VNIVERSITAT DE VALÈNCIA

Facultat d'Economia

DEGREE IN ADMINISTRATION AND BUSINESS MANAGEMENT

35836 Operations Management: Decisions and Resources (OR/English Group)

Practical Exercises - Chapter 8 - Project Management

Year 2018-19

PRACTICAL EXERCISE 8.1

To complete the wing assembly for an experimental aircraft, Jim Gilbert has laid out the seven activities involved. They are labelled A through G in the following table, which also shows their estimated completion times in weeks.

Activity	a	m	b	IMMEDIATE PREDECESSORS
A	1	2	3	--
B	2	3	4	--
C	4	5	6	A
D	8	9	10	B
E	2	5	8	C, D
F	4	5	6	D
G	1	2	3	E

Please determine:

A) The critical path of the project and its minimum duration.
B) Calculate the variance for each activity and for the project.

Source: Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

PRACTICAL EXERCISE 8.2

Stephen Hall is developing a programme for supply chain management certification for managers. Hall has listed a number of activities that must be completed before a training programme of this nature could be conducted. The activities, immediate predecessors, and times appear in the accompanying table:

Activity	Immediate predecessors	Time (Days)
A	--	2
B	--	5
C	--	1
D	B	10
E	A, D	3
F	C	6
G	E, F	8

a) Develop a network for the project.
b) What is the critical path?
c) What is the total project completion time?
d) What is the slack time for each individual activity?

Source: Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

PRACTICAL EXERCISE 8.3

Using PERT, Adam Munson was able to determine that the expected project completion time for the construction of a pleasure yacht is 21 months, and the project variance is 4.

a) What is the probability that the project will be completed in 17 months?

b) What is the probability that the project will be completed in 20 months?
c) What is the probability that the project will be completed in 23 months?
d) What is the probability that the project will be completed in 25 months?
e) What is the due date that yields a 95% chance of completion?

Source: Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

PRACTICAL EXERCISE 8.4

Rich Cole's Control Devices Inc produces custom-built relay devices for car makers. The most recent project undertaken requires 14 different activities. Cole's managers would like to determine total project completion time in days and those activities that lie on the critical path. Data is shown in the following table.

a) What is the probability of the project being finished in 53 days?
b) What date results in a 99% probability of completion?

ACTIVITY	PREDECESSORS	OPTIMISTIC TIME	MOST LIKELY TIME	PESSIMISTIC TIME
A	--	4	6	7
B	--	1	2	3
C	A	6	6	6
D	A	5	8	11
E	B, C	1	9	18
F	D	2	3	6
G	D	1	7	8
H	E, F	4	4	6
I	G, H	1	6	8
J	I	2	5	7
K	I	8	9	11
L	J	2	4	6
M	K	1	2	3
N	L, M	6	8	10

Source: Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

PRACTICAL EXERCISE 8.5

The Tesla 6 is a new custom-designed sports car. An analysis of the task of building the Tesla 6 reveals the following list of relevant activities, their immediate predecessors, and durations:

Job letter	Description	Immediate predecessors	Normal time (days)
A	Start	--	0
B	Design	A	8
C	Order special accessories	B	0.1
D	Build frame	B	1
E	Build doors	B	1

F	Attach axles, wheels, fuel tank	D	1
G	Build body shell	B	2
H	Build transmission and drive train	B	3
I	Fit doors on body shell	G, E	1
J	Build engine	B	4
K	Bench-test engine	J	2
L	Assemble chassis	F, H, K	1
M	Road-test chassis	L	0.5
N	Paint body	I	2
O	Install wiring	N	1
P	Install interior	N	1.5
Q	Accept delivery of special accessories	C	5
R	Mount body and accessories on chassis	M, O, P, Q	1
S	Road test car	R	0.5
T	Attach exterior trim	S	1
U	Finish	T	0

A) Draw a network diagram for the project.
B) Mark the critical path and state its length
C) If the Tesla 6 had to be completed 2 days earlier, would it help to:
    a. Buy preassembled transmissions and drive trains?
    b. Install robots to halve engine-building time?
    c. Speed delivery of special accessories by 3 days?
D) How might resources be borrowed from activities on non-critical paths to speed activities on the critical path?

