Scheduling, Material Requirement Plan (MRP) And Cash Outflow Analysis: A Case Study

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Abstract : *Scheduling, Material Requirement Plan (MRP) and cash outflow analysis are some of the major elements which need to work out in a construction project. Generally, different softwares are available for each of this task. When there is a delay in the planned schedule, it is time consuming to get MRP and cash outflow plan updated according to the revised schedule.*

An ongoing Residential cum Commercial project located at Nasik has been taken up for the present case study. Microsoft Project software for Scheduling and Microsoft Excel software for MRP and cash outflow analysis have been adopted in the present study. As both the softwares are made by Microsoft, they have a built-in feature to interlink with each other. It is found when there is a delay in an activity; the schedule gets automatically updated by changing the starting date of the delayed activity. It is also found that it is easier to get the MRP and cash outflow to get updated according to the revised schedule.

Keywords : *CPM; MRP; Scheduling; Cash outflow analysis*

INTRODUCTION

A critical path method is used for scheduling the construction process. A critical path is determined by identifying the longest path of dependent activities required to complete them from start to finish. If there is a delay in any of the activities under the critical path, there will be a delay in the construction process (Lu and Li, 2003; Hegazy and Menesi, 2010).

The Material Requirement Plan (MRP) is a systematic plan to control inventory (Mabert (2007). (Specifically, it is a procedure for planning and controlling the raw materials, purchased parts, and work in progress inventory required in manufacturing a product (Imetieg and Lutovac, 2015, Cox and Clark,1978).

The total outgoing funds from a company in a given period of time is nothing but cash outflow analysis. For the purpose of this study the cash outflow analysis is made for the material purchases of a construction process (Navon, 1996).

LITERATURE REVIEW

Zhu, Kan, Bao, Wang and Zhang (2018) deals with the problem of the conditional splitting of tasks, a multi-objective project planning and scheduling model under resource constraints is developed based on project cost and completion time. This paper provides theoretical support and decision support for the scheduling of key resources and selection of partners, and improves resource utilization and establishing a new decision-making mechanism for selecting partners.

Lu and Li (2003) deal with the long-standing scheduling problem of how to consider resource capabilities and availability in CPM scheduling by proposing the Resource Activity Critical-Path Method (RACPM), in which the dimension of resources is considered in addition to activity and time in construction planning. This potentially leads to an integrated scheduling and cost-estimating process that will produce realistic schedules, estimates, and control budgets for construction.

Hegazy and Menesi (2010) argue that many of critical path method (CPM) drawbacks stem from the rough level of detail at which the analysis is conducted, where activities durations are considered as

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continuous blocks of time. Thus, they propose a new critical path segment (CPS) mechanism with a finer level of granularity by decomposing the duration of each activity into separate time segments. Hegazy and Menesi (2010) presented a CPS approach for micro level critical path analysis, particularly suited to progress documentation, as-built schedule analysis, and corrective action optimization.

Mabert (2007) concludes that Material Requirements Planning (MRP) systems became a prominent approach to managing the flow of raw material and components on the factory floor in the late 20th century. Mabert (2007) highlights changes in computer technology and contributions by key early proponents of this approach for managing the flow of material on the factory floor.

Imetieg and Lutovac (2015) states that Materials Requirements Planning (MRP) is a system of production planning and inventory control, which is used to manage manufacturing processes. There is a correlation between the time and cost of each activity. Imetieg and Lutovac (2015) show that the overall repair process of completion time can be reduced, that it depends on the resources available on time, which can be controlled and planned using computational techniques such as MRP, in order to provide the necessary budget to pay all clients on time.

Cox and Clark (1978) give reports which represent only a few examples of the possible types of informative reports that can be generated by using an MRP system. Most current MRP systems are developed to fit the specific information needs of the user. The benefits derived from a material requirement planning system are a function of the accuracy of the input data. The three primary inputs required by most MRP systems are a master production schedule, a bill of material file and an inventory status file.

Navon (1996) describes the development of a cash-flow management model for the organizational level, followed by the detailed computer program written on this basis. The system presented by Navon (1996) is unique because it manages the cash flow of the company as a whole, it is flexible-accepting projects with varying degrees of detail levels, it requires no human involvement in a cash-flow generation, it is accurate, and it is a typical management tool.

Sadeghian (2011) shows studies about materials requirements planning (MRP) approach, applied in production planning and management has some weaknesses. One of those is the discreteness of time known as time periods in this approach which makes it impossible to order the requirements at irregular time moments or periods. Sadeghian (2011) introduced a new form of MRP, named as continuous materials requirements planning (CMRP).

