

المحاضرة (٤)

PROGRAMME EVALUATION AND REVIEW TECHNIQUE (PERT)

The network methods discussed so far may be termed as deterministic, since estimated activity times are assumed to be known with certainty. However, in research project or design of gear box or a new machine, various activities are based on judgment. It is difficult to obtain a reliable time estimate due to the changing technology. Time values are subject to chance variations. For such cases where the activities are non-deterministic in nature, PERT was developed. Hence, PERT is probabilistic method where the activity times are represented by a probability distribution. This probability distribution of activity times is based upon three different time estimates made for each activity. These are as follows.

- (i) Optimistic time estimate
- (ii) Most likely time estimate
- (iii) Pessimistic time estimate

is denoted by tp or b. These three time values are shown in the following figure 1





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Program Evaluation & Review Technique Zlivel as pries and - (PERT) هذف الاداره هو اتخاذ بقرارات بدروسة لغرف الحصول على اعظم فائدة ممانه منمن المعلومات المتوفنة حب نشائت الحاجة لاستخدا انظران الاحصاءوالاحمالات لمعالجة المساريع غير المتكرة حاددي الى ظهور طيقة تعييم والحقه الرناج (PERT) للساعدة على تحصول على المستقرار ممان ممن العطيات المتع مرة. معود ظهور طريقة PERT الحد او آخر الخسينات من لقرن العشرين 12 ي فنس القرق بم ظريت فلاطريقة لخطط السهمي التشاء استخدام مفاصر لاحمالية عادة ما تكون علية اتخاذ القرارة الادارية فاضعه لاحدى كالات التالية : (Risk) Edit , (Un certainty) with pres (certainty) with الم الفارق ارتبعي من طريقة الخطط المجمو (AOA) وطريقة PERT هوات المطبقة الخطط السجعى تحقد على حالة التأكد والتاك استخدام الاساليب لحددة (Deterministic) للتقامل مع بيانات إشريع , من فد ستطيع , لحول علي من فلال مراجعة متاريخ سايقه مشاريه للشريع الذي تراد تنقيذه / اما طيع PERT حادت لمالية المشاريع الحديدة في الخالات الحديثة إنما لايوجد مساريع سابقة مسابه لها وبالتابي لارة معدمات مؤكرة حول بشروع ما ادى لاعماد على معلومات (Probabilistic) sulino, Eulas I malia ماان طريقة تعم مراحقة المراج (PERT) تعدم على السرى اهماليه مسبة على بانات اجعانيه لذ تستعرف معن بناهم لإجعانيه قبل بدر ف تطبيق هذه auk, ٢- معاسى بنزعة الركزية لايكن وجنع إسانات في تعذيع تكرارى ذى منات لدراسة كال توزيع الكرارى وطبيعته ، لذلك توجد مقايسين عد ريه تعسن سوقع بتوزيع . نديما بكون حنان توزيبات تكاريه مشابه غطبيعول ستكلها وتلها تختلف غطاقها ومفاضا نشائ (Measures of Central Tendency) - eije (Measures of Central Tendency) - eije نظامة تركز القم اوبساهات عنداماء تربه ما مول قراءه معينه د من هذه بلقاسیس : (Arithmetic Mean 4) cours, end -1



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وهم ماصل فسمه محموعة شم على عددها $M = X_1 + X_2 + \dots + X_n$ ۲- المسط (Median) : معدف بوسط لجعيدة من المتم برتية حسب قديماً العددية تصاعدياً او تدازلياً بانة العدد الادسط من اذا كان مددها فردياً ، وهو لوسلاً الحساى للرقين للذين يعسمات هذه العتم الم يحقق متسا وس ٢- المنال (علمه) : معف بانه اعتمه الما تعاملها اكر اذا ومعنا السانات في توزيع تكرري للقم. (Measures of Dispersion) cuining comulia خاصة التشت عاسى ظاهرة التركيز حب فد ان اعتم ستباعدا وتستثبت ، وقدت الظاهران ع نفس التحرية ختعد ان أكثر القم تشرك عول نقطهما / وخد معن إعم تقع على جانبي هذه التقطه متياعدة كما يُح جالة التوزيع المتعاش واحم معايس التنقن ، ,- بادى (Range) : ومعرف بارى تجويدة من اعيم او بساهدت با بن الغرق بن اكبر قيمة واجعر قية ومعتر لدى متياساً غير دقيقاً للتشت · inbal , usb = , ~ and us - 1 ga, and are. مع مربع الخراف (Variance - 02) : (Variance - 02) في المانات عن و سطر الحدارى مستوماً على عدد م PI sut is your: (standard Deviation - or) sut is your - Y متايس التشت لمحديد من اعم اوبشاهدت والزهادته لانه بافر عميم , لقم او بساهدت بعين بلاستار / فه بلاتك ستبوعة واستخدامة ويوف يا ته لفعة المحدة للحدر التريد في للسان ، : autral notico يعف لاحمال على انه سية عدد وات تحقيق حادثه معينه في عدد لخاولات المن تم اح مط لتحقيق ذلك الحادث ، وستكل عام مالاحمال هرمتياس عددى لقياس فرصه تحقيق طادنه عير مؤكدة كأنهاد فقالته ارعماسة ما فلال auro ña



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منافعول حسان $Z = \frac{X - \mathcal{H}}{\mathcal{K}}$ X : enapole G. highense, : M س ، الانخاف لعدارى : PERT aubis $Z = \frac{T_s - T_E}{5E}$ Ts: time schedule augusti augusti TE: Expected time an information of standard deviation for critical Path (PERT) مقن في في التي و بغرضيات لستخدمة : طريقة (PERT) العقبة المتفاؤلي (OPtimistic Time - a) : هم النصف المتعمد ضالية عندما تكون ظروف إتنفيذ مثالية ولاحتل تنغيذ إغاليه 2 وقت اقصر. العقة التك الممتالة (Most Probable Time - m) : وهم بزمن المتقع لتنفيذ العفالله عندما تكون ظرون التفنيز طبيعيه ولكن لسب مثالية. الوقت السَّمَارَى (d - Pessimistic Time) : وهو بزمن بالترقيع لتنفيذ ولعالله عندما تكون ظررت بستعبد مية ولانتها منا بظرف عد بطبيعية اد الكور عن الالال ولقيماً ت. ان توزيع اومات , لفاليات يتبع توزيع بيتًا (Beta Distribution) Jusil الاعتال وزع متوفى كاالمي توزيع مترف كم ليسار



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 $6^2 = \frac{(b-a)^2}{36}$ 52 - Variance cities TE; TE; tei $(T_E)_{start} = Base time = 0$ $\left(\begin{array}{c} & \\ & \\ & \\ & \\ & \\ \end{array} \right)$ start = 0 TEj = Max [TEi + teij] $\sigma_E^2 = \sigma_{Ei}^2 + \sigma_{eij}^2$ If TE; Can be found from events take the longer variance This = Min [This - teij] ولايحاد الوقت المتوقع لافاز المندمع اذا كابر هنائ مسار حرج واحد في الخطط بقرن TE = tacitivity A + tactivity B + tactivity C + اما اذا كابر هناك آنكر من مسارحرج نقارن بين بسّيابين مناهد الكبر تسابناً. اما الانخان المساري لاكامار في المشريع هد لجذ المتسبق المحمع المساب



