Practical Methods to Measure Productivity and Estimate Activity Duration

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From Theory to Practice

EQUATIONS

RD = OD – (PC * OD)

RD = (RQ * OD) / TQ

RD = (AD/PC) – AD

RD = (RQ * AD) / AQ

…

week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Date	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr	26-Apr	3-May	10-May	17-May	24-May	31-May	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul	26-Jul	2-Aug	9-Aug
Planned Quantity	1200	1600	2000	2500	3200	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	2500	2500	2500	2000	1000
Actual Quantity	0	1500	2000	1000	2000	1000	500	1500	2000	2500	3000	3000	?	?	?	?	?	?	?	?				

?

1 Remaining Duration

- Current Practices
- Problems and Solutions
- Proposed Model

2 Schedule Required Productivity Index (SRPI)

3 Conclusion

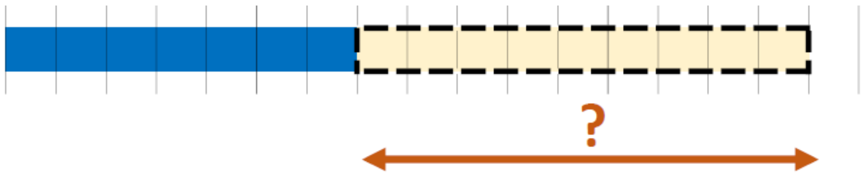
Remaining Duration

Current Practices of Forecasting Remaining Duration

Based on Baseline Assumptions

In this way, the planned schedule serves as a reference, and two different formulas can be applied.
The first formula considers the original duration and the current percent complete of activity as follows:

RD = OD – (PC * OD)



OD: Original Duration
RD: Remaining Duration
PC: Percent Complete
RQ: Remaining Quantity
TQ: Total Quantity

The second formula considers the original duration, remaining quantity, and total quantity as follows:

RD = (RQ * OD) / TQ

Example for Current Practices

Example

Assume an activity of installing 70,000 dia-inch pipe spools.

This activity was initially planned to be completed in 24 weeks, but in actual, after 12 weeks, 20,000 dia-inch has been installed, as indicated in the table below:

week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Date	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr	26-Apr	3-May	10-May	17-May	24-May	31-May	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul	26-Jul	2-Aug	9-Aug
Planned Quantity	1200	1600	2000	2500	3200	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	2500	2500	2500	2000	1000
Planned Quantity Cumulative	1200	2800	4800	7300	10500	14000	17500	21000	24500	28000	31500	35000	38500	42000	45500	49000	52500	56000	59500	62000	64500	67000	69000	70000
Actual Quantity	0	1500	2000	1000	2000	1000	500	1500	2000	2500	3000	3000												
Actual Quantity Cumulative	0	1500	3500	4500	6500	7500	8000	9500	11500	14000	17000	20000												
Actual Man-hour	0	150	200	200	200	200	250	350	550	550	600	650												

Answer

In this case, the remaining duration of this activity is calculated as follows:

Equation 1: RD = OD – (PC * OD) = 168 – (0.2857 * 168) = **120** : **Finish Date: 11 Sep 2020**

Equation 2: RD = (RQ * OD) / TQ = (50,000 * 168) / 70,000 = **120** : **Finish Date: 11 Sep 2020**

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First Problem of Current Practices and Proposed Solution

First Problem: Unrealistic Approach

In many practical cases, activities do not progress exactly according to the first baseline plan.

In these cases, real conditions are reflected in actual progress curve, making the baseline progress curve appear less realistic compared to actual progress curve.

Solution

Considering current project status instead of the baseline.

Based on Current Status (As a response to problem of unrealistic approach)

In this way, the current status is considered as a reference, and two different formulas can be used.

The first formula considers the actual duration and current percent complete of activity as follows:

RD = (AD/PC) – AD

The second formula considers the actual duration, remaining quantity, and actual quantity as follows:

RD = (RQ * AD) / AQ

RD: Remaining Duration

AD: Actual Duration

PC: Percent Complete

RQ: Remaining Quantity

AQ: Actual Quantity

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Example of Forecasting Remaining Duration by Considering Current Status

Example

Assume an activity of installing 70,000 dia-inch pipe spools.

This activity was initially planned to be completed in 24 weeks but in actual after 12 weeks, 20,000 dia-inch has been installed, as indicated in the table below:

week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Date	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr	26-Apr	3-May	10-May	17-May	24-May	31-May	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul	26-Jul	2-Aug	9-Aug
Planned Quantity	1200	1600	2000	2500	3200	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	2500	2500	2500	2000	1000
Planned Quantity Cumulative	1200	2800	4800	7300	10500	14000	17500	21000	24500	28000	31500	35000	38500	42000	45500	49000	52500	56000	59500	62000	64500	67000	69000	70000
Actual Quantity	0	1500	2000	1000	2000	1000	500	1500	2000	2500	3000	3000												
Actual Quantity Cumulative	0	1500	3500	4500	6500	7500	8000	9500	11500	14000	17000	20000												
Actual Man-hour	0	150	200	200	200	200	250	350	550	550	600	650												

Answer

Equation 3: RD = (AD/PC) – AD

RD = (84 / 0.2875) - 84 = 208 : **Finish Date:** 08 Dec 2020

Equation 4: RD = (RQ * AD) / AQ

RD = (50,000 * 84) / 20,000 = 210 : **Finish Date:** 10 Dec 2020

Second Problem of Current Practices and Proposed Solution

Second Problem : Unstable Pattern in Actual Quantities

In many practical cases, a scattered pattern can be observed in the progress curve from the start of the activity up to the cut-off-date. For example, the progress during the initial intervals is significantly lower compared to later ones, or there may be gaps in actual progress curve.

Solution

In such cases, relying on the entire duration from the start to the cut-off-date can lead to misleading future forecasts.

So, a dynamic approach that focuses on a selected time span is required.

week	1	2	3	4	5	6	7	8	9	10	11	12
Quantity	0	1500	2000	1000	2000	1000	500	1500	2000	2500	3000	3000

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First Stage of Proposed Method

Method- Stage 1 : As a response to problem of unstable pattern …
Considering Time Span

Stage	Steps	Abbreviation	Equation	Result
Stage 1	Start Date of Time Span	SDTS		19 Apr 20
	Finish Date of Time Span	FDTS		23 May 20
	Duration of Time Span	DTS	FDTS – SDTS + 1	23 May 20 – 19 Apr 20 + 1 = 35
	Cut-Off Date	COD		23 May 20
	Remaining Quantity	RQ		50,000
	Actual Quantity	AQ		10,500
	Actual Productivity	AP	AQ / DTS	10,500 / 35 = 300
	Forecasted Remaining Duration 1	RD1	RQ / AP	50,000 / 300 = 166.67
	Forecasted Finish Date 1	FD1	COD + RD1	23 May 20 + 167 = 06 Nov 20

Problem of First Stage and Proposed Solution

Problem: Changes in Future Conditions

In many cases, project circumstances, such as manpower, resources, and other factors, may change in future. As a result, the future trend can differ from the past.

In such situations, relying solely on previous experience for forecasting the future is not sufficient.

So, a dynamic approach in which the changes of conditions can be considered, is essential.

Solution

The main factors that can change and impact productivity are quantity and quality of resources.

To account for their influence, two adjustment factors are defined, namely:

- **Resource Adjustment Factor (RAF)**
- **Efficiency Adjustment Factor (EAF)**

Second Stage of Proposed Method

Method- Stage 2 : As a response to problem of changes in future conditions
Considering Adjustment Factors

Resource Adjustment Factor (RAF):

One of the reasons why future productivity may differ from past productivity is the change in resources.

To address this issue, the Resource Adjustment Factor (RAF) is considered and calculated as follows:

Resource Adjustment Factor (RAF) = Past Available Resources (PAR) / Future Available Resources (FAR)

Efficiency Adjustment Factor (EAF):

Another reason why the future productivity may differ from past productivity is the change in productivity resulting from variations in the quality of resources or other conditions.

To address this issue, the Efficiency Adjustment Factor (EAF) is considered.

EAF does not have a specific formula for calculation; rather, it is a qualitative factor determined by the project team based on their perception of the future project situation.

It is recommended to consider a EAF of 1.0; however, a range from 0.75 to 1.5 can also be used.

Both the RAF and EAF will be multiplied by the remaining duration obtained from the first stage.

Second Stage of Proposed Method

Method- Stage 2 : As a response to problem of changes in future conditions
Considering Adjustment Factors

Stage	Steps	Abbreviation	Equation	Result
Stage 2: With Adjustment Factors	Previous Available Resources Per Time	PAR		84 mh/day
	Future Available Resources Per Time	FAR		90 mh/d
	Resource Adjustment Factor	RAF	PAR / FAR	84 / 100 = 0.84
	Efficiency Adjustment Factor	EAF		1.1
	Forecasted Remaining Duration 2	RD2	(RQ / AP) * RAF *PAF	(50,000 / 300) * 0.84 * 0.9 = 126
	Forecasted Finish Date 2	FD2	COD + RD	23 May 20 + 126 = 26 Sep 20

Problem of Second Stage

Problem: Not Considering Network

The ultimate goal of calculating the remaining duration of the activities is to determine their finish date.

In some practical cases, some predecessors or pre-requisites must be completed before an activity can begin.

In such cases, relying solely on the calculation of the remaining duration may not provide a reliable finish date, as the dependencies on the predecessors must also be taken into account.

For example:

Assume based on information from the piping supervisor, the last batch of piping material, comprising 10,000 dia inches, will arrive on 09 Sep 2020. According to the previous assumption (in stage 2), the time required to fabricate 10,000 dia inches will be calculates as follows:

(10,000 / 300) * 0.84 * 0.9 = 25.2 days

To address this issue, stage 3 of calculations, as introduced in the next slide, is proposed.

Note: If the schedule adjustment in the P6 file resolves this problem, then stage 3 may not be necessary.

Third Stage of Proposed Method

Method- Stage 3 : As a response to fourth problem
Considering Predecessors

Stage	Steps	Abbreviation	Equation	Result
Stage 3: With Predecessors	Finish date of all n predecessors	FDPn		09 Sep 20
	Required time after n predecessors	RTn		26 days
	Forecasted Finish Date 3	FD3	The latest FDPn + RTn	09 Sep 20 + 26 = 05 Oct 20

And depending on the stage to which calculations have been done, the final finish date is defined as follows:

1. If calculations have been done at stage 1: FFD = FD1
2. If calculations have been done at stage 1 & 2: FFD = FD2
3. If calculations have been done at stage 1 & 3: FFD = the later between FD1 & FD3
4. If calculations have been done at stage 1 & 2 & 3: FFD = the later between FD2 & FD3

So, in the example provided, the finish date of pipe spool installation will be 05 Oct 20.

Importance of Selecting Correct Method

Compare Results

Method	Finish Date
Based on Baseline	11 Sep 20
Based on Current Status	10 Dec 20
Based on Stage one of proposed method: Current Status with Considering Time Span	06 Nov 20
Based on Stage two of proposed method: Current status with considering time span and adjustment factors	26 Sep 20
Based on Stage three of proposed method: Current status with considering time span, adjustment factors, and predecessors	05 Oct 20

As shown in the table above, there is a significant difference in the results obtained from different methods.

Choosing the most appropriate method is a critical factor in achieving a precise estimation.

Schedule Required Productivity Index

Required Productivity

Calculate Required Productivity

In some cases, the finish date of an activity is fixed, and the required productivity to meet that finish date is needed to be calculated.

In such cases, the required productivity is calculated as follows:

Required Productivity = Remaining Quantity (RQ) / Remaining Duration (RD)

The table below outlines the steps to calculate the required productivity to achieve the pre-defined finish date:

Steps	Abbreviation	Equation
Cut-Off Date	COD	
Remaining Quantity	RQ	
Required Finish Date	RFD	
Available Duration	AVD	RFD - COD
Required Productivity	RP	RQ / RRD

Required Productivity

Example for Required Productivity

To finish this activity as per plan on 09 Aug

week	1	2	3	4	5	6	7	8	9	10	11	12
Date	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr	26-Apr	3-May	10-May	17-May
Planned Quantity	1200	1600	2000	2500	3200	3500	3500	3500	3500	3500	3500	3500
Planned Quantity Cumulative	1200	2800	4800	7300	10500	14000	17500	21000	24500	28000	31500	35000
Actual Quantity	0	1500	2000	1000	2000	1000	500	1500	2000	2500	3000	3000
Actual Quantity Cumulative	0	1500	3500	4500	6500	7500	8000	9500	11500	14000	17000	20000
Actual Man-hour	0	150	200	200	200	200	250	350	550	550	600	650

week	13	14	15	16	17	18	19	20	21	22	23	24
Date	24-May	31-May	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul	26-Jul	2-Aug	9-Aug
Planned Quantity	3500	3500	3500	3500	3500	3500	3500	2500	2500	2500	2000	1000
Planned Quantity Cumulative	38500	42000	45500	49000	52500	56000	59500	62000	64500	67000	69000	70000
Actual Quantity												
Actual Quantity Cumulative												
Actual Man-hour												

Steps	Equation	Result
Cut-Off Date		17 May 2020
Remaining Quantity		50,000
Required Finish Date		09 Aug 2020
Available Duration	RFD - COD	09 Aug 2020 – 17 May 2020 = 84
Required Productivity	RQ / RRD	50,000 / 84 = 595.2 per day

Schedule Required Productivity Index

Schedule Required Productivity Index (SRPI)

This index is utilized to indicate the amount of work required to complete an activity by a predefined finish date in comparison to the work already completed in the past.

in some cases, the finish date is fixed and required productivity to meet assumed finish date needs to be calculated. In such cases, the following index can be utilized to compare the required productivity is compared with previous productivity.

Schedule Required Productivity Index (SRPI) = Actual Productivity (AP) / Required Productivity (RP)

SRPI < 1	Current productivity is insufficient to meet the required finish date.
SRPI >1	Current productivity is more than sufficient to meet the required finish date.
SRPI = 1	Maintaining current productivity will be sufficient to meet the required finish date.

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Schedule Required Productivity Index

Example for Schedule Required Productivity Index (SRPI)

week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Date	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr	26-Apr	3-May	10-May	17-May	24-May	31-May	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul	26-Jul	2-Aug	9-Aug
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Planned Quantity Cumulative	1200	2800	4800	7300	10500	14000	17500	21000	24500	28000	31500	35000	38500	42000	45500	49000	52500	56000	59500	62000	64500	67000	69000	70000
Actual Quantity	0	1500	2000	1000	2000	1000	500	1500	2000	2500	3000	3000												
Actual Quantity Cumulative	0	1500	3500	4500	6500	7500	8000	9500	11500	14000	17000	20000												
Actual Man-hour	0	150	200	200	200	200	250	350	550	550	600	650												

In the given case, the required productivity to finish work by 09 Aug 2020 was calculated at **595.2** per day.

The average actual productivity from 1 Mar 2020 to 17 May 2020 is **238.1**

So, the SRPI is:

SRPI = AP / RP = 238.1 / 595.5 = **0.4**

Since the SRPI is less than 1 (0.4 in this case), It can be concluded that the Current productivity is insufficient to meet the required finish date.

Conclusion

Conclusion

To have reliable estimation and avoid erroneous results:

Practicality

Need to find practical solutions that can align the core theoretical concepts with the realities of work.
It is important to take into account all influencing factors.

Applicability

Various methods yields varying results.
It is critical to determine the most suitable method for each specific case.

Way Forward

To enhance practicality of this model by generating the curve of quantities.
To improve current scheduling software by incorporating this model.

THANK YOU