

Assignment #4

PROJECT SCHEDULING

From: Bianca Chitiu, CC Consultant Co.
To: Ottawa Construction Company
Date: January 1st, 2017
Subject: Development of a Three Bedroom Conceptual Home

Introduction:

Local construction companies have moved to create more healthy communities and innovated places others to live in. Ottawa Construction Company is one of many that for over 75 years has focused on development homes, condominiums, rental properties and commercial areas. As a Telfer graduate student working as part of the CC Consultants Co. I have been assigned to provide the company with detailed knowledge on their new construction project using my skills and abilities.

Ottawa Construction Company is planning on making a three bedroom environmentally friendly conceptual home that will be used as a show home for potential buyers. Their project is expected to begin around mid-May, however, have asked for us to determine the optimal completion time of the project using CPM, PERT and project crashing tools.

Recommendation:

After a detailed consideration of all activities and immediate predecessors, the critical path in order to complete the project in the shortest amount of time would be site cleaning (Activity A), laying out the foundation (Activity B), laying concrete blocks (Activity C), plumbing (Activity E), roofing shingles (Activity F), flooring (Activity J), doing the exterior fixtures (Activity L), and lastly landscaping (Activity N). This calculation was done using the CPM analysis. Critical paths are chosen because they contain no slack, meaning they're guaranteed to finish and start on the right dates. The diagram and chart, in the analysis and data, depict the critical path and how it was found. If they choose to follow the critical path they are looking at a time of 44 days in order to complete the entire project.

One problem arose using the CPM analysis, the project is supposed to be completed within the duration estimate, however, there is no guarantee that it will be. For whatever reason some projects may last longer than the duration and might not be completed on schedule, if this is the case we moved to a PERT analysis. A PERT analysis determines the probability of the project deadline being met. Each activity was then investigated in terms of three types of durations: an optimistic estimation, a realistic estimation and a pessimistic estimation. The conclusion of the analysis was as follows: the expected completion time is 44 days, the variance completion time is 9 day and the standard deviation time is 3 days.

The question then was, could the company finish the project before Canada Day which is 47 days following the start of the project. The CPM analysis would have said that yes they could, however, with a PERT analysis the company was shown that there's only an 84.13% that it will actually be completed before then.

The company was then looking at throwing an Independence Day celebration for all their American customers and declared a 99.5% chance of being sure the project would be completed by then. After numerous calculation, we concluded that there's a 99.5% chance the project would only finish in 52 days. This still fell at least a day short from the eligibility of doing an Independence Day celebration as it would take them at least 53 days to complete the project.

After a recent meeting with the senior managers and executives, they expressed concerns of the project not being completed on time for Canada's 150th anniversary. We were given a budget of \$1,000 and agreed to a reduction of 2 days. The question became, can the company afford to crash the project by 2 days. Using the CPM critical path determined earlier, we were able to achieve the crash cost per period for each critical activity. They're looking to crash 2 days with the lowest cost, in this case it would be laying out foundation (Activity B) and since activity B allowed to be crashed twice we were able to crash it twice and stay within budget. The total crash cost is \$849.4 and this allowed us to complete the project 2 days earlier.