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 $6 \text{ path} = \sqrt{\frac{2}{6A} + \frac{2}{6B} + \frac{2}{6C} + \cdots}$: centrallie باعتبادة مهندس مفطط لاحد المشاريع واردت الجاد الزمن اللادم لانجان فعاليه مب السقف والتي تدر من مصب المعالب الخشي الى بال المعالجة وإن البداية تكون في منتصف شهر سنون الثاني أي الشهر الحادي عشر / اوجد زمن انجاز الفعالية مقدر هذه الفترة وفق الاحتما لات المتوقفة واعتادة على الخيرة - بأخاد المعدل المتوقع لمدة النقالية والاخراف القياسي لمعدل المدة والتفادت المطلوب الحواب : عادن الفاليه تدر في منتصف شهر تشرين الثاى ، خان هذا له اجما لات عد م- , لاحمال بدول : هوان الحالم الحرية تكون عيدة (عدم وجود امطار - الحوعترغام ورزلات عكن الحاد لفتر ما قصر مرة مكنه (a) ارتصب رترس اعالد بنسم و - 6 م cierul, uno . s 1 27 ۲- رضح بقالب ولجعا كمه <u>8 مرم 8</u> 15 ميم تتريباً المحوع ب - الاحتال الآئم حدمت غ حدث لفتر . الحاله محربه حد معدد عنوم الاختان < رجات مراجع رطوية - غير معطى ويذلك عكن الجار الفترة (M) ١- في وتركيب لتاب لخشي ويشلم 8 مرم r= 1 cerul, cup -۲ ع الخ 20 يوم ٢- رفع لقاله ولمعالحه حر الاحمال بشرائم ، على اعتبار سقوط امطار وباستمار مع وجود طويه عاليه وانخفاهن درجات بحرارة ويذلك عكن ايجا د اغتره الزمينه (ط ۱- نصب وترکیب لقائل الخشیمی و بستیلیج ۲- صب بسقف ۲- نف لقائل المعالیه 3 وم (على ما ما وجود مناصل تدد) ٢- رفع إقال والمعالحه 5216 Pr 33



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$$\begin{array}{c} \textcircled{0} \\ \hline & Cribical Path T = 5 - 15 - 20 - 25 - 35 \\ \hline & Cribical Path T = 5 - 15 - 20 - 35 \\ \hline & \sigma_{1} = \sqrt{(0:44) + 0:109 + 0:44 + 0:109} = 1.048 \\ \hline & \sigma_{2} = \sqrt{0:44 + 0.109 + 1.0} = 1.244 \\ \hline & \sigma_{2} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{2} = \sqrt{0:44 + 0.109 + 1.0} = 1.244 \\ \hline & \sigma_{2} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{1} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{2} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{1} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{2} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{1} = \frac{1}{\sqrt{9}} \\ \hline & \sigma_{2} = \frac{1}{\sqrt{9}} \\ \hline$$