Source: Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

PRACTICAL EXERCISE 8.6 PROJECT MANAGEMENT AT SYRACUSE HOSPITAL

THIS EXERCISE TO BE PRESENTED BY THE TEAM

The equivalent of a new kindergarten class is born every day at Orlando's Syracuse Hospital. With more than 13,000 births in the mid-2000s in a hospital that was designed 15 years earlier for a capacity of 6,500 births a year, the newborn intensive care unit was stretched to the limit. Moreover, with continuing strong population growth in central Florida, the hospital was often full. It was clear that new facilities were needed. After much analysis, forecasting, and discussion, the management team decided to build a new 273-bed building across the street from the existing hospital. But the facility had to be built in accordance with the hospital's Guiding Principles and its uniqueness as a health centre dedicated to the special needs of women and infants. Those Guiding Principles are: *Family-centered focus, a healing environment where privacy and dignity are respected, sanctuary of caring that includes warm and serene surroundings with natural lighting, sincere and dedicated staff providing the highest quality care, and patient-centered flow and function.*

The vice president of business development, Karl Hodges, wanted a hospital that was designed from the inside out by people who understand the Guiding Principles, who knew

most about the current system, and who were going to use the new system, namely, the doctors and nurses. Hodges and his staff spent 13 months discussing expansion needs with this group, as well as with patients and the community, before developing a proposal for the new facility. An administrative team created 35 user groups, which held over 1,000 planning meetings (lasting from 45 minutes to a whole day). They even created a 'Supreme Court' to deal with conflicting views on the multifaceted issues facing the new hospital.

Funding and regulatory issues added substantial complexity to this major expansion, and Hodges was very concerned that the project stay on time and within budget. Tom Hyatt, director of facility development, was given the task of onsite manager of the $100 million project, in addition to overseeing ongoing renovations, expansions, and other projects. The activities in the multiyear project for the new building at Syracuse are shown in the following table.

Discussion questions

1. Develop the network for planning and construction of the new hospital at Syracuse.
2. What is the critical path and how long is the project expected to take?
3. Why is the construction of this 11-story building more complex than the construction of an equivalent office building?
4. What percent of the whole project duration was spent in planning prior to the proposal and reviews? What percent was prior to the building construction? Why?

ACTIVITY	SCHEDULED TIME	PRECEDENCE ACTIVITIES
1. Proposal and review	1 month	--
2. Establish master schedule	2 weeks	1
3. Architect selection process	5 weeks	1
4. Survey whole campus and its needs	1 month	1
5. Conceptual architect's plans	6 weeks	3
6. Cost estimating	2 months	2, 4, 5
7. Deliver plans to board for consideration/decision	1 month	6
8. Surveys/regulatory review	6 weeks	6
9. Construction manager selection	9 weeks	6
10. State review of need for more hospital beds ('Certificate of Need')	3.5 months	7,8
11. Design drawings	4 months	10
12. Construction documents	5 months	9, 11
13. Site preparation/demolish existing building	9 weeks	11
14. Construction start/building pad	2 months	12, 13
15. Relocate utilities	6 weeks	12
16. Deep foundations	2 months	14
17. Building structure in place	9 months	16
18. Exterior skin/roofing	4 months	17
19. Interior buildout	12 months	17

20. Building inspections	5 weeks	15, 19
21. Occupancy	1 month	20

Note: for calculations assume 1 week = 0.25 months

Source: Adapted from Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

PRACTICAL EXERCISE 8.7 MANAGING SINGLES' FESTIVAL THIS EXERCISE TO BE PRESENTED BY THE TEAM

At the Singles' Club (fictitious name), like many organisations, project management is a key planning tool. With the Singles' Club's constant growth in hotels and cafes, remodelling of existing cafes, scheduling for Singles' Club Live concert and event venues, and planning the annual Singles' Festival, managers rely on project management techniques and software to maintain schedule and budget performance.

'Without Microsoft Project,' says Singles' Club vice-president Chris Pérez, 'there is no way to keep so many people on the same page'. Pérez is in charge of the Singles' Festival event, which is attended by well over 100,000 enthusiastic fans. The challenge is pulling it off within a tight 9-month planning horizon. As the event approaches, Pérez devotes greater energy to its activities. For the first 3 months, Pérez updates his Microsoft Project charts monthly. At the 6-month mark, he updates his progress weekly. At the 9-month mark, he checks and corrects his schedule twice a week.
Early in the project management process, Pérez identifies 10 major tasks (called level-2 activities in a work breakdown structure, or WBS) (Level 1 task is the festival itself): talent booking, ticketing, marketing/PR, online promotion, television, show production, travel, sponsorships, operations, and merchandising. Using a WBS, each of these is further divided into a series of subtasks. The following table identifies 26 of the major activities and subactivities (total number of activities is 136), their immediate predecessors, and time estimates. Pérez enters all these into the Microsoft Project software. Pérez alters the Microsoft Project document and the time line as the project progresses. 'It's okay to change it as long as you keep on track', he states.
The day of the rock concert itself is not the end of the project planning. 'It's nothing but surprises. A band not being able to get to the venue because of traffic jams is a surprise, but an 'anticipated' surprise. We had a helicopter on stand-by ready to fly the band in', says Pérez.