Yenisey (2006) says Material Requirements Planning (MRP) has been a very popular and widely used multi-level inventory control method since 1970s. Yenisey (2006) discussed a new approach, which consists of the Flow Network with Side Constraints to optimize the material flows in MRP problems. Yenisey (2006) developed a model that shows that the flow-network approach can be applied to the MRP problems. This approach is very suitable to express the material flow logic behind the MRP since materials flow within a production system.

METHODOLOGY

(1) Collection of information regarding current schedule followed on case study i.e. all activities and its duration is measured on site.

(2) Supplier information i.e. lead time, credit limit, the unit cost of raw materials is collected from the case study.

(3) The current schedule that has been followed is prepared in Microsoft project and studies it to reduce the total over time of the construction process- RCC one slab to another slab process.

(4) From data and discussion with site authority and RCC contractor, a new schedule is prepared in

Microsoft Project by dividing big activities into small activities and with proper sequencing of all activities, the overall time is reduced.

(5) Quantity estimation is done using MS Excel from drawings collected on site.

(6) From above collected data Material requirement plan is prepared in MS Excel and it is then linked with Microsoft Project to auto update it with the schedule.

(7) From this a cash outflow plan is prepared in MS Excel which is linked with the Material requirement plan to auto update it.

CASE STUDY IN NASHIK

Dekaradian Buildcon – Morya Parashare Heights

Location Of building

"Morya Parashare Heights", P No 62 +57 S.no 891 at Chetana Nagar, Rane Nagar, near Guru Gobind Singh College, Nashik- 422009, Maharashtra, India.

A repetitive activity from one RCC slab to another slab is considered for the purpose of this study.

(1) Residential and Commercial project.

(2) 2BHK and 3BHK luxurious flat.

(3) Basement + ground floor + 7 floor building.

(4) Total building area is 29,050 sq. ft

Table 1: Activity And Duration Of Each Activity

Activity	Duration (days)
Centerline marking	01
Outer de-shuttering	01
Column steel binding	04
Column formwork	03
Column casting work	02
Lift steel binding	01
Lift formwork	02
Lift casting work	01
Staircase formwork	02
Staircase steel binding	01
Staircase casting work	01
Slab work	16
Beam bottom work	03
Slab shuttering work	05
Slab steel binding work	04
Slab supporting and outer formwork	02
Electrical piping work	01
Slab casting work	01

Table 2: Supplier Information Collected From Site

Supplier Name	Material Type	Lead Time (days)	Credit limit (days)
Anand sales corporation	Fe 500 Steel bars and binding wire	3	15
Shree Ram Sham traders	Cement	2	25

Figure 1: Snapshot Of Google Maps Location Of The Site

Table 2: Supplier Information Collected From Site (*Contd...*)

Supplier Name	Material Type	Lead Time (days)	Credit limit (days)
Shree Saptashrungi building material suppliers	Aggregate	2	45
Jamuna Infra Project Ltd	Fine aggregate (sand)	3	7
Shree Dhaneshwari Enterprises	Cover blocks	2	15

Table 3: Unit Cost Of Raw Material

Material Type	Unit	Unit Price (Rs.)
Steel	Kg	47.5
Cement	Per bag	285
Course aggregate	Brass	2400
Sand	Brass	4300
Cover blocks	Per bag	3750
Binding wire	60 kg Bundle	3300

DATA COLLECTION AND DATA ANALYSIS

Data Collection

Current activities, its duration, supplier information and their lead time, all necessary drawings are collected from the site.

Problem Identification

(1) Activity during slab to slab work was not divided properly.

(2) There was no scheduling of activities or proper sequencing of work.

(3) The lead time for every labor team i.e. formwork team, reinforcement team and casting team was too high hence overall time to complete one cycle was very high.

(4) There was no Material requirement plan made during construction and due to this material was ordered without considering supplier lead time and requirement date on site. As the material gets delayed activities also get delayed.

(5) As there was no material requirement plan sometimes the quantity of order was not properly given and due to this either their was material shortage or excess material was delivered by the suppliers.

(6) Due to this either activities were getting delayed or the organization was suffering through high inventory cost.