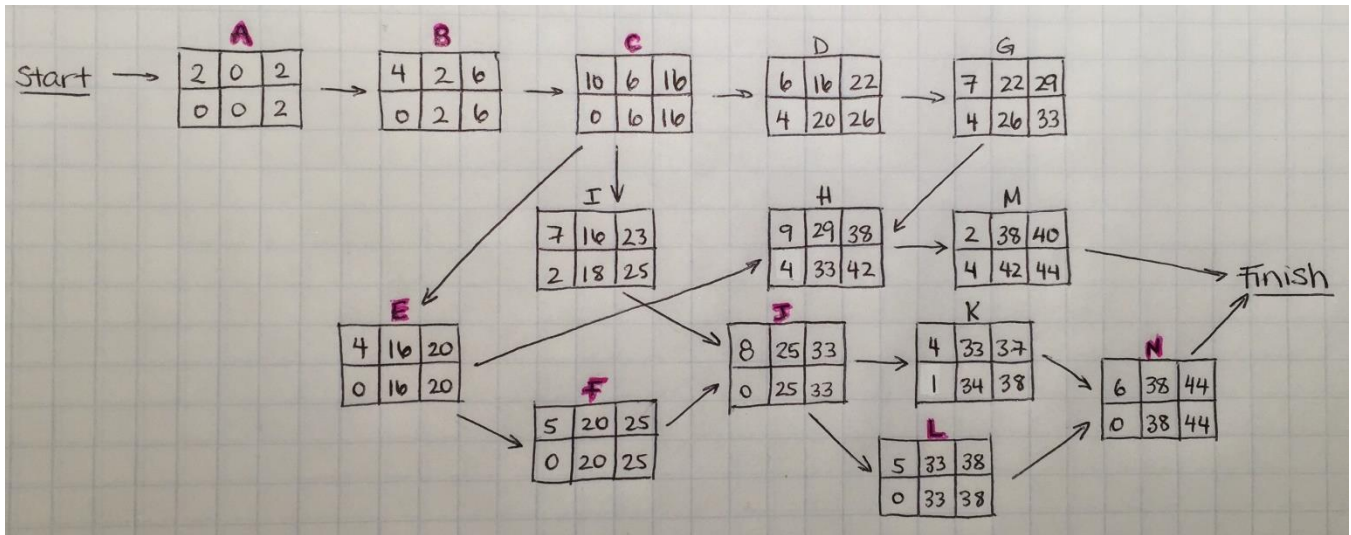
Analysis and Data:

Part 1:

The following diagram follows this formatting:

Duration	Earliest Start	Earliest Finish
Slack	Latest Start	Latest Finish

In order to better show the critical path, the activity code is underlined in pink.



Entire critical path is underlined in pink.

Activity	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack
<u>A</u>	0	2	0	2	0
<u>B</u>	2	6	2	6	0
<u>C</u>	6	16	6	16	0
D	16	22	20	26	4
<u>E</u>	16	20	16	20	0
<u>F</u>	20	25	20	25	0
G	22	29	26	33	4
H	29	38	33	42	4
I	16	23	18	25	2
<u>J</u>	25	33	25	33	0
K	33	37	34	38	1
<u>L</u>	33	38	33	38	0
M	38	40	42	44	4
<u>N</u>	38	44	38	44	0

Critical Path: Start -> A -> B -> C -> E -> F -> J -> L -> N -> Finish

If they choose to follow the critical path they are looking at a time of 44 days in order to complete the entire

project (2 + 4 + 10 + 4 + 5 + 8 + 5 + 6 = 44, which is done by adding all the durations of the activities on the critical path).

Part 2:

Activity	Optimistic Estimate (a)	Most Likely Estimate (m)	Pessimistic Estimate (b)	Expected Values	Variance	Standard Deviation
A	1	2	3	2	0.111111	0.333333
B	2	3.5	8	4	1	1
C	6	9	18	10	4	2
D	4	5.5	10	6	1	1
E	1	4.5	5	4	0.444444	0.666667
F	4	4	10	5	1	1
G	5	6.5	11	7	1	1
H	5	8	17	9	4	2
I	3	7.5	9	7	1	1
J	3	9	9	8	1	1
K	4	4	4	4	0	0
L	1	5.5	7	5	1	1
M	1	2	3	2	0.111111	0.333333
N	5	5.5	9	6	0.444444	0.666667