On completion of the Singles' Festival in July, Pérez and his team have a 3-month reprieve before starting the project planning process again.

ACTIVITY	DESCRIPTION	PREDECESSORS	TIME (WEEKS)
A	Finalise site and building contracts	--	7
B	Select local promoter	A	3
C	Hire production manager	A	3
D	Design promotional website	B	5
E	Set TV deal	D	6
F	Hire director	E	4
G	Plan for TV camera placement	F	2

H	Target headline entertainers	B	4
I	Target support entertainers	H	4
J	Travel accommodations for talent	I	10
K	Set venue capacity	C	2
L	Ticketmaster contract	D, K	3
M	On-site ticketing	L	8
N	Sound and staging	C	6
O	Passes and stage credentials	G, R	7
P	Travel accommodations for staff	B	20
Q	Hire sponsor coordinator	B	4
R	Finalize sponsors	Q	4
S	Define/place signage for sponsors	R, X	3
T	Hire operations manager	A	4
U	Develop site plan	T	6
V	Hire security director	T	7
W	Set police/fire security plan	V	4
X	Power, plumbing, AC, toilet services	U	8
Y	Secure merchandise deals	B	6
Z	Online merchandise sales	Y	6

Discussion questions

1. Identify the critical path and its activities for Singles' Festival. How long does the project take?
2. Which activities have a slack time of 8 weeks or more?
3. Identify five major challenges a project manager faces in events such as this.
4. Why is a work breakdown structure useful in a project such as this? Take the 26 activities and break them into what you think should be level-2, level-3, and level-4 tasks. Use for this task the free Clickcharts application (https://www.nchsoftware.com)

Source: Adapted from Heizer, Render, Ops Mgmt, 11th ed., Pearson 2014

EXERCISE 8.8 THE CEREAL FACTORY PROJECT

A firm working on mechanical constructions has received an order to build a new facility for a customer (ALMACER). This order is the subject of an individual project approach with the following activities:

A. Preliminary design: definition and scope of the project. Basic design of the facility.
B. Civil works project: levelling of the plot, silo foundations, and general plot arrangements.
C. Civil works construction: of the buildings
D. Detailed silo design: walls, general structure, and ancillaries.
E. Manufacture of the silo parts: metal sheet fabrication, pre-welding, and transport of parts to site.
F. Detailed design of ancillary machinery: transport installation, elevators, and other mechanical components (including electrical installation)
G. Purchase + fabrication of ancillary machinery and preassembly of elements in factory (ancillary machinery is partly purchased and partly made in-house)
H. Packing of machinery pre-assemblies and transport to site
I. Assembly of silos and their structures.
J. Assembly of ancillary machinery.

K. Testing and delivery of the facility.

Your team is responsible for the planning of this project. On the following table you can find duration and cost of the project activities - as well as additional info:

ACTIVITY	DURATION	PRECEDENCES	COST	REMARKS
A	4 WKS	--	€8000	
B	1 WKS	A	€5000	
C	9 WKS	B	€45000	It can be crashed up to 2 weeks at an extra-cost of €3000/week
D	2 WKS	A	€6000	
E	8 WKS	D	€90000	
F	3 WKS	A	€9000	It can be crashed up to 1 week at an extra-cost of €1500/week
G	8 WKS	F	€70000	It can be crashed up to 2 weeks at an extra-cost of €4000/week
H	3 WKS	G	€5000	It can be crashed up to 1 week at an extra-cost of €1500/week
I	5 WKS	C, E	€18000	It can be crashed up to 2 weeks at an extra-cost of €2500/week
J	4 WKS	H, I	€15000	
K	3 WKS	J	€5000	

Questions:
1. Determine the minimum duration of the project, the critical path, and the cost of the project, without any crashing.
2. What would be the duration of the project if activity I lasts one week more?
3. Analyse the changes in the project that can be attained by crashing it 2 weeks. The objective is to reduce the overall duration of the project by 2 weeks, by investing money in speeding up activities. Your analysis has to be sequential: once you reduce the duration of one activity by one week, the critical path(s) can and do change, and hence your priorities for the next time reduction. If there are several strategies, please describe all of them, in terms of time reduction and associated costs.