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0.7431 0.7491 0.7324 0.7324 0.7340 0.7480 0.7480 0.7340 0.7681 0.7340 0.7681 0.7791 0.7734 0.7784 0.7782 0.7882 0.7881 0.7910 0.7939 0.7939 0.7939 0.7939 0.7939 0.7939 0.7939 0.7939 0.7939 0.7939 0.8130 0.8130 0.8130 0.8130 0.8130 0.8139 0.8661 0.8139 0.8661 0.8031 0.8031 0.8154 0.8139 0.8611 0.8031 0.8130 0.8131 0.8130 0.8131 0.8141<	c	0.7017								4	0 0.1224			2.9	0.0014	0.0014	0.0015	0.0015	0.0010	5
0.7481 0.7642	2	0.7237	0.7291	0.732	4 0.735	0.7389	0.7423	0.745	4 0.748	6 0.751	7 0 7540		C	2.8	0.0019	0.0020	0.0021	0.0021	0.002	2
9 0.7831 0.7910 0.7939 0.7939 0.7939 0.8033 0.8039 0.8133 0.8134 0.8145 0.8133 0.8134 0.8145 0.8134 0.8145 0.8135 0.8135 0.8134 0.8135 0.8134 0.8134 0.8413 0.8465 0.8666 0.8133 0.8134		0.7580	0.7611	0.764	2 0.767;	0.7704	0.7734	0.776	1 0 770.	1 0.707	0.7049	1		-2.1	0.0026	0.0027	0.0028	0.0029	0.003	à
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0.8433 0.8438 0.8461 0.8433 0.8433 0.8334 0.8334 0.8337 0.8389 0.8321 1 0.8443 0.8640 0.8646 0.8646 0.8646 0.0084 0.0066 0.0069	2	0.8159	0.8186	0.821	0.8238	0.8264	0.8289	0.831	5 0.8340	0.816	5 0.0133	3			0.000	1.0			0.0040	
1 0.8643 0.8645 0.8636 0.8706 0.8770 0.8770 0.8790 0.8810 0.8810 0.0064 0.0066 0.0069 0.0091 0.0091 2 0.8849 0.8869 0.8807 0.8725 0.8740 0.8970 0.0015 -2.3 0.0034 0.0068 0.0091 0.0016 0.0118 0.0118 0.0114 0.0144 0.0144 0.0146 0.0119 0.0131 0.0114 0.0151 0.0151 0.0151 0.0151 0.0151 0.0115 0.0115 0.0115 0.0115 0.0115 0.0115 0.0115 0.0115 0.0115 0.0115 0.0116 0.0119 0.0114	0	0.8413	0.8438	0.846	0.8483	0.8308	0.8531	0.8554	0.857	7 0.8500	0.0201	day	-	-2.3	0.0048	0.0049	0.0051	0.0052	0.0054	É I
1.499-5 0.4895-5 0.4915-5 0.4915-5 0.4915-5 0.9125-5	1	0.0415		n variante				a service de	C. C. C. W. M. M.	0.007	0.0021	-		2.4	0.0064	0.0066	0.0068	0.0069	0.0071	
1 0.8889 0.8889 0.8897 0.8839 0.8830 0.0921 0.0114 0.01014 0.0114 0.0114	2	0.8043	0.8663	0.868	5 0.8708	0.8729	0.8749	0.8770	0 8700	0.9917	0.0000	4	k	-2.3	0.0084	0.0087	0.0089	0.0091	0.0094	
0.0912 0.9042 0.9042 0.9045 0.9045 0.9043 0.0143<	4	0.8849	0.8869	0.888	3 0.8907	0.8925	0.8944	0.896	2 0.8980	0.800	7 0.8830	10.0		-2.2	0.0110	0.0113	0.0116	0.0119	0.0122	E
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0.9312 0.9313 0.9313 0.9313 0.9313 0.9313 0.9313 0.9313 0.9313 0.0313 0.0188 0.0192 0.0120 0.0120 0.0123 0.0188 0.0192 0.0120 0.0123 0.0314 0.0233 0.0324 0.0325 0.0314 0.0323 0.0314 0.0323 0.0314 0.0323 0.0314 0.0313 0.0314 0.0323 0.0314 0.0323 0.0314 0.0323 0.0314 0.0323 0.0314 0.0323 0.0314 0.0313 0.0101 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0131 0.0123 0.0314 0.0323 0.0314 0.0323 0.0314 0.0323 0.0314 0.0323 0.0314 0.0313 0.01311 0.0131	4	0.0112	0.9207	0.922	0.9236	0.9251	0.9265	0.9275	0.9292	0.910	6 0.9110			-20	0.0100	0.0100	12102110702-5			
0.9432 0.9463 0.9474 0.9484 0.9495 0.9515 0.9515 0.9535 0.9315 0.9335 0.9345 1.7 0.0313 0.0329 0.0244 0.0200 0.0312 0.9541 0.9546 0.9566 0.9515 0.9505 0.9515 0.9535 0.9535 0.9545 0.0616 0.0321 0.0307 0.0314 0.0307 0.0314 0.0307 0.0317 0.0455 0.0446 0.0456 0.0411 0.0117 0.0117 0.0116 <	1	0.9.3.32	0.9343	0.935	0.9370	0.9382	0.9394	0.9400	0.9418	0.9479	0.9.119	1		-1.0	0.0183	0.0188	0.0192	0.0197	0.0202	
0.554 0.554 0.574 0.564 0.574 0.6301 0.0301 0.0314 0.0312 0.554 0.554 0.5733 0.552 0.5931 0.5941 0.5941 0.5941 0.5941 0.0301 0.0301 0.0314 0.0312 0.0401 0.0544 0.5646 0.5733 0.5924 0.5933 0.5941 0.5945 0.0301 0.0301 0.0301 0.0314 0.0312 0.0401 0.5773 0.5778 0.5773 0.5773 0.5773 0.5773 0.5784 0.5845 0.4853 0.4653	6	0.9482	0.0461	0.040							0.2441	1		-1 R	0.0233	0.0239	0.0244	0.0250	0.0256	
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0.9713 0.9713 0.9704 0.9714 0.9716 0.9706 0.9773 0.9778 0.9783 0.9784 0.9736 0.9737 0.9737 0.9737	3	0.9641	0.0640	0.957.	0.9382	0.9591	0.9599	0.9608	0.9616	0.962:	0.9633	1:0		-1.6	0.0307	0.0375	0.0384	0.0392	0.0401	
