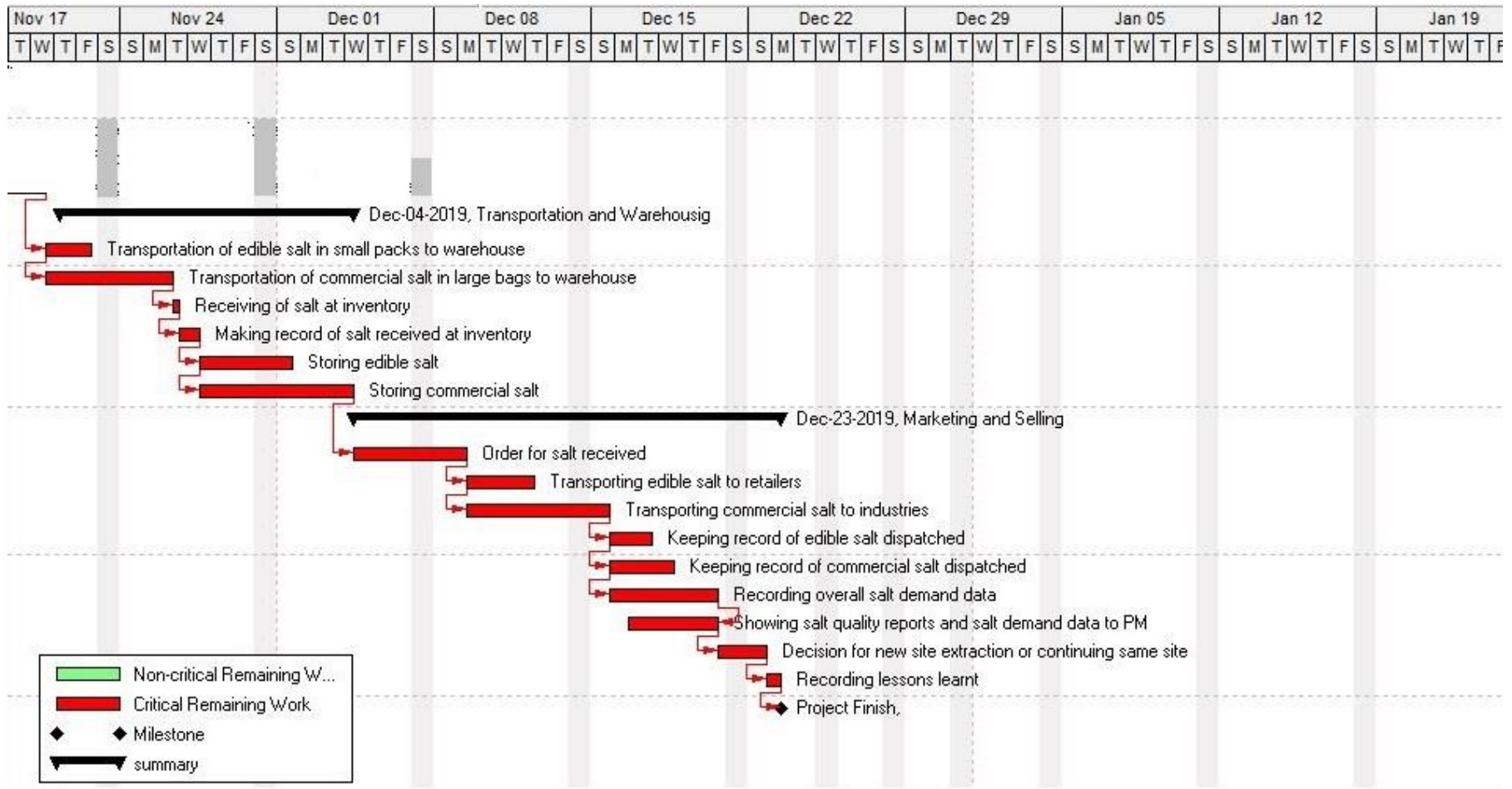
The project start and finish milestones have zero duration.



### 3.9 Gantt Chart for the Project as per Planned Activities







### 3.10 Resources

There are three major type of resources:

- Labor
- Non-labor
- Material

The resource list for Khewra Salt Mines project is shown in below sections.

#### 3.10.1 List of Labor resources for the project

The labor resources for the project are added in hierarchical form. The list of labor resources along with hierarchical levels can be seen from the table below.

Resources						
Activities WBS Projects Resources						
▼ Display: All Resources						
Resource ID	Resource Name	Resource Type	Unit of Measure	Primary Role	Default Units / Time	
R	Project Manager Khewra Salt Mines	Labor			1d/d	
R-1	Assistant Manager	Labor			1d/d	
R-2	Senior Project Engineer	Labor			1d/d	
R-7	Senior Site Supervisor	Labor			1d/d	
R-9	AutoCAD operator	Labor			1d/d	
R-10	Foreman	Labor			1d/d	
R-11	Labourer	Labor			1d/d	
R-23	Helper	Labor			1d/d	
R-35	Driver	Labor			1d/d	
R-13	Drilling machine operator	Labor			1d/d	
R-15	Site Surveyor	Labor			1d/d	
R-27	Assiatant Site Surveyor	Labor			1d/d	
R-8	Site Engineer	Labor			1d/d	
R-12	Laboratory Assistant	Labor			1d/d	
R-37	Warehouse Manager	Labor			1d/d	
R-36	Quality Assurance Engineer	Labor			1d/d	
R-3	Administrative Head	Labor			1d/d	
R-4	Human Resource Head	Labor			1d/d	
R-5	Head Machinery	Labor			1d/d	
R-14	Doctor	Labor			1d/d	
R-6	Head Finance	Labor			1d/d	

### 3.10.2 List of Non-labor resources for the project

Resources						
Activities	WBS	Projects	Resources			
▼ Display: All Resources						
Resource ID	Resource Name	Resource Type	Unit of Measure	Primary Role	Default Units / Time	
R-16	Tunnel Boring Machine	Nonlabor			1d/d	
R-17	Drilling machine	Nonlabor			1d/d	
R-18	Crushing machine	Nonlabor			1d/d	
R-19	Loader	Nonlabor			1d/d	
R-20	Dumper	Nonlabor			1d/d	
R-21	Truck	Nonlabor			1d/d	
R-22	Lifter	Nonlabor			1d/d	
R-24	Grader	Nonlabor			1d/d	
R-25	Excavator	Nonlabor			1d/d	
R-26	Crane	Nonlabor			1d/d	

### 3.10.3 List of Material resources for the project

Resources						
Activities	WBS	Projects	Resources			
▼ Display: All Resources						
Resource ID	Resource Name	Resource Type	Unit of Measure	Primary Role	Default Units / Time	
R-29	First Aid Box	Material	Number		8Number/d	
R-30	Helmet	Material	Each		8each/d	
R-33	Electric poles	Material	Each		8each/d	
R-34	Lights	Material	Each		8each/d	
R-32	Dynamite	Material	Unit		8Unit/d	
R-28	Computer	Material	Number		8Number/d	

## 3.11 Resource Assignments and Costing

After the resource pool had been made, the next step was assigning resources to activities and assigning budgeted units for each resource.

Taking example of the activity A1018 (Installation of lights in mine), the following labor, non-labor and material resources are assigned to the activity:

- Crane (non-labor)
- Electric poles (material)
- Excavator (non-labor)

- Foreman (labor)
- Lights (material)
- Senior site supervisor (labor)
- Site engineer (labor)

These resources are also assigned Budgeted units.

These budgeted units are used to compute the budgeted cost for each resource.

The budgeted cost calculation depends on the price per unit set while adding the resources in the resource pool.