EXERCISE 8.9 PROJECT MANAGEMENT

A company needs to perform a project in its IT Department. After a careful planning, it has identified a list of tasks with duration estimates and precedences:

	Tasks	Duration	Precedences
0	PROJECT START	0 (Miles tone)	--
A	SETUP DESIGN	5 days	0

B	SOFTWARE PURCHASE	8 days	A
C	HARDWARE PURCHASE	3 days	A
D	SOFTWARE CONFIGURATION	6 days	B
E	INSTALLATION OF COMMUNICATIONS SOFTWARE	13 days	B, C
F	NETWORK WIRING	2 days	C
G	SOFTWARE TESTS	5 days	D
H	HARDWARE TESTS	4 days	E, F
I	INSTALLATION OF SOFTWARE	6 days	G, H
J	TRAINING	8 days	I
K	DATA UPLOADING	4 days	I
L	PROJECT END	0 (Milestone)	J, K

You have to determine:

a) Project CPM diagram
b) Minimum duration of project and slack of each activity
c) Critical path of project.
d) What would happen if:
    a. Activity H is delayed 6 days (it now lasts 10 days)
    b. Activity C is delayed 3 days (it now lasts 6 days)
    c. Activity J is shortened 5 days (it now lasts 3 days)

EXERCISE 8.10 PROJECT MANAGEMENT

We want to launch a new product in the market. The associated project consists of the following activities with duration and precedences. The duration of tasks has been estimated and we will apply the beta distribution formula.

ACTIVIDAD	Prece-dences	Duration in weeks		
		Optimistic	Realistic	Pessimistic
A. Purchase of raw materials		1	2	3
B. Production of the first batch	A	2	4	6
C. Filling of the first batch	B, H	0	1	2
D. Market research		3	6	9
E. Planning of advertising campaign	G	2	3	4
F. Implementation of advertising campaign	E	3	5	7
G. Package design	D	1	2	3
H. Package preparation	G	1	2	3
I. Selection of sales team	D	1	3	5
J. Training of sales team	I	3	4	5
K. Selection of distributors	D	2	3	4
L. Sales to distributors	J, K	3	5	7
M. Delivery of first orders	C, L	1	2	3

You have to determine:

1) Project diagram, duration of the project, slack of activities, and critical path.
2) What would happen if:
    a- Activity A is delayed 9 weeks.
    b- Activity D is delayed 3 weeks.

c- Duration of activity L is shortened by one week.

EXERCISE 8.11 PROJECT CRASHING

Activity	Predecessor	Normal time (weeks)	Minimum time (weeks)	Normal Cost (euros)	Maximum Cost (euros)
A	--	2	2	10,000	10,000
B	--	1	1	2,000	2,000
C	--	4	2	5,000	10,000
D	A, B, C	2	1	20,000	25,000
E	C	3	1	10,000	30,000
F	D	1	1	7,000	7,000
G	F, E	1	1	10,000	10,000
H	G	6	5	3,000	4,000

1) Obtain the network for this project for the normal time
2) Obtain the length (in weeks) of this project for the normal time
3) Obtain activity slacks for the normal time
4) Highlight in your network the critical path for the normal time
5) Reduce the project duration by one week, giving two options with the associated cost of each.

EXERCISE 8.12 PROJECT CRASHING

Activity	Predecessor	Normal time (weeks)	Minimum time (weeks)	Normal Cost (euros)	Maximum Cost (euros)
A	--	6	6	10,000	10,000
B	--	4	3	2,000	3,000
C	A	3	3	5,000	5,000
D	A,B	2	1	20,000	25,000
E	C	5	3	10,000	15,000
F	D	6	6	7,000	7,000
G	F, E	4	3	10,000	12,000
H	G	3	3	3,000	3,000

1) Obtain the network for this project for the normal time
2) Obtain the length (in weeks) of this project for the normal time
3) Obtain activity slacks for the normal time
4) Highlight in your network the critical path for the normal time
5) Reduce the project duration by one week, giving two options with the associated cost of each one.

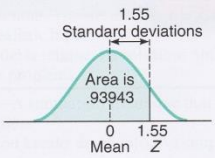
Deliverables in this paper:

a) A written solution to Exercises 8.6 and 8.7, to be uploaded on Moodle not later than the specified date.

b) A presentation of Exercises 8.6 and 8.7 backed by a PowerPoint presentation, to be shown to the rest of the class on the specified date.

APPENDIX: NORMAL CURVE TABLES

NORMAL CURVE AREAS



To find the area under the normal curve, you can apply either Table I.1 or Table I.2. In Table I.1, you must know how many standard deviations that point is to the right of the mean. Then, the area under the normal curve can be read directly from the normal table. For example, the total area under the normal curve for a point that is 1.55 standard deviations to the right of the mean is .93943.

TABLE I.1

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97784	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99899	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997