(7) There was no cash outflow plan prepared hence it was difficult to estimate how much cash would be needed to pay all bills of suppliers hence due to

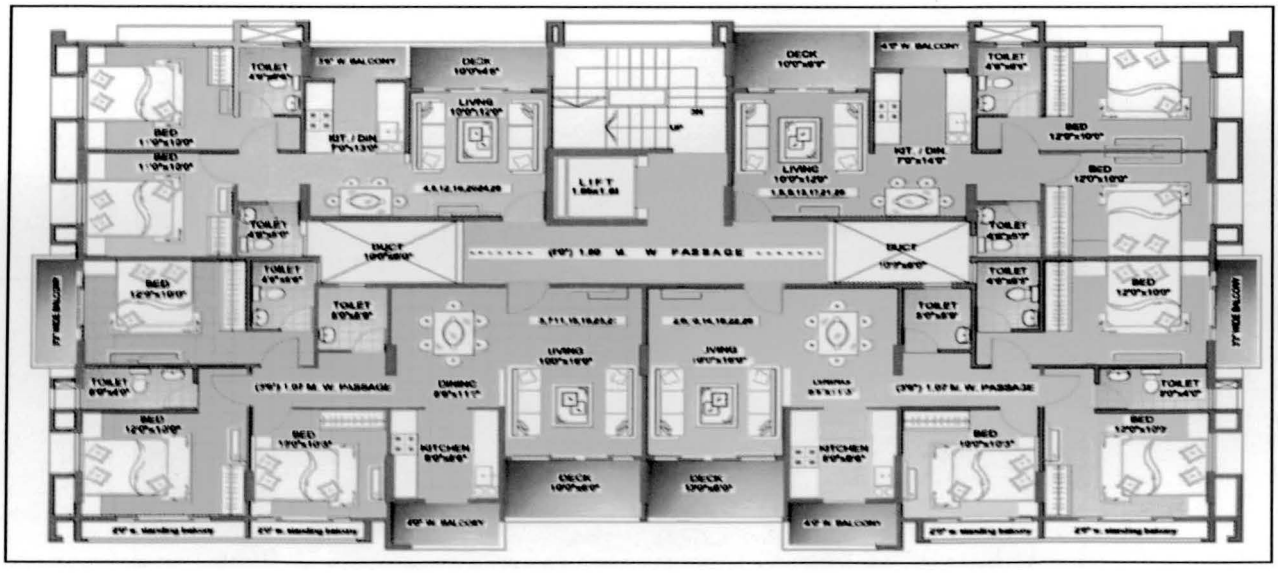

Figure 2: Snapshot Of The Floor Plan

irregular payment, suppliers were delaying the raw material supply on site.

Data Analysis

Development Of The Construction Schedule

From above collected data Existing schedule is prepared in Microsoft Project which is of 27 days.

From discussion with Site engineer and RCC contractor new improved Schedule is prepared which is of 17 days. The new schedule reduces overall time by reducing the idle time of labor by dividing big activities into small activities.

In the *Figure 5*, the X-axis shows cycle names and Y-axis shows cumulative time (days). This case study has a total of such 8 cycles as shows in the figure.

Table 4: Existing Schedule

Task Name	Duration	Start	Finish
Centerline Marking	1 day	Oct 01	Oct 01
Outer Deshuttering	1 day	Oct 01	Oct 01
Column Steel Binding	4 days	Oct 02	Oct 05
Column Formwork	3 days	Oct 06	Oct 08
Column Casting Work	2 days	Oct 09	Oct 10
Lift Steel Binding	1 day	Oct 06	Oct 06
Lift Formwork	2 days	Oct 09	Oct 10
Lift Casting Work	1 day	Oct 11	Oct 11
Staircase Formwork	2 days	Oct 11	Oct 12
Staircase Steel Binding	1 day	Oct 13	Oct 13
Staircase Casting Work	1 day	Oct 14	Oct 14
Beam Bottom Work	3 days	Oct 12	Oct 14
Slab Shuttering Work	5 days	Oct 15	Oct 19
Slab Steel Binding Work	4 days	Oct 20	Oct 23
slab supporting & outer formwork	2 days	Oct 24	Oct 25
electrical piping work	1 day	Oct 26	Oct 26
slab casting work	1 day	Oct 27	Oct 27