Layout: Classic Schedule Layout Filter: All Activities

Activity ID	Activity Name	Original Duration	Remaining Duration	Predecessors	Successors	Budgeted Total Cost	Start	Finish	Total Float
<b>Digging Mines and Salt Extraction</b>									
A1011	Testing a small sample from site	0d 6h	0d 6h	A1010	A1012	Rs.2,040.00	Aug-29-2019 A	Aug-29-2019	0d
A1012	Salt mine digging 0.5km using Tunnel Boring Machine (TBM)	0d 4h	0d 4h	A1011	A1013	Rs.21,680.00	Aug-30-2019 A	Aug-30-2019	0d
A1013	Digging the total length of 10km using TBM	5d	7d	A1012	A1014	Rs.128,800.00	Aug-30-2019 A	Sep-08-2019	0d
A1014	Cleaning the dug mine for labors work	3d 6h	3d 6h	A1013	A1015	Rs.109,440.00	Sep-08-2019 A	Sep-12-2019	0d
A1015	Installing ventilation sytem in mine	8d 4h	8d 4h	A1014	A1016, A1019	Rs.520,200.00	Sep-12-2019 A	Sep-23-2019	0d
A1016	Installing first aid medical facility in mine	4d	4d	A1015	A1017	Rs.78,960.00	Sep-12-2019 A	Sep-17-2019	5d 4h
A1017	Training of workers and labors on safety	2d 6h	2d 6h	A1016	A1018	Rs.96,656.00	Sep-12-2019 A	Sep-16-2019	5d 4h
A1018	Installation of lights in mine	3d	3d	A1017	A1019	Rs.346,640.00	Sep-12-2019 A	Sep-16-2019	5d 4h
A1019	Selecting a site for blasting	0d 3h	0d 3h	A1018, A1015	A1020	Rs.420.00	Sep-23-2019 A	Sep-23-2019	0d
A1020	Analyzing soil/rock strength at site	1d 6h	1d 6h	A1019	A1021	Rs.6,720.00	Sep-23-2019 A	Sep-25-2019	0d
A1021	Calculating type of deposits to be used	0d 6h	0d 6h	A1020	A1022	Rs.1,260.00	Sep-24-2019 A	Sep-25-2019	0d

Nov 17  
T W T

General Status Resources Predecessors Successors Relationships

Activity: A1018 Installation of lights in mine Project: Khewra Salt Mines Project

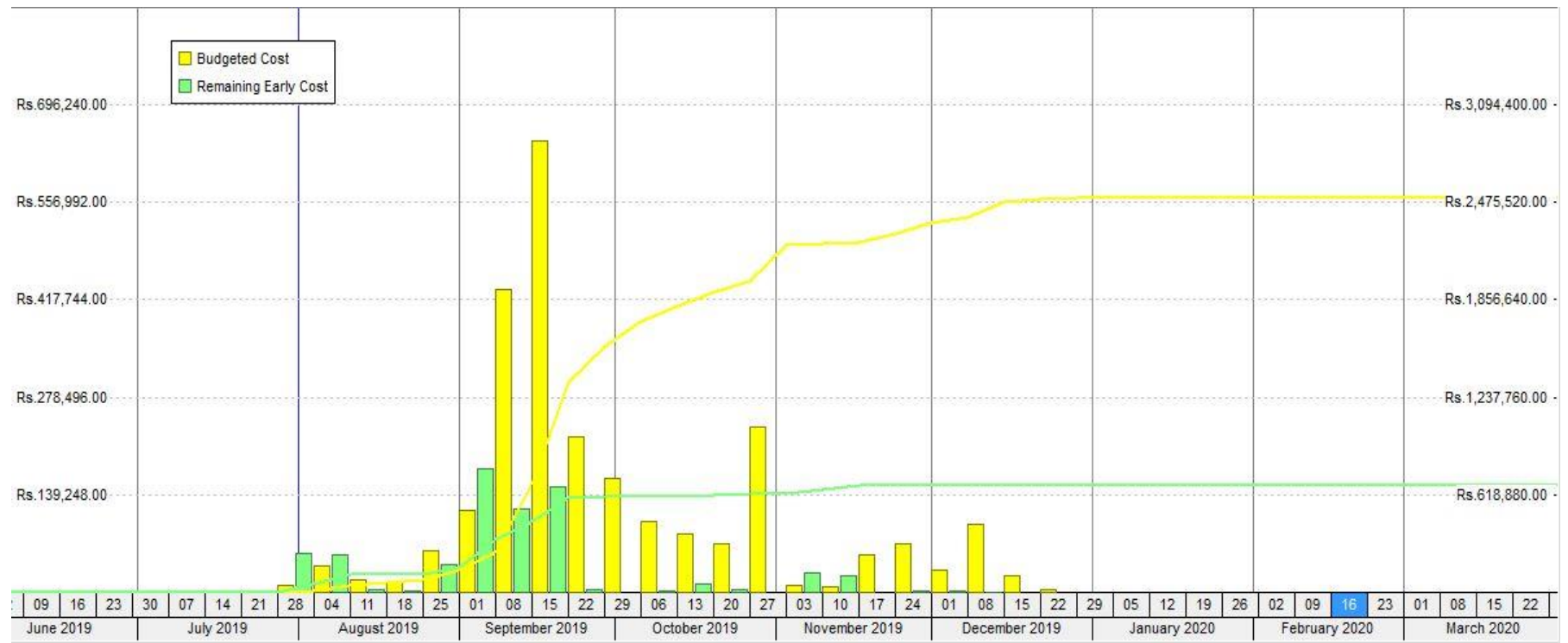
Resource ID Name	Primary Resource	Budgeted Units / Time	Budgeted Units	Budgeted Cost	Original Lag	aining Units / Time	Start	Finish	Remaining Units	Role
R-26.Crane	<input type="checkbox"/>	1d/d	3d	Rs.84,000.00	0d	0d/d	Sep-12-2019 A	Sep-16-2019	0d	
R-33.Electric poles	<input type="checkbox"/>	8each/d	24each	Rs.144,000.00	0d	0each/d	Sep-12-2019 A	Sep-16-2019	0each	
R-25.Excavator	<input type="checkbox"/>	1d/d	3d	Rs.60,000.00	0d	0d/d	Sep-12-2019 A	Sep-16-2019	0d	
R-10.Foreman	<input type="checkbox"/>	1d/d	3d	Rs.2,400.00	0d	0d/d	Sep-12-2019 A	Sep-16-2019	0d	
R-34.Lights	<input type="checkbox"/>	33each/d	100each	Rs.50,000.00	0d	0each/d	Sep-12-2019 A	Sep-16-2019	0each	
R-7.Senior Site Supervisor	<input type="checkbox"/>	1d/d	3d	Rs.3,120.00	0d	0d/d	Sep-12-2019 A	Sep-16-2019	0d	
R-8.Site Engineer	<input checked="" type="checkbox"/>	1d/d	3d	Rs.3,120.00	0d	0d/d	Sep-12-2019 A	Sep-16-2019	0d	

Add Resource Add Role Assign by Role Remove

### 3.12 Histogram and S Curve

#### 3.12.1 Resource Usage Profile for the project

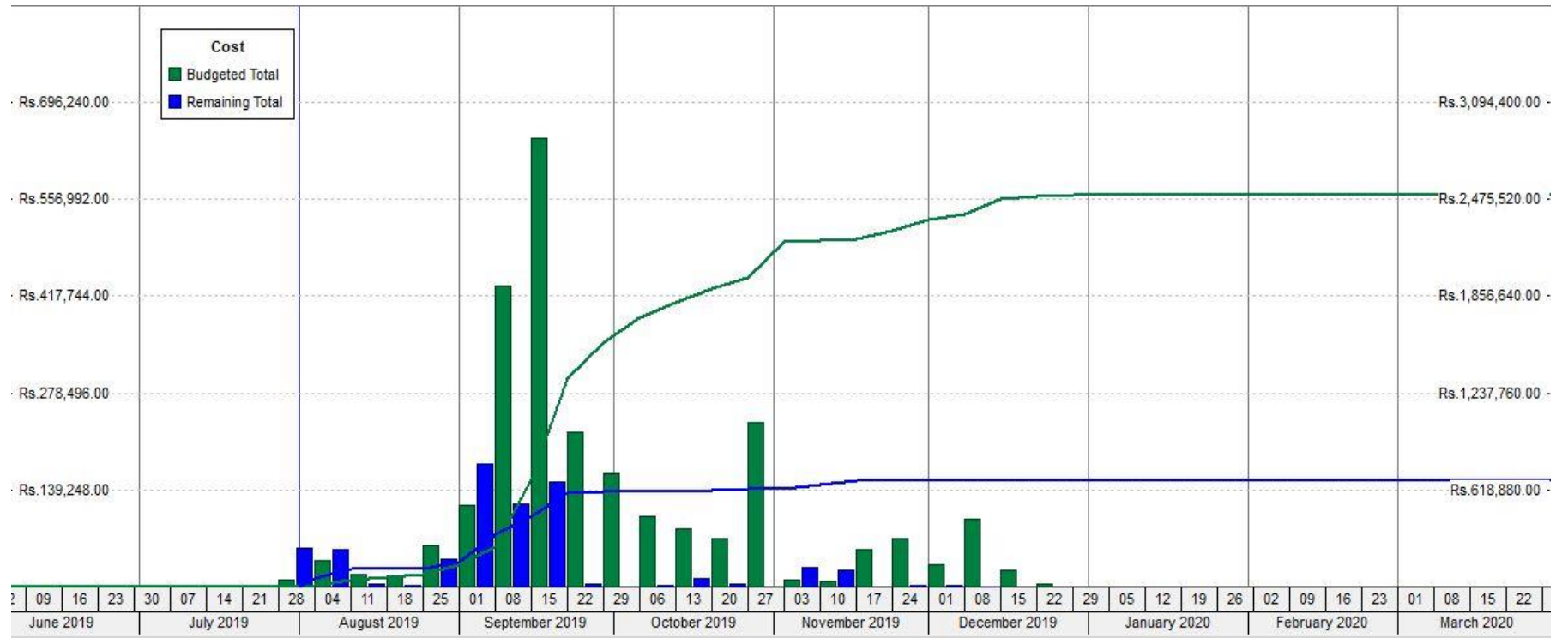
Resource usage profile for Cost is shown below. The trend of resource usage depending on cost can be seen.