Expected Value = $(a + 4m + b)/6$

A: $(1 + 4(2) + 3)/6 = 2$

B: $(2 + 4(3.5) + 8)/6 = 4$

C: $(6 + 4(9) + 18)/6 = 10$

D: $(4 + 4(5.5) + 10)/6 = 6$

E: $(1 + 4(4.5) + 5)/6 = 4$

F: $(4 + 4(4) + 10)/6 = 5$

G: $(5 + 4(6.5) + 11)/6 = 7$

H: $(5 + 4(8) + 17)/6 = 9$

I: $(3 + 4(7.5) + 9)/6 = 7$

J: $(3 + 4(9) + 9)/6 = 8$

K: $(4 + 4(4) + 4)/6 = 4$

L: $(1 + 4(5.5) + 7)/6 = 5$

M: $(1 + 4(2) + 3)/6 = 2$

N: $(5 + 4(5.5) + 9)/6 = 6$

Variance = $[(b - a)/6]^2$

A: $[(3 - 1)/6]^2 = 0.111111$

B: $[(8 - 2)/6]^2 = 1$

C: $[(18 - 6)/6]^2 = 4$

D: $[(10 - 4)/6]^2 = 1$

E: $[(5 - 1)/6]^2 = 0.444444$

F: $[(10 - 4)/6]^2 = 1$

G: $[(11 - 5)/6]^2 = 1$

H: $[(17 - 5)/6]^2 = 4$

I: $[(9 - 3)/6]^2 = 1$

J: $[(9 - 3)/6]^2 = 1$

K: $[(4 - 4)/6]^2 = 0$

L: $[(7 - 1)/6]^2 = 1$

M: $[(3 - 1)/6]^2 = 0.111111$

N: $[(9 - 5)/6]^2 = 0.444444$

Standard Deviation = $(b - a)/6$

A: $(b - a)/6 = 0.333333$

B: $(b - a)/6 = 1$

C: $(b - a)/6 = 2$

D: $(b - a)/6 = 1$

E: $(b - a)/6 = 0.666667$

F: $(b - a)/6 = 1$

G: $(b - a)/6 = 1$

H: $(b - a)/6 = 2$

I: $(b - a)/6 = 1$

J: $(b - a)/6 = 1$

K: $(b - a)/6 = 0$

L: $(b - a)/6 = 1$

M: $(b - a)/6 = 0.333333$

N: $(b - a)/6 = 0.666667$

$$\begin{aligned} \text{Expected Value of Completion Time} &= \sum(\text{expected values of all critical path activities}) \\ &= \sum(\text{Expected Values of A, B, C, E, F, J, L, N}) \\ &= 2 + 4 + 10 + 4 + 5 + 8 + 5 + 6 = 44 \text{ days} \end{aligned}$$

$$\begin{aligned} \text{Variance of Completion Time} &= \sum(\text{Variances of all critical path activities}) \\ &= \sum(\text{Variances of A, B, C, E, F, J, L, N}) \\ &= 0.11111 + 1 + 4 + 0.44444 + 1 + 1 + 1 + 0.44444 = 8.99999 \text{ days}^2 \text{ or } 9 \text{ days}^2 \end{aligned}$$

$$\begin{aligned} \text{Standard Deviation of Completion Time} &= \sqrt{\text{Variance Completion Time}} \\ &= \sqrt{\text{Variances of A, B, C, E, F, J, L, N}} \\ &= \sqrt{8.99999} = 2.99999 \text{ days or } 3 \text{ days} \end{aligned}$$

Project would take 44 days to accomplish. The amount they have if they wanted to complete it before Canada's 150th Anniversary is 47 days.

$$\begin{aligned} Z &= (\text{target time} - \text{expected completion time}) / \text{standard deviation} \\ &= (47 - 44) / 2.99999 = 1.0000033 \end{aligned}$$

Z = 0.8413 (found on Appendix A: Z-Table)

Therefore probability ($T \leq 47$ days) is 84.13%

Duration to report if they're 99.5% sure project would be completed is:

$$\text{Due date} = 44 + 2.807 * 2.99999 = 52.42097193 \text{ or } 52.421$$

99.5% sure that in 52 days the project will be done given the average completion time.