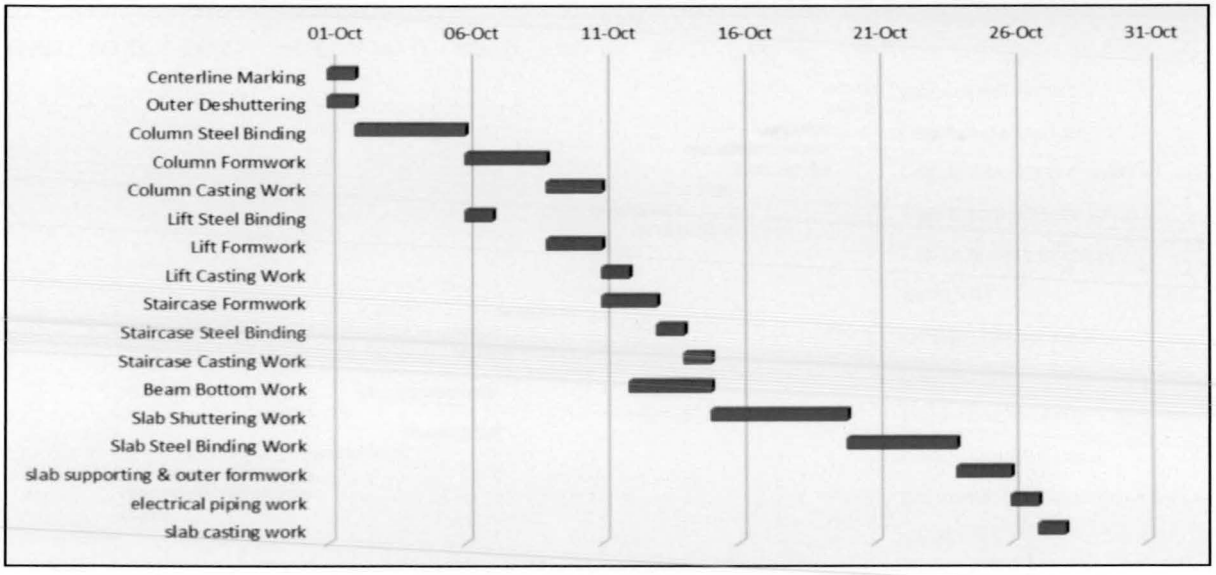

Figure 3: Bar Chat Of Existing Schedule

Table 5: New Improved Schedule

Task Name	Duration	Start	Finish
Center line marking	1 day	Oct 01	Oct 02
Outer De-shuttering	1 day	Oct 01	Oct 02
Lift formwork stage 1	1 day	Oct 02	Oct 03
Column steel binding stage 1	3 days	Oct 02	Oct 05
Column Formwork stage 1	2 days	Oct 02	Oct 04
Column casting stage 1	1 day	Oct 04	Oct 05
Column steel binding stage 2	2 days	Oct 05	Oct 07
Column formwork stage 2	2 days	Oct 04	Oct 06
Column casting stage 2	1 day	Oct 06	Oct 07
Lift formwork stage 2	1 day	Oct 06	Oct 07
Lift casting	1 day	Oct 06	Oct 07
Staircase formwork & steel binding	2 days	Oct 07	Oct 09
Staircase casting work	1 day	Oct 09	Oct 10
Slab steel prework	3 days	Oct 07	Oct 10
Bottom work stage 1	2 days	Oct 07	Oct 09
Slab shuttering stage 1	3 days	Oct 09	Oct 12
Steel binding stage 1	2 days	Oct 12	Oct 14
Bottom work stage 2	2 days	Oct 09	Oct 11
Slab shuttering stage 2	2 days	Oct 11	Oct 13
Steel binding stage 2	3 days	Oct 13	Oct 16
Outer and sunk formwork and supporting	4 days	Oct 13	Oct 17
Electrical piping	1 day	Oct 16	Oct 17
Checking work	0 days	Oct 17	Oct 17
Slab casting	1 day?	Oct 17	Oct 18