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0.9821 0.9826 0.9830 0.9808 0.9812 0.9817 -1.4 0.0637 0.0637 0.06364 0.0606 0.9821 0.9826 0.9830 0.9834 0.9838 0.9842 0.9846 0.9837 0.9857 0.0638 0.07797 0.9779 0.9971 0.9971 0.9971 0.9971 0.9971 0.9971 0.9971 0.9977 0.9978 0.9986	0	0.9773	0.9778	0.978	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767	(heigh		-1.5	0.0540	0.000	0.0400			
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0.9893 0.9896 0.9901 0.9904 0.9984 0.9897 0.9890 0.9916 0.9918 0.9920 0.9922 0.9925 0.9927 0.9929 0.9911 0.9913 0.9913 0.9916 0.9916 0.1170 0.1190 0.1210 0.1230 0.1251 0.9933 0.9940 0.9941 0.9945 0.9945 0.9946 0.9949 0.9951 0.9952 0.9953 0.9956 0.9957 0.9957 0.9959 0.9911 0.9951 0.9952 0.9952 0.1401 0.1423 0.1446 0.1469 0.9953 0.9956 0.9957 0.9959 0.9971 0.9972 0.9973 0.9974 0.9973 0.1401 0.1423 0.1446 0.1469 0.9974 0.9973 0.9977 0.9977 0.9977 0.9977 0.9973 0.9977 0.9976 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.9986 0.99976 0.9976 0.2483 0.2817 0.3228 0.3228 <	2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9342	0.9846	0.9850	0.9854	0.9857	1		-1.2	0.0895	0.1003	0.0853	0.0869	0.0885	
1 0.9918 0.9920 0.9922 0.9923 0.9923 0.9924 0.9931 0.9934 0.9936 1 0.9918 0.9940 0.9941 0.9943 0.9946 0.9931 0.9934 0.9936 0.9933 0.9940 0.9941 0.9945 0.9946 0.9946 0.9931 0.9942 0.9942 0.9955 0.9956 0.9957 0.9957 0.9939 0.9960 0.9971 0.9972 0.9973 0.9974 0.9974 0.9975 0.9976 0.9977 0.9979 0.9970 0.9971 0.9972 0.9973 0.9974 0.9985 0.9986 0.9987 0.9986 0.9986 0.9987 0.9986 0.9981 0.2207 0.2236 0.2276 0.99865 0.99869 0.99874 0.99884 0.9988 0.9986 0.99800 0.99900 0.9911 0.2207 0.2243 0.2277 0.2243 0.2277 0.2243 0.2277 0.2243 0.2276 0.2378 0.2976 0.3986 0.99816 0.99962 0.99962 0.99962 0.99962 0.99962 0.99962	3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9878	0.9881	0.9884	0.9887	0.9890			-1.1	0.1170	0.11003	0.1020	0.1038	0.1057	
0.9938 0.9940 0.9941 0.9945 0.9945 0.9946 0.9946 0.9931 0.9951 0.9952 0.9953 0.9955 0.9956 0.9957 0.9959 0.9960 0.9961 0.9962 0.9963 0.9952 0.9953 0.9955 0.9956 0.9957 0.9959 0.9960 0.9970 0.9971 0.9972 0.9973 0.9974 0.9953 0.9956 0.9976 0.9957 0.9977 0.9977 0.9978 0.9973 0.9970 0.9971 0.9972 0.9973 0.9974 0.9954 0.9985 0.9983 0.9984 0.9984 0.9983 0.9986 0.9981 0.2451 0.2443 0.2877 0.2912 0.9983 0.99844 0.99844 0.99844 0.99924 0.99926 0.99929 0.39860 0.99920 0.3483 0.3264 0.3276 0.3243 0.2877 0.2912 0.99933 0.99934 0.99938 0.99938 0.99924 0.99926 0.99926 0.99929 0.3289 0.3285 0.3264 0.32 0.3483 0.3520 0.3377	4	0.9918	0.9920	0.9922	0.9925	0.0027	0.0000	0.9909	0.9911	0.9913	0.9916	1 AL			0.1110	0-1130	0.1210	0.1230	0.1251	
0.9953 0.9955 0.9956 0.9957 0.9959 0.9950 0.9951 0.9952 0.1611 0.1613 0.16160 0.1665 0.1711 0.9953 0.9956 0.9957 0.9959 0.9959 0.9957 0.9959 0.9959 0.9951 0.9952 0.9964 0.1611 0.1613 0.16160 0.1685 0.1711 0.9953 0.9956 0.9957 0.9957 0.9979 0.9971 0.9972 0.9973 0.9974 0.9974 0.7977 0.2148 0.2177 0.2207 0.2236 0.2266 0.99865 0.99887 0.99878 0.99884 0.99885 0.99885 0.99866 0.999900 0.2481 0.22431 0.2877 0.2912 0.99903 0.99906 0.99910 0.99913 0.99921 0.99921 0.99924 0.99926 0.99929 0.3483 0.3520 0.3577 0.3154 0.4611 0.4611 0.4611 0.4611 0.4145 0.1446 0.1445 0.1446 0.1426 0.1426 0.1426 0.1426 0.1236 0.2176 0.2176 0.2126 0.2176 0.22	5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9919	0.9931	0.9932	0.9934	0.9936	1	- 1	-1.0	0.1379	0 1401	0 1 400			
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 $P(x \le C)$) represents the probability that the project will be completed on or before the C time u This can be converted into the standard normal statistic *z* as:

$$p\left[\frac{x-\mu}{\sigma} \le \frac{c-\mu}{\sigma}\right] = P[Z \le \frac{c-\mu}{\sigma}]$$



المحاضرة (٤)

Example Consider Table 1 summarizing the details of a project involving 11 activities Table 1 Details of Project with 11 Activities

Activity	Predecessor(s)	I	Duration (week	cs)
		t _o	t _m	t _p
А		6	7	8
В		1	2	9
С		1	4	7
D	A	1	2	3
E	A, B	1	2	9
F	С	1	5	9
G	C	2	2	8
Н	E,F	4	4	4
1	E, F	4	4	10
J	D, H	2	5	14
К	I,G	2	5	8

(a) Construct the project network.

(b) Find the expected duration and variance of each activity.

(c) Find the critical path and the expected project completion time.

(d) What is the probability of completing the project on or before 25 weeks?

(e) If the probability of completing the project is 0.84, find the expected project completion t

Solution (a) The project network is shown in Figure 1.

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المحاضرة (٤)



(b) The expected duration and variance of each activity are shown in Table 1.Table 2 Computations of Expected Duration and Variance

		Duration (we	eeks)	Mean	Variance
Activity	t	t _m	t _p	duration	
А	6	7	8	7	0.11
В	1	2	9	3	1.78
С	1	4	7	4	1.00
D	1	2	3	2	0.11
E	1	2	9	3	1.78
F	1	5	9	5	1.78
G	2	2	8	3	1.00
Н	4	4	4	4	0.00
1	4	4	10	5	1.00
J	2	5	14	6	4.00
К	2	2	8	3	1.00

(c) The calculations of critical path based on expected durations are summarized in Figure

2. The critical path is A-DI –E-F-J and the corresponding project completion time is 20 weeks.

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Also





*D1 — Dummy activity

(d) The sum of the variances of all the activities on the critical path is:

$$0.11 + 1.78 + 0.00 + 4.00 = 5.89$$
 weeks.

