

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



ENGINEERING MANAGEMENT

(GE 404)

1

LECTURE #9

Cash Flow Analysis

Contents

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- **Introduction**
- Terminologies
- Cash Flow: Cash in and Cash out
- Most common types of construction contracts
- Contract cash flow curves
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- Problem
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Objectives of the Present lecture

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- *To discuss the fundamentals of cash flow analysis*
- *To explain the steps involved in drawing the contract cash flow curves*

Introduction

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- As with any businesspersons, contractors are primarily concerned with making money in their businesses.
- The decisions they make in preparing for and running each of their projects are inevitably related to costs and income.
- The application of resources (materials, workforce, and machines) relates directly to another resource, money.
- CPM provides a means for relating time and money.

Terminologies

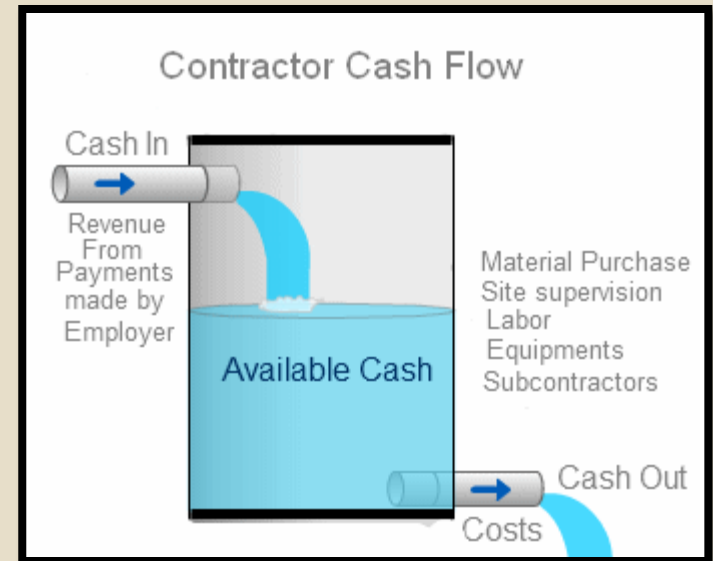
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- **Bid**: to offer to do work or provide a service for a particular price
 - *French firm will be bidding for the contract.*
- **Tender**: a formal offer to do work at a stated price
 - *A local firm submitted the lowest tender*
- **Disbursement**: the process of paying money; an amount of money paid
There have been delays in the disbursement of funds
- **Retainage**: Portion of a contract's final payment withheld by a principal (client or owner) until the project is complete in all respects
- **Lien**: the right to keep somebody's property until a debt is paid
- **Markup**: an increase in the price of something based on the difference between the cost of producing it and the price it is sold at
 - *an average markup of 10%*
 - *The markup on food in a restaurant is at least 100%.*

Cash Flow

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- A cash flow analysis is an investigation of a project in which the focus is on the flow of money.
- Thus *Cash flow* refers to a contractor's income and outgo of cash.
- The *net cash flow* is the difference between cash out and income at any point in time.
- A positive cash flow is when the cumulative revenues exceed the cumulative expenditures (meaning that surplus cash is available)
- A negative cash flow can also occur, and this means that more money is being spent than received.
- A **negative cash flow** will mean that the firm will need to take the appropriate steps to borrow from within the firm or financial institutions to cover the shortfall in funds.



Factors that Minimize Contractor's Negative Cash Flow

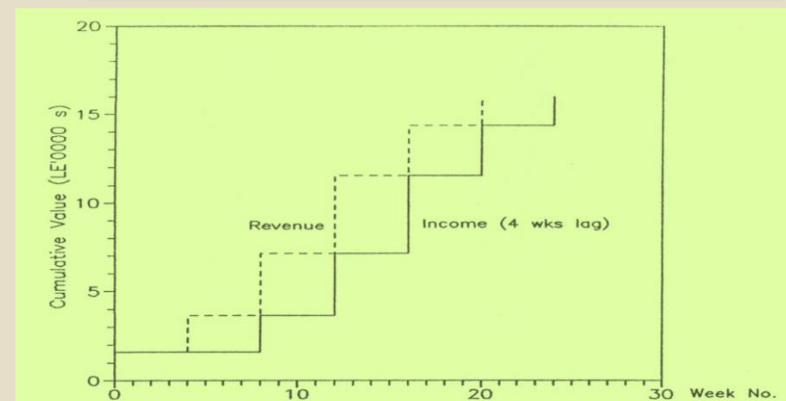
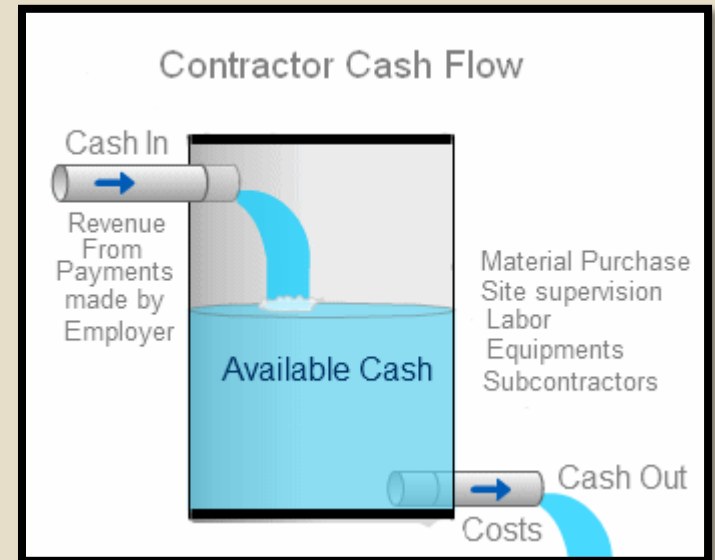
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- Front end rate loading: earlier items in bill of quantities carry a higher mark-up than later items. This reduces negative cash flows in contract early stages
- Reduction of delays in receiving revenue
- Adjustment of work schedule to late start timing
- Coinciding the timing of delivery of large materials orders with the submittal of the contractor's monthly pay estimate
- Delay in paying labor, plant hirers, materials suppliers, and subcontractors. This would reduce negative cash flows but undermine commercial confidence in the company
- Increasing the mark-up and reducing the retentions
- Increasing advance payment
- Achievement of maximum production in the field
- Quick settlement of claims