Part 3:

Activity	Normal Time		Allowed Crash Time		Crash Cost per Period
	Time(Days)	Cost (\$)	Time(Days)	Cost (\$)	
A	2	1,841.52	1	2,433.37	591.85
B	4	1,264.34	2	2,113.74	424.7
C	10	5,281.16	7	7,049.89	589.5767
D	6	4,165.82	4	4,996.76	415.47
E	4	5,017.92	3	5,597.21	579.29
F	5	5,268.11	3	6,978.68	855.285
G	7	6,389.43	4	8,281.45	630.6733
H	9	3,590.55	6	5,352.24	587.23
I	7	4,099.73	5	4,987.63	443.95
J	8	4,239.48	6	5,136.11	448.315
K	4	4,764.31	3	5,221.87	457.56
L	5	3,388.74	3	4,709.21	660.235
M	2	4,153.91	1	4,780.65	626.74
N	6	3,691.33	3	4968.25	425.64

Crash Cost per Period = (Crash Cost – Normal Cost)/ (Normal Time – Crash Time)

A: $(2,433.37 - 1,841.52) / (2 - 1) = 591.85$

B: $(2,113.74 - 1,264.34) / (4 - 2) = 424.7$

C: $(7,049.89 - 5,281.16) / (10 - 7) = 589.5767$

D: $(4,996.76 - 4,165.82) / (6 - 4) = 415.47$

E: $(5,597.21 - 5,017.92) / (4 - 3) = 579.29$

F: $(6,978.68 - 5,268.11) / (5 - 3) = 855.285$

G: $(8,281.45 - 6,389.43) / (7 - 4) = 630.6733$

H: $(5,352.24 - 3,590.55) / (9 - 6) = 587.23$

I: $(4,987.63 - 4,099.73) / (7 - 5) = 443.95$

J: $(5,136.11 - 4,239.48) / (8 - 6) = 448.315$

K: $(5,221.87 - 4,764.31) / (4 - 3) = 457.56$

L: $(4,709.21 - 3,388.74) / (5 - 3) = 660.235$

M: $(4,780.65 - 4,153.91) / (2 - 1) = 626.74$

N: $(4968.25 - 3,691.33) / (6 - 3) = 425.64$

Critical Path: A, B, C, E, F, J, L, N

They're looking to crash 2 days with the lowest cost, in this case it would be activity B. Activity B allows to be crashed twice.

Total Crash Cost = $424.7 + 424.7 = 849.4$

Appendix A: Z-Table

Table entry for z is the area under the standard normal curve to the left of z .

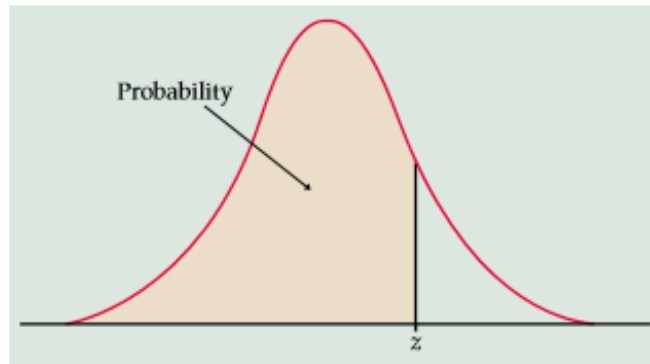


TABLE A Standard normal probabilities (*continued*)

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Personal Ethics Statement

Individual Assignment:

By signing this Statement, I am attesting to the fact that I have reviewed the entirety of my attached work and that I have applied all the appropriate rules of quotation and referencing in use at the Telfer School of Management at the University of Ottawa, as well as adhered to the fraud policies outlined in the Academic Regulations in the University's Undergraduate Studies Calendar. [Academic Fraud Webpage](#)

<u>Bianca Chitiu, BC</u>	<u>Tuesday, December 12, 2016</u>
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