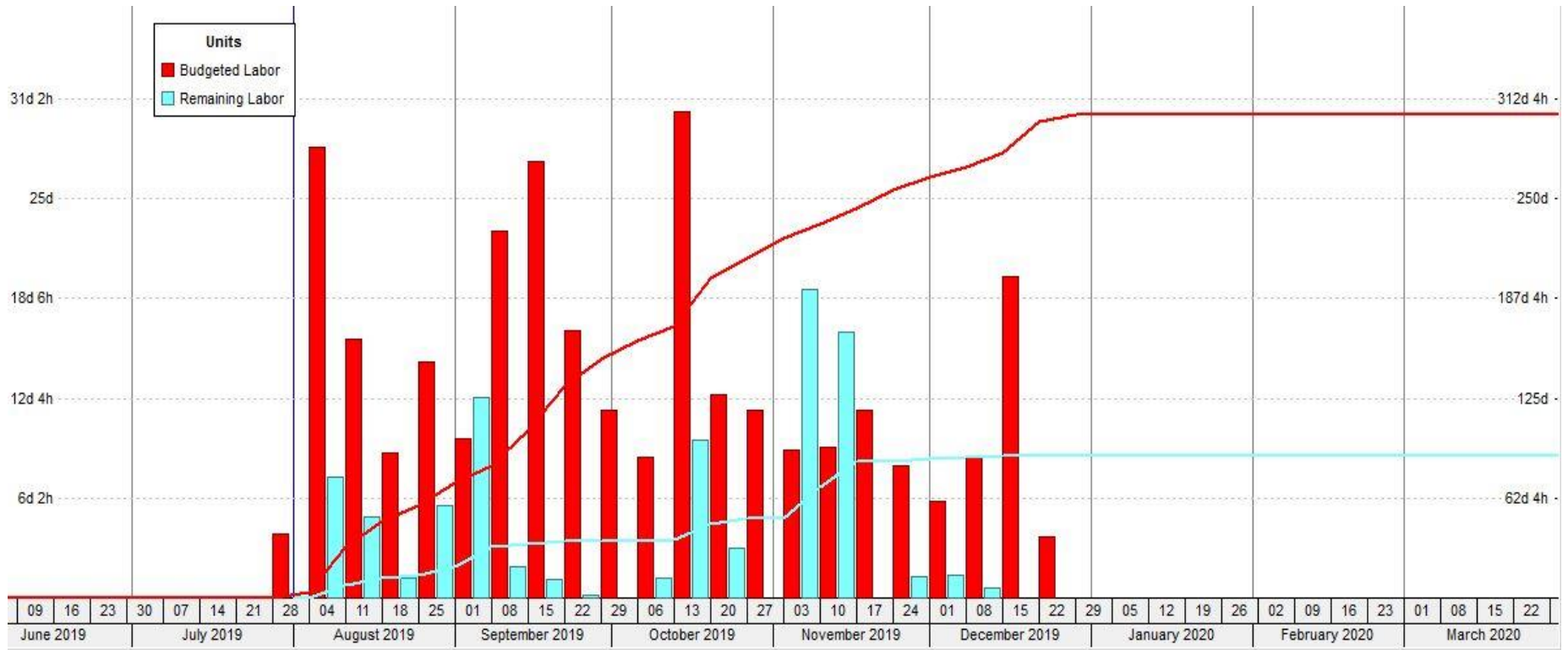


### 3.12.2 Activity Usage Profile for the project

Activity usage profile for Cost is shown below.



Activity usage profile for Units is shown below.



## 4 References

- [1] [Online]. Available: <https://tradingeconomics.com/pakistan/gdp>.
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