Therefore
$$\sigma = \sqrt{5.89} = 2.43$$
 weeks.
 $P(x \le 25) = P\left(\frac{x - \mu}{\sigma} \le \frac{25 - 20}{2.43}\right) = P(z \le 2.06) = 0.9803.$

This value is obtained from standard normal table. Therefore, the probability of completing the project on or before 25 weeks is 0.9803.

(e)We also have $P(x \le C) = 0.84$. Therefore,

$$P\left(\frac{x-\mu}{\sigma} \le \frac{C-\mu}{\sigma}\right) = 0.84$$
$$P\left(z \le \frac{C-20}{2.43}\right) = 0.84$$

From the standard normal table, the value of z is 0.99, when the cumulative probability is 0.84.

Therefore,

$$\frac{C-20}{2.43} = 0.99$$
 or $C = 22.4$ weeks

The project will be completed in 22.41 weeks (approximately 23 weeks) if the probability of completing the project is 0.84.



المحاضرة (٤)

EXERCISES:

1- Consider the following data of a project.

Activity	Predecessor(s)	Duration (weeks)						
		a	m	ь				
A		3	5	8				
В		6	7	9				
С	A	4	5	9				
D	C	A	4	5				
D	В	3	5	8				
E	A	4	6	9				
F	C, D	5	8	11				
G	C, D, E	3	6	9				
Н	F	1	2	9				

(a) Construct the project network.

(b) Find the expected duration and variance of each activity.

(c) Find the critical path and the expected project completion time.

(d) What is the probability of completing the project on or before 30 weeks?

(e) If the probability of completing the project is 0.9, find the expected project completion time.

2- Consider the following table summarizing the details of a project:

Activity	Predecessor(s)		Duration (weeks)							
		a	m	ь						
A		4	4	10						
В		1	2	9						
С		2	5	14						
D	A	1	4	7						
E	A	1	2	3						
F	A	1	5	9						
G	B, C	1	2	9						
н	С	4	4	4						
1	D	2	2	8						
J	E, G	6	7	8						
K	F, H	2	2	8						
L	F, H	5	5	5						
M	1, J, K	1	2	9						
N	L	6	7	8						



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- (a) Construct the project network.
- (b) Find the expected duration and variance of each activity.
- (c) Find the critical path and the expected project completion time.
- (d) What is the probability of completing the project on or before 35 weeks'?
- (e) If the probability of completing the project is 0.85, find the expected project completion time.



The Construction Industry (الصناعة الانشائية):

The construction industry is vast and varied. Just take a look around from homes to highways to hospitals—and you see the results of this industry.

As our needs expanded, so did our building capabilities. We eventually built political capitals, great cities bustling with business and commerce. Though the means and the methods have changed over the centuries, the construction industry is still about building communities that serve people. Construction is big business, totaling more than \$3.9 trillion annually Worldwide, and there is no slowdown in sight. The industry employs about 7 million people directly (plumbers, carpenters, welders, and so on) and hundreds of thousands more indirectly. It gives rise to the steel industry, the lumber industry, the carpet industry, the furniture industry, the paint industry, the concrete industry, the paving industry, and so on. It goes even further than that if you consider the trucking, shipping, manufacturing, and mining industries.

There are three principal players in any construction project are the owner, the designers (architects and engineers), and the contractor

Owners (اصحاب العمل)

No construction would ever be accomplished without owners. They are the driving force behind the construction industry. Their demands for housing, commercial facilities, industrial products, and infrastructure are the chief motivation to build.

(المعماريون) Architects

Architects design the overall aesthetic and functional look of buildings and other structures. Architectural technicians are typically the drafters of the building plans. They are the ones who actually produce the drawings that are used for construction. Today drafters have become computer operators and produce their drawings electronically using computer-aided design (CAD) software. Some CAD operators have expanded their skills to include 3D building information modeling (BIM) as well. As the trend toward information modeling continues, these technicians will become more and more valuable in the marketplace.

Specification writers accompanying (ارفاق) the plans for a new building is a written project manual that contains the specifications for the project. The