Cash in

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- Owner shall make progress payments of the contract amount to the prime contractor as the work progresses
- Cash in = Cash receipt = income
- Principal components of cash in
 - Value of work actually performed in the field
 - Material stored on the site, but not yet incorporated into work, as well as any prefabrication or pre assembly work that the contractor may have done at some location other than the job site
- A step curve is used to represent contract cash income
- *An income is the actual receipt of revenue.*

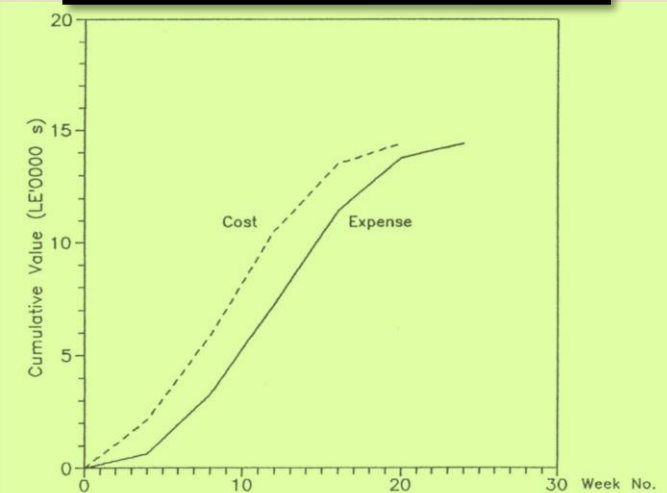
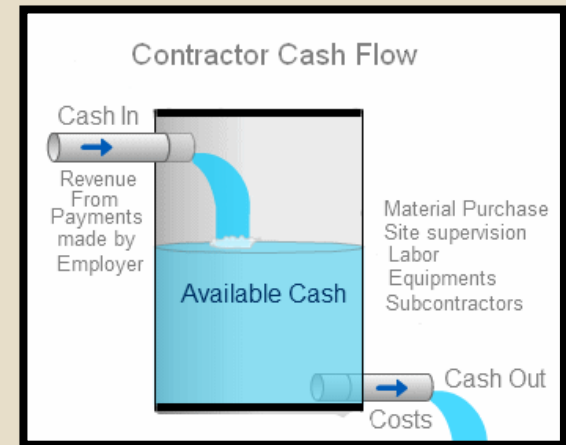


Contract revenue and income curves

Cash Out

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- Cash out = payment of costs = expense
- An *expense* is the actual payment of *costs*.
- Principal components of cash out
 - “Up-front” costs = initial expenses = start-up costs are costs necessary to start the project such as costs of moving in workers and equipment; erecting field offices, storage sheds, fences; job layout; installation of temporary electrical, water, telephone, sanitary, and other services; bonds; permits and project insurance.
 - Payment of direct job costs. These include costs associated with payrolls, materials, equipment, and subcontractor payments.
 - Payments for field overhead expense and tax.
- An S-curve (a smooth curve) is used to represent contract cash out.



Contract cost and expense curves

Most Common Types of Construction Contracts

- A construction contract is an agreement that outlines the way a construction job is executed and the specific amount of compensation for the job.
- **Unit price contract** – This contract type is based on anticipated quantities of items which are counted in the project in addition to their unit prices. The final price of the project depends upon the quantities required to carry out the work.
 - Generally, this contract is suitable only for construction and supplier projects which involve accurate identification of different types of items, but not their numbers, in the contract documents.
- **Lump sum contract** – Under this contract type, the engineer or contractor agrees to perform the specified and described project for a fixed price. This type of contract is also referred to as a “**Fixed Price Contract**”.
 - A Lump Sum or Fixed Price contract is appropriate where scope and schedule of the project are defined sufficiently thus allowing the contractor or engineer to estimate the costs of the project.

Contd.

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- **Cost plus contract** – The cost plus contract is an agreement which involves the buyer's consent to pay the complete cost for material and labor in addition to the amount for contractor overhead and profit.
 - This contract type is favored where the scope of work is highly uncertain or indeterminate in addition to the types of labor, material, and equipment being similarly uncertain in nature (Uncertainty in scope and resource type).
- **Incentive contracts** – The incentive contracts feature compensation based on the contracting and/or engineering performance in accord with an agreed target – schedule, quality, and budget.
 - Incentive contracts commonly fall into one of two common categories: Fixed Price Incentive Contracts and Cost Reimbursement Incentive Contracts.
- **Percentage of construction contracts**—This contract type is common for engineering contracts. The compensation involved in these contracts is based on a percentage of the cost of construction.

Payment request for unit price contract

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- The quantities of work done on unit-price contracts are determined by actual field measurement of the bid items put into place.
- The total quantity accomplished to date on each bid item is multiplied by its corresponding contract unit price.
- All of the bid items are totaled and the value of materials stored on the site as well as any prefabrication or pre assembly work that the contractor may have done at some location other than the job site is then added.
- The prescribed retainage is subtracted from this total.
- The resulting figure represents the entire amount due to the contractor for his work to date. The sum of all prior progress payments that have already been paid is then subtracted, this yielding the net amount of money payable to the contractor for his work that month.

Payment request for lump sum contract

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- Under lump sum contract the project is divided for payment purposes into relatively few work classifications (major job components). Contracts progress is measured in terms of estimated percentages of completion of work classifications.
- The contractor estimates the percentage completed and in place.
- The total value of each work classification is multiplied by its percent completion.
- To the total of completed work is added the value of all materials stored on the site. From this total is subtracted the retainage. This gives the total amount of money due to the contractor (up to the date of the pay request).
- From this is subtracted the amount of progress payments already made. The resulting figure gives the net amount now payable to the contractor.

Payment Request for Negotiated (e.g. Cost-Plus) Contract

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- Negotiated contracts of the cost-plus variety usually provide for the contractor's submission of payment *vouchers* to the owner at specified intervals during the life of the contract.
- The contractor must make periodic accountings to the owner for the cost of the work, either to receive direct payment from the owner or to obtain further advances of funds.
- A common provision is **weekly reimbursement** of **payrolls** and **monthly reimbursement** of all **other costs**, including a proportion of the contractor's fee.

Contract Provisions that Impact Cash in

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- Advanced payment
- Progress payment
- Materials stored on the site
- Final Payment
- Retention
-

Retainage or Retention

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- A prescribed percentage of each progress payment is usually retained by the owner in accordance with the terms of the contract
- The retainage may be held by the owner until the work receives final certification by the A/E, the owner accepts the project
- Final payment is then made to the contractor, including the accumulated retainage

Final Payment

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- After the work has been finalized and all deficiencies remedied, the owner makes formal written acceptance of the project and the contractor presents his application for final payment
- Under a lump-sum form of contract, the final payment is the final contract price less the total of all previous payment installments made
- With a unit-price contract, the final total quantities of all payment items are measured and the exact final contract price is determined. Final payment is again equal to the contract price less the sum of all progress payments previously made
- In all cases, final payment by the owner includes all **retainage** that has been held by him

Cash Flow Forecasting

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- A determination of the future rates of cash outs and cash income together with their combined effect on the project cash balance is called a "*cash flow forecast*"
- Cash flow forecasting is required to determine whether or not the funds to execute the plan are available.
- Cash flow forecasting is the **forecasting of both cash in and cash out of the project.**
- Forecast of cash flow is required:
 - To determine the negative cash flow and how to cover it
 - To determine the positive cash flow and how to use it (the positive cash flow of one contract may be used to handle the negative cash flow of another)

Simplified Approach to Forecast Contract Cash Flow (Contract Revenue/Income Curve)

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1. Produce an activity schedule in bar chart or time-scaled form. Determine the value/price of each activity per week
2. Find the monthly revenue
3. Adjust the revenue for advanced payment and retention
4. Draw cumulative adjusted revenue versus time curve
5. Shift the above curve by the lag between submitting payment requests and receiving revenue to get the income curve

Simplified Approach to Forecast Contract Cash Flow (Contract Cost/Expense Curve)

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When the mark-up is uniformly spread throughout the contract, the cost/expense curve can be derived as follows:

If the mark-up; M , is expressed as a percentage of tender price, then:

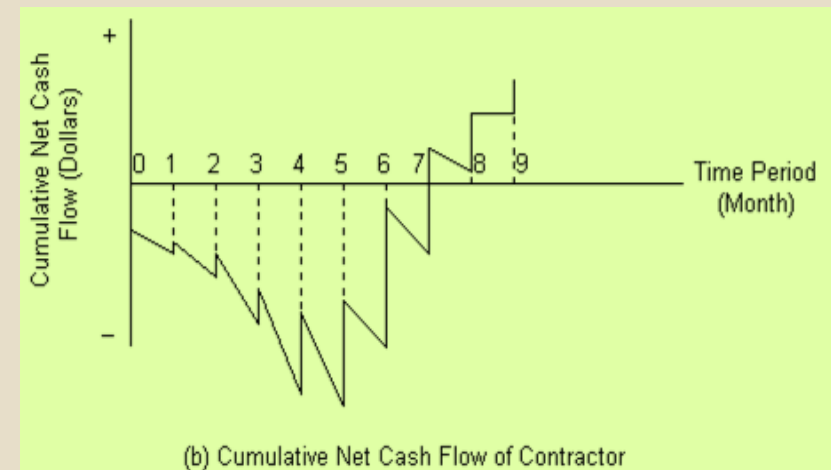
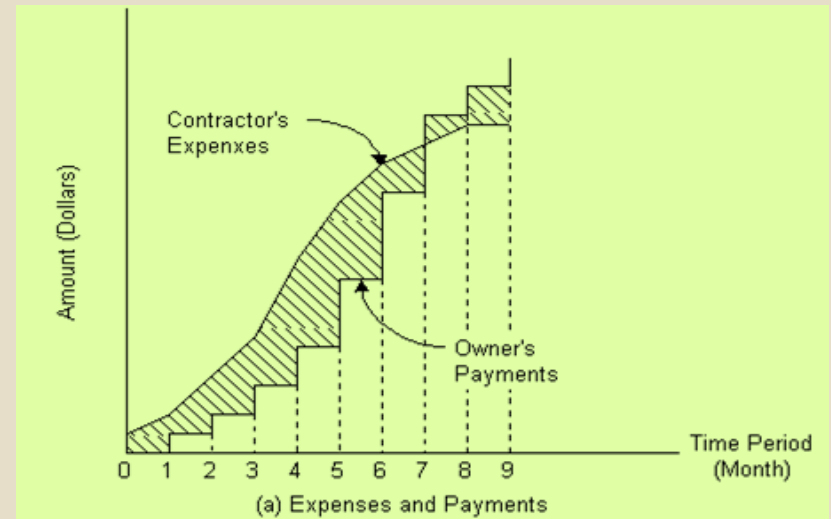
$$\text{Cumulative cost} = \text{cumulative revenue} \times (1 - M)$$

1. Draw cumulative cost versus time curve
2. Group cost headings that have the same payment delay between incurring the cost and making the payment
3. Calculate the proportion of costs due to each group
4. Shift the cumulative cost of each group by the specified amount to get its cumulative expense
5. Sum up contract cumulative expenses
6. Draw cumulative expense curve

Contract Cash Flow Curves

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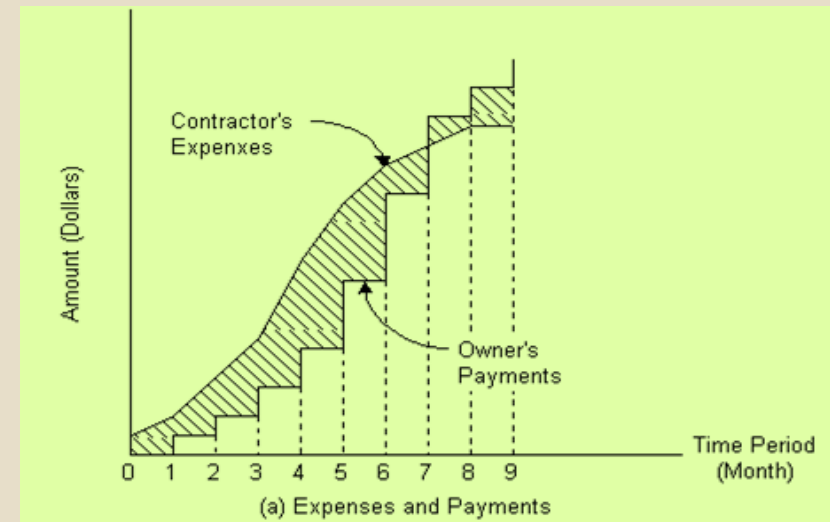
- Having determined the contract cumulative income and expense curves, one can combine them on one graph to represent the contract *cumulative cash flow* curves
- The difference between contract cumulative income and expense curves can be drawn to represent the contract *cumulative net cash flow*



Financial Charges

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- The **cash invested** in the contract is represented by the negative area between the expense and income curves.
- This area, A , can be calculated in units of “SR. weeks” if the vertical scale is in Saudi Riyal and the horizontal scale in weeks.
- If the rate of investment is $r\%$ per year, then the financial charges can be calculated as follows:
 - $\text{Financial charges} = A \times r / 52$
- It is important to point out that if the contractor borrows the negative cash with interest, then r equals the interest rate.



Note

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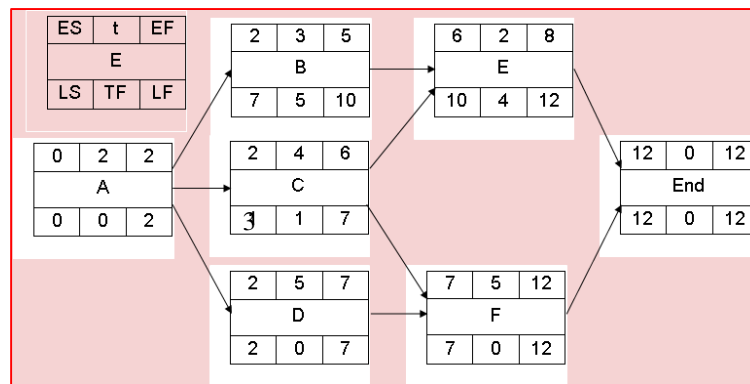
- $Cost = Price \times (1 - M)$
- $Price = Cost \times (1 + M)$
- $Cost/Price = 1 - M$
- $Price/Cost = 1 + M$

- **M is in fraction (e.g. 20% in fraction will be 0.2)**

The following network shows the activities of small project. The activities' durations are in weeks. The price of each activity is shown in below table.

Problem-1

- According to contract conditions, the contractor will receive **advanced payment** of 20%. This will be deduced from each monthly revenue.
- Applications of payments will be submitted by the contractor to the client every 4 weeks and **payment** will be after 2 weeks from the submission of the application.
- The client will deduct 10% from each payment as **retention**. All retentions will be paid to the contractor with the last payment.
- The ratio between **project price to project cost** is 1.1 (project price /project cost = 1.1). There is no delay in paying the costs by the contractor.
- *Calculate and draw the cash flow curves (cash-in and cash-out) based on early start time.*



Activity	A	B	C	D	E	F
Price (SR)	20000	45000	20000	30000	16000	30000

Solution

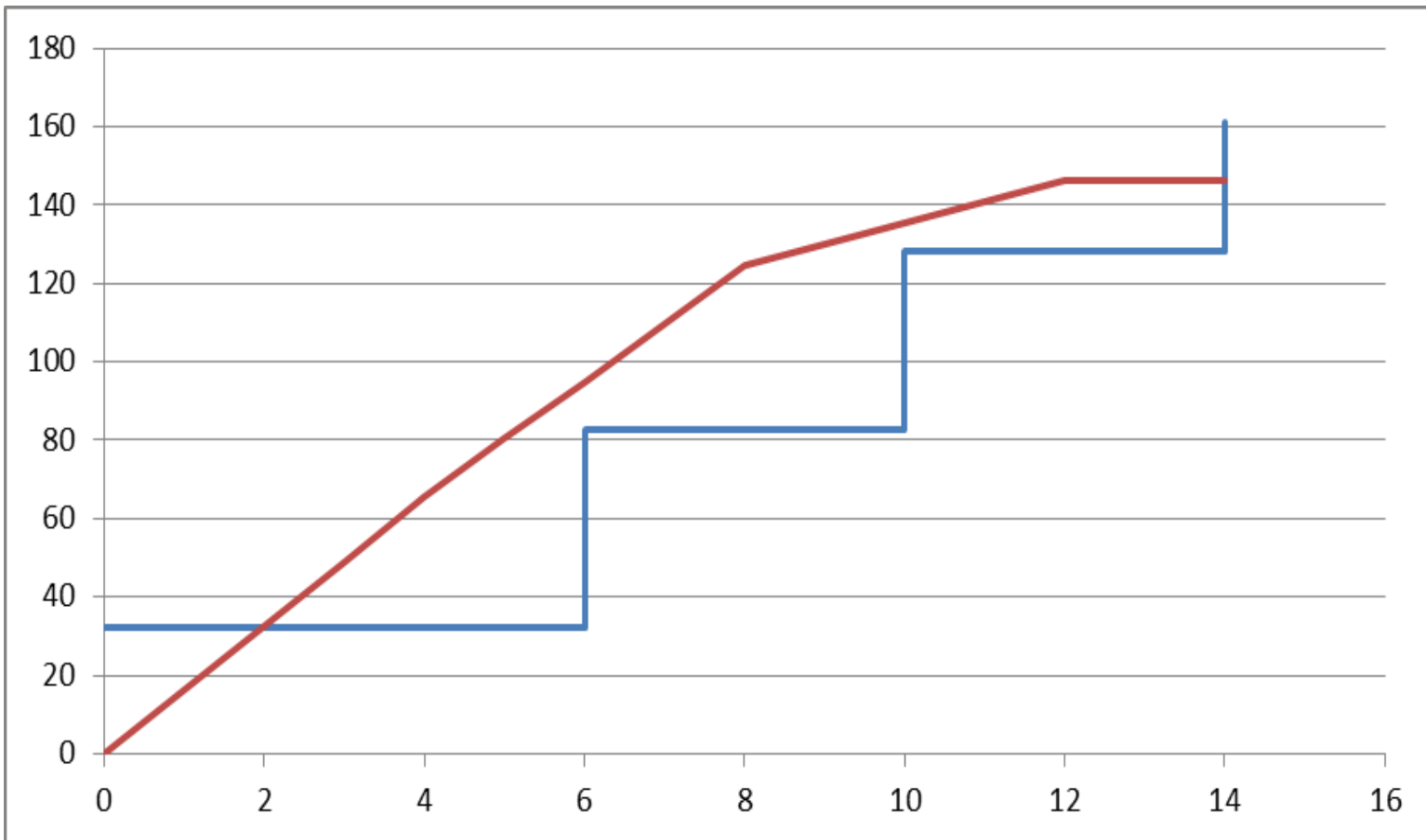
	Time (week)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	10	10													
B			15	15	15										
C			5	5	5	5									
D			6	6	6	6	6								
E							8	8							
F								6	6	6	6	6			
Weekly Revenue	10	10	26	26	26	11	14	14	6	6	6	6			
Monthly Revenue				72				65				24			
Advanced payment	32.2														
Retention												16.1			
Adjust. Revenue				50.4				45.5				16.8			
Income	32.2						82.6				128.1			161	
monthly cost				65.45				59.1				21.82			
cumulative cost				65.45				124.55				146.37			

$\Sigma = 161$
 $20\% * 161$
 $10\% * 161$

$(72 - .1 * 72 - .2 * 72)$

$(72 / 1.1)$

Income	32.2					82.6			128.1			161
Cost		32.73	65.45	95	124.55	135.46	146.37	146.37				
	32.2	-0.53	-33.25	-62.8	-41.95	-52.86	-18.27	-18.27				
						-12.4			-7.36			14.63



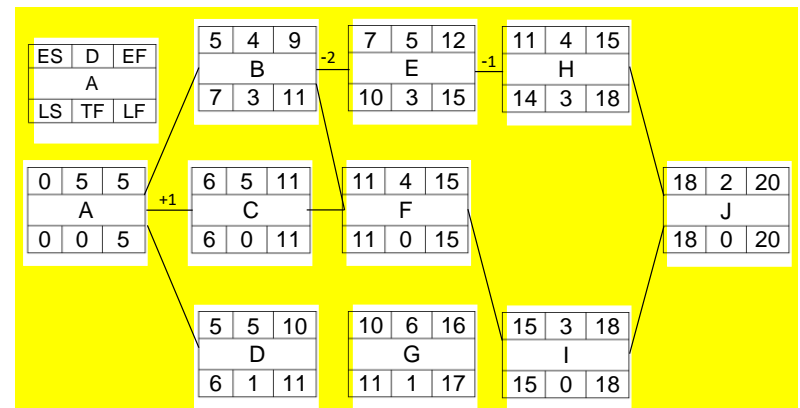
Solution (Contd.)

To get the cost in each week distribute the monthly cost evenly over 4 weeks.
 For example, Cost after 2 weeks from the start will be:
 $65.45/4 * 2 = 32.73$.

Problem-2

Activity	Duration (Week)	Preceding Activity	Value of Lag	Value (SR)
A	5	-		30000
B	4	A		20000
C	5	A	+1	15000
D	5	A		15000
E	5	B	-2	25000
F	4	B,C		16000
G	6	D		18000
H	4	E	-1	8000
I	3	F,G	-2 with G	9000
J	2	H,I		4000

- The activities involved in a small engineering project are given in the table. The value of the work involved in each activity is listed in the table.
- The **mark-up** is 10% of tender value and is assumed to be uniformly distributed over the contract.
- The contractor will receive an advanced payment of 10% of tender value. This will be deducted from each monthly revenue.
- Retention is 5% and is paid on contract completion.
- Labor cost is assumed to be 30% of total contract cost.
- The **delay** for other payment is one month.
- Revenue is received after 4 weeks from submitting invoices
- Assume all the activities are scheduled on their early start timings
- Derive income and expense curve and contract cash flow curves.**



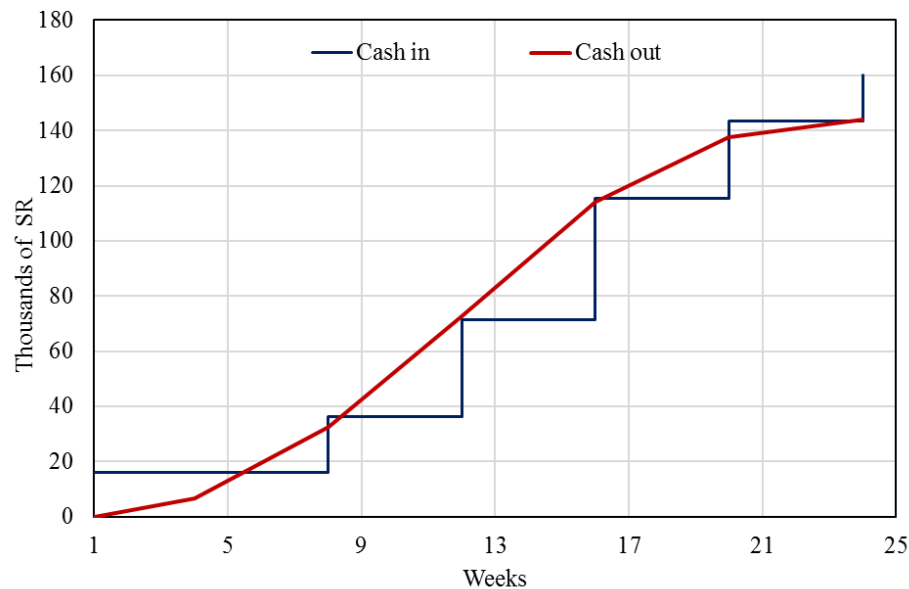
Solution

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	month1					month2				month3				month4				month5				month6			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
A	6	6	6	6	6																				
B						5	5	5	5																
C							3	3	3	3	3														
D						3	3	3	3	3															
E								5	5	5	5	5													
F												4	4	4	4										
G											3	3	3	3	3	3									
H												2	2	2	2										
I																3	3	3							
J																			2	2					
a	Weekly Revenue	6	6	6	6	6	8	11	16	16	11	11	14	9	9	9	6	3	3	2	2				
b	Monthly Revenue				24				41				52				33			10					
c	cumulative Revenue				24				65				117				150			160					
d	Advanced payment	16																							
e	Adju. month Revenue				20.4				34.85				44.2				28.05			8.5					
f	Retention																			8					
G	cumulat. Adju. Revenue	16			36.4				71.25				115.45				143.5			160					
h	In come 4 week	16							36.4				71.25				115.45			143.5			160		

(24-
.1×24-
.05×
24)

j	cumulative cost 0.9C				21.6			58.5			105.3			135			144		
k	cumulative labor cost				6.48			17.55			31.59			40.5			43.2		
L	cumulative labor expen.				6.48			17.55			31.59			40.5			43.2		
H	other cost 0.7 j				15.12			40.95			73.71			94.5			100.8		
n	other expen.							15.12			40.95			73.71			94.5		100.8
o	cumulative expen. L+n				6.48			32.67			72.54			114.21			137.7		144
Q	mid month cumula. Expen.		3.24			19.575			52.605			93.375			125.96			140.85	
q	Cash flow	16			9.52			-16.67			-36.14			-42.69			-22.25		-0.5



Sample Mid Month expense Calculations

$$= [(72.54 - 32.67) / 4] \times 2 + 32.67 = 52.605$$

$$= (72.54 - 32.67) / 2 + 32.67 = 52.605$$

Similarly

$$= (137.7 - 114.21) / 2 + 114.21 = 125.96$$

Similarly

$$= (144 - 137.7) / 2 + 137.7 = 140.85$$

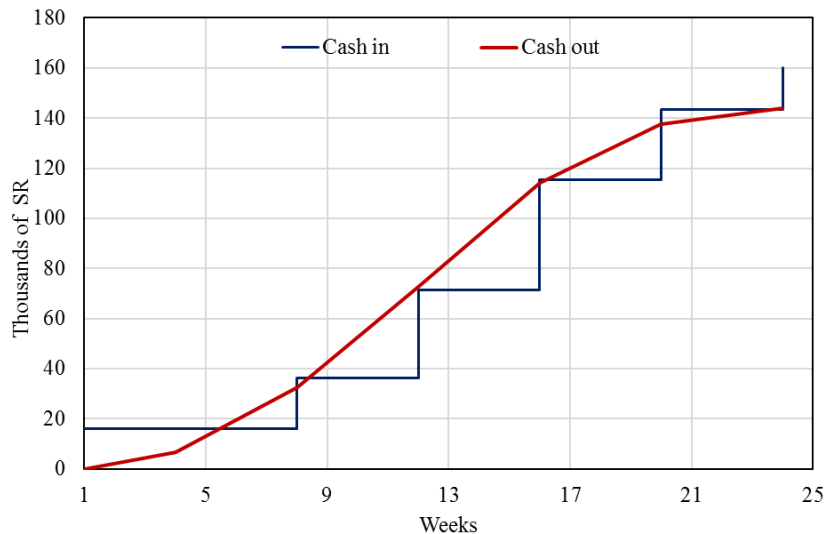
Sample Cash flow Calculations:

$$16 - 6.48 = 9.52$$

$$16 - 32.67 = -16.67$$

$$36.4 - 72.54 = -36.14$$

Activity	Time (weeks)																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	6	6	6	6	6																			
B						5	5	5	5															
C							3	3	3	3	3													
D						3	3	3	3	3														
E								5	5	5	5													
F												4	4	4	4									
G											3	3	3	3	3	3								
H												2	2	2	2									
I																3	3	3						
J																			2	2				
Weekly Revenue	6	6	6	6	6	8	11	16	16	11	11	14	9	9	9	6	3	3	2	2				
Monthly Revenue				24				41				52				33					10			
Advanced Payment	16																							
Retention																								
Adjust. Revenue				20.4				34.9				44.2				28.1					8.5			
Cumulative revenue	16			36.4				71.3				115.5				143.5					160.0			
Cumulative Income	16							36.4				71.3				115.5					143.5			160.0
Cost				21.60				36.90				46.80				29.70					9.00			
Cumulative Cost				21.60				58.50				105.30				135.00					144.00			
Cumulative labour cost				6.48				17.55				31.59				40.50					43.20			
Cumulative other cost								15.12				40.95				73.71					94.50			100.80
Cumulative expense				6.48				32.67				72.54				114.21					137.70			144.00
Net Cash Flow	16			9.52				-16.67				-36.14				-42.96					-22.25			-0.50
								3.73				-1.29				1.24					5.80			16.00



Sample Mid Month expense Calculations

$$= [(72.54 - 32.67) / 4] \times 2 + 32.67 = 52.605$$

$$= (72.54 - 32.67) / 2 + 32.67 = 52.605$$

Similarly

$$= (137.7 - 114.21) / 2 + 114.21 = 125.96$$

Similarly

$$= (144 - 137.7) / 2 + 137.7 = 140.85$$

Sample Cash flow Calculations:

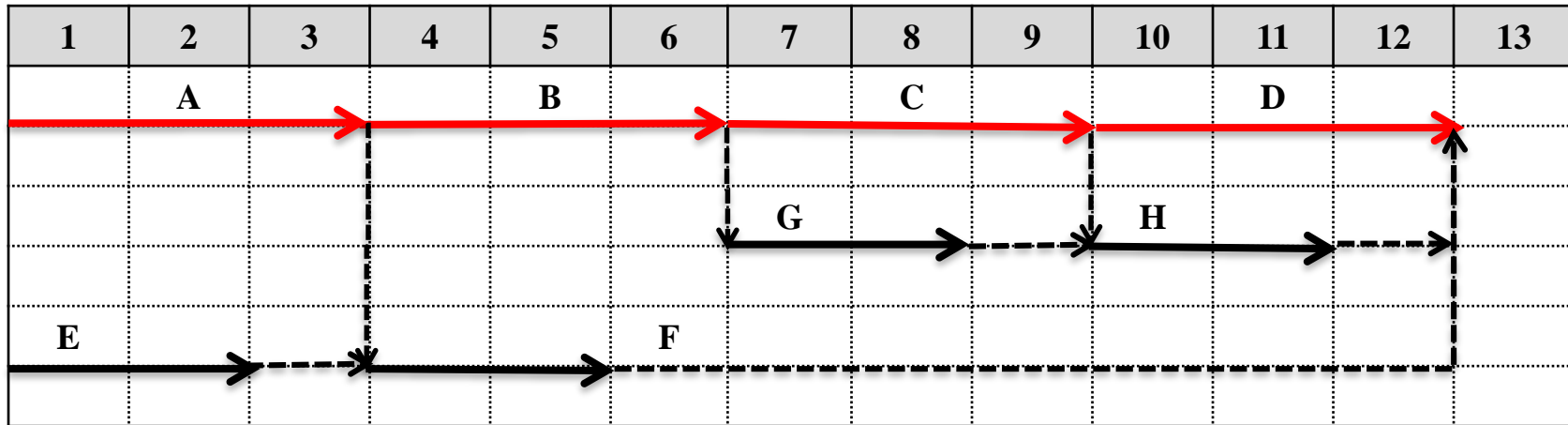
$$16 - 6.48 = 9.52$$

$$16 - 32.67 = -16.67$$

$$36.4 - 72.54 = -36.14$$

The following Time scaled network shows the activities of a small engineering project. The cost of each activity is shown in the table below.

Problem-3



Activity	A	B	C	D	E	F	G	H
Total cost	10000	25000	10000	5000	15000	5000	7500	15000

- The contractor will receive advance payment of 15% of the project price. This will be deducted from each monthly revenue.
- Application of payment will be submitted by the contractor to the client every month and payment will be after 4 weeks from the submission of the application.
- The client will deduct 5% from each payment as retention . All retention will be paid to the contractor with the final payment .
- Assume the markup is 20% of the total project cost and is uniformly distributed over the work. There is no delay in paying costs by the contractor.

Calculate the cash-in and cash-out values and find maximum negative cash flow.

Solution

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Price = Cost \times (1+M) ; M:markup= 20%=0.2

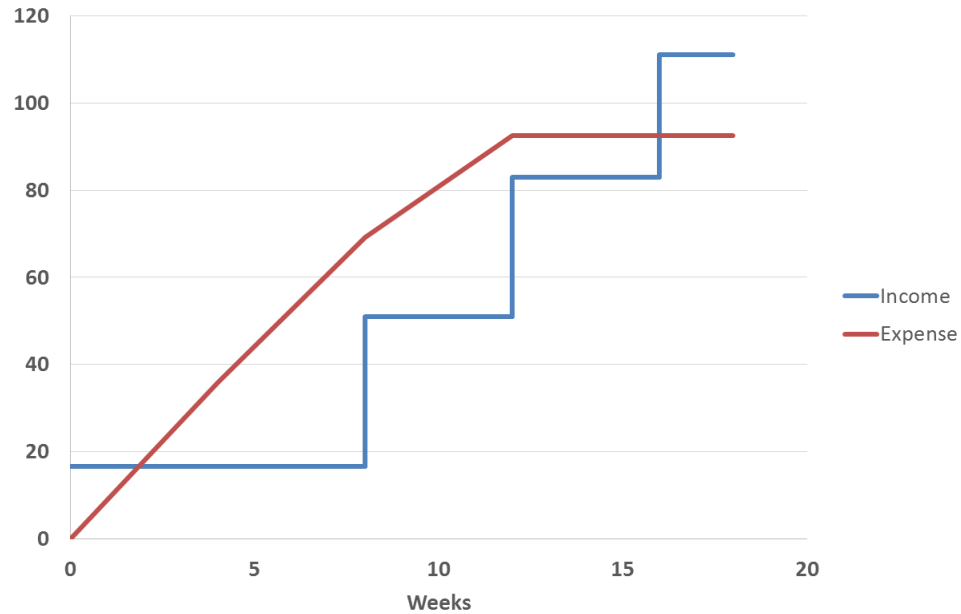
Activity	A	B	C	D	E	F	G	H	Total
Total cost	10000	25000	10000	5000	15000	5000	7500	15000	92500
Revenue	12000	30000	12000	6000	18000	6000	9000	18000	111000

Advanced payment = $0.15 \times 111000 = 16650$

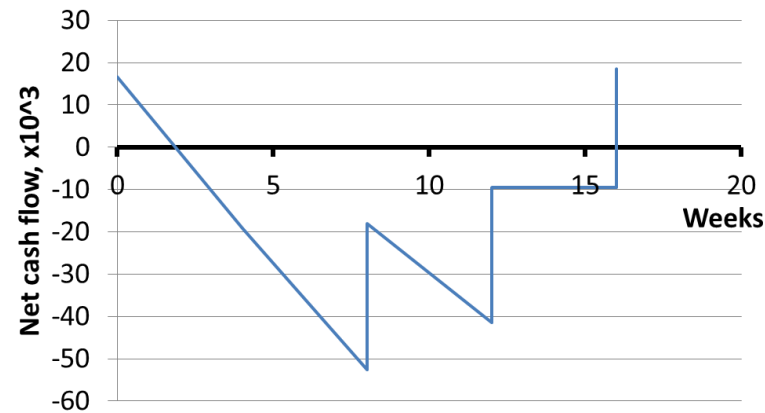
Retention = $0.05 \times 111000 = 5550$

	Time (weeks)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A (12)	4	4	4														
B (30)				10	10	10											
C (12)							4	4	4								
D (6)										2	2	2					
E (18)	9	9															
F (6)				3	3												
G (9)							4.5	4.5									
H (18)										9	9						
Weekly Revenue	13	13	4	13	13	10	8.5	8.5	4	11	11	2					
Monthly Revenue				43				40				28					
Advanced payment	16.65																
Retention												5.55					
Adjust. Revenue				34.4				32				22.4					105.45+
Cumulative Income	16.65							51.05				83.05					111
Cost				35.83				33.3				23.3					
Cumulative Cost				35.83				69.17				92.5					92.5
Net Cash flow	16.65			-19.18				-52.51				-41.45					-9.45
								-18.12				-9.45					18.5

Solution (contd.)



Net cash flow vs. time



Problem-4

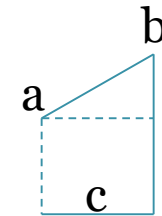
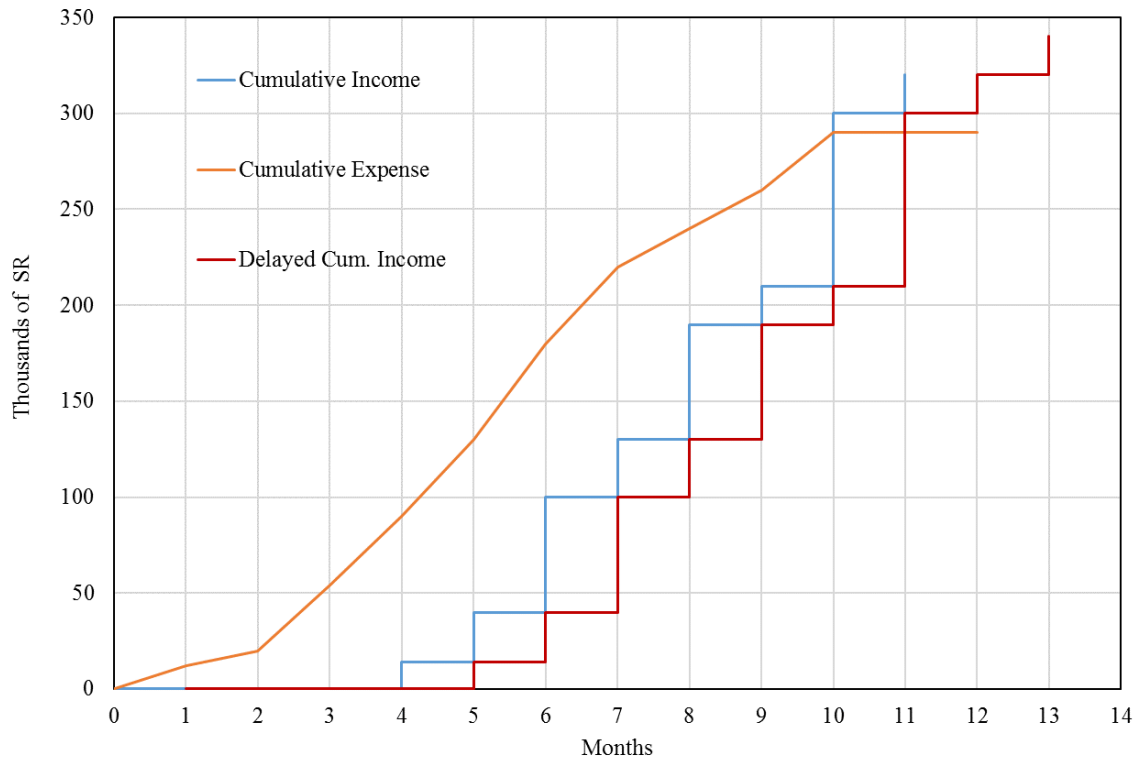
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The table below lists the cumulative monthly expenses incurred by contractors and the corresponding monthly incomes which are received from the owner of a project.

If the owner makes all his payments one month later than anticipated in the table above, by what percentage will the cash invested (i.e. negative area between the expense and income curves) increase?

End of Month	Cumulative Expense, (1000SR)	Cumulative Income, (1000SR)
0	0	0
1	12	0
2	20	0
3	54	0
4	90	14
5	130	40
6	180	100
7	220	130
8	240	190
9	260	210
10	290	300
11	290	320
12	290	340

Solution



$$Area = \frac{1}{2} \times c \times (b - a) + a \times c$$

$$\Rightarrow Area = \frac{1}{2} \times (a + b) \times c$$

Sample Calculation:

$$= 0.5(12+20) \times 1 = 16$$

$$= 0.5(20+54) \times 1 = 37$$

$$= 0.5(54+90) \times 1 = 72$$

$$= 0.5(130+90) \times 1 - 14 \times 1 = 96$$

End of Month	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Cumulative Expense (1000 SR)	0	12	20	54	90	130	180	220	240	260	290	290	290	
Cumulative Income (1000 SR)	0	0	0	0	14	40	100	130	190	210	300	320	340	
Negative Area	0	6	16	37	72	96	115	100	100	60	65	*	*	290
Additional Negative Area						14	26	60	30	60	20	80		957

$$\% \text{ Increase in negative area} = \frac{290}{667} \times 100 = 43.5\%$$

Further Reading

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Read more about the Cash-flow from:

Jimmie W. Hinze. “Construction Planning and Management,” Fourth Edition, 2012, Pearson.

Thank You

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Questions Please