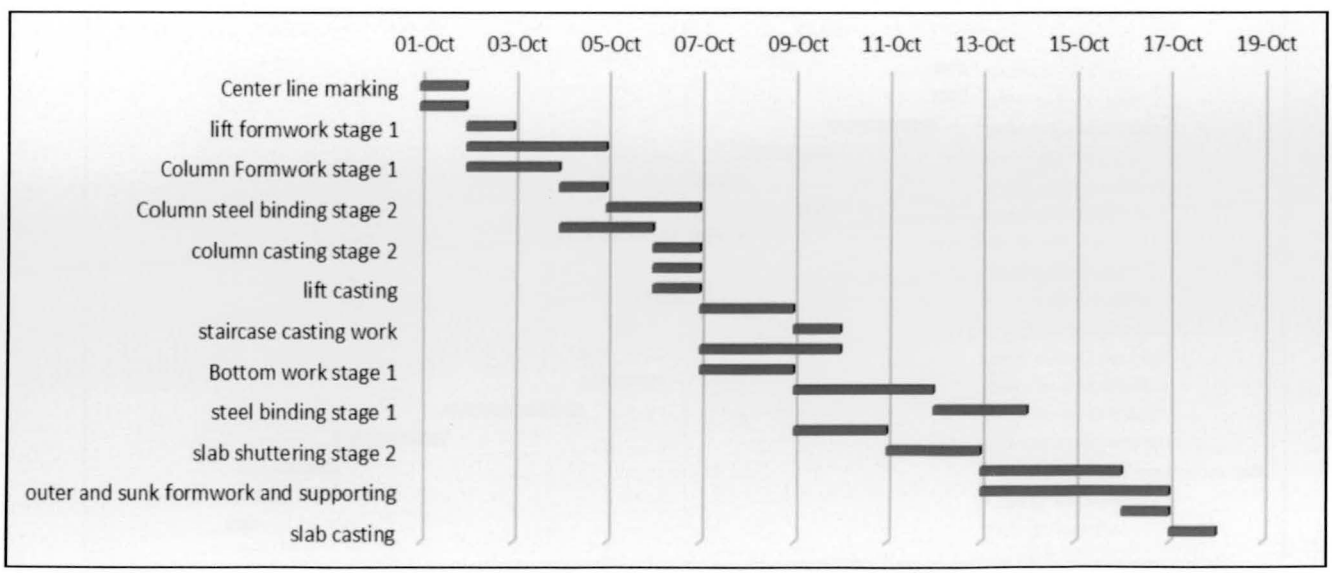

Figure 4: Bar Chat Of New Improved Schedule

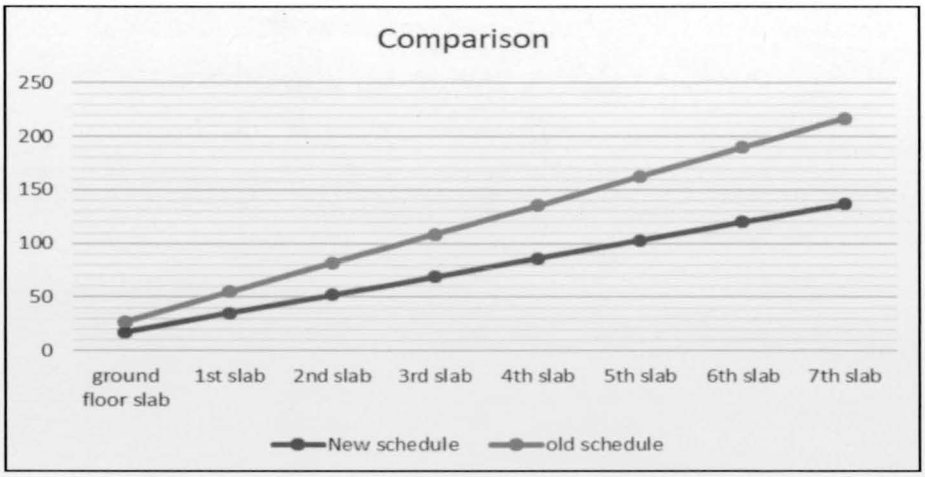

Figure 5: Old Vs New Schedule Comparative Chart

supplier name	Requirement area	order quantity	unit	order date	on site requirement	note
Anand sales corporation	column-lift-staircase steel	8mm- 285 10mm- 50 12mm- 110 16mm- 17	nos	29-Sep	2-Oct	fe500
	slab-beam steel	8mm- 1000 10mm- 185 12mm- 35 16mm- 140	nos	6-Oct	9-Oct	fe500
Shree Ram Sham traders	column-lift-staircase cement	200	bag nos	30-Sep	2-Oct	opc cement
	slab-beam cement	600	bag nos	15-Oct	17-Oct	opc cement
ptashrungi building material s	column-lift-staircase aggregate	4	Brass	30-Sep	2-Oct	20 mm
	slab-beam aggregate	14	Brass	15-Oct	17-Oct	20 mm
Jamuna infra project Ltd	column-lift-staircase sand	4	Brass	29-Sep	2-Oct	wash sand
	slab-beam sand	14	Brass	14-Oct	17-Oct	wash sand
hree Dhaneshwari enterprise	column-lift-staircase cover	40mm -2	bag nos	30-Sep	2-Oct	0
	slab-beam cover	25mm -2 20mm- 2	bag nos	7-Oct	9-Oct	0
Anand sales corporation	column-lift-staircase wire	1	bundle	29-Sep	2-Oct	60kg bundle
	slab-beam wire	2	bundle	6-Oct	9-Oct	60kg bundle

Figure 6: Snapshot Of MRP

This study can be used for similar repetitive activities. Hence by using this improved schedule for 80 days a total of 8 cycles are reduced.

Development Of Material Requirement Plan

1) Quantifying Quantity using Microsoft Excel.
2) Developing Material Requirement Plan.
3) Linking Microsoft Project with Microsoft Excel so that it can automatically change according to each other.

Development Of Cash Outflow Plan

With the help of material requirement plan and credit limit of supplier, cash outflow plan with the graph is prepared and linked it with material requirement plan.

CONCLUSION

Major outcomes of the study appear to be

1. Use of softwares for scheduling, MRP, cash outflow with interconnecting features helped updating the schedule on delays and consequent updating of MRP and cash out flow
2. Breaking a major activity into smaller activities and proper sequencing in the preparation of schedule reduce the construction time significantly.
3. A proper MRP and cash outflow help avoid delays in construction.

Anand sales corporation	3208	8mm- 285 10mm- 50 12mm- 110 16mm- 17	29-Sep	14-Oct	₹152,380.00
	9111	8mm- 1000 10mm- 185 12mm- 35 16mm- 140	6-Oct	21-Oct	₹432,772.50
Shree Ram Sham traders	200	bag nos	30-Sep	25-Oct	₹57,000.00
	600	bag nos	15-Oct	9-Nov	₹171,000.00
Shree saptashrungi building material suppliers	4	Brass	30-Sep	14-Nov	₹9,600.00
	14	Brass	15-Oct	29-Nov	₹33,600.00
Jamuna infra project Ltd	4	Brass	29-Sep	6-Oct	₹17,200.00
	14	Brass	14-Oct	21-Oct	₹60,200.00
Shree Dhaneshwari enterprises	2	40 mm bag	30-Sep	30-Oct	₹2,000.00
	4	25/20 mmbag	7-Oct	6-Nov	₹15,000.00
Anand sales corporation	60	KG	29-Sep	14-Oct	₹198,000.00
	120	KG	6-Oct	21-Oct	₹396,000.00

Figure 7: Snapshot Of Cash Outflow Plan

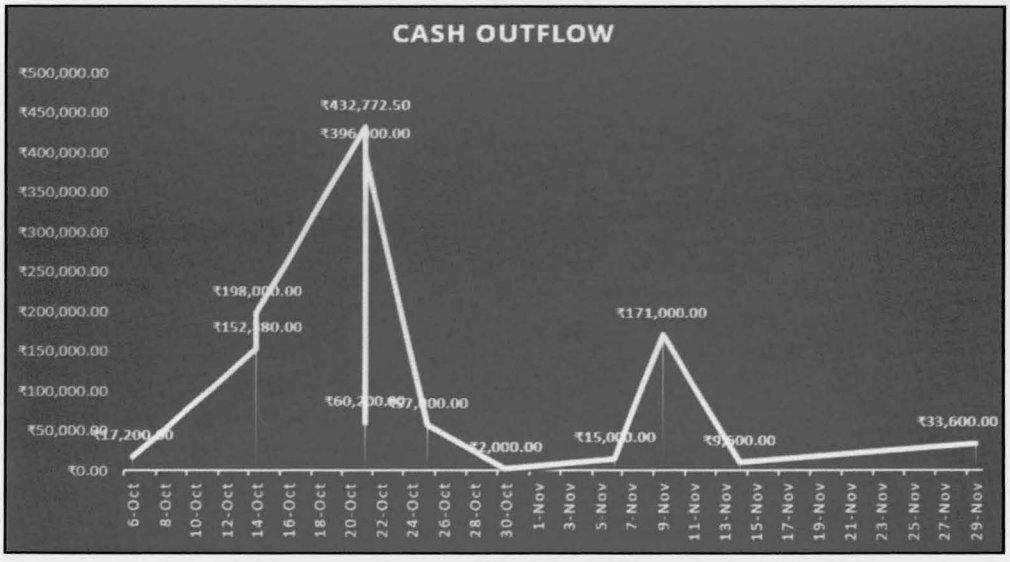

Figure 8: Cash Outflow Graph

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