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Appendices:

Appendix A ابرام العقود لسنة 1994 – منشور وزارة العدل

Appendix B1 Selected Construction Resourses Indices

Appendix B2 Plant Partial Indices Versus E. Bricks

Appendix B3 Worldwide Inflation - Interest Rates

Appendix B4 Annual Monthly Inflation Rates

Appendix C1 Questionnaire

Appendix C2 استبيان

Appendix D1 Programme Flow Chart

Appendix D2 programme

Appendix F Selected Equations' Details

Appendix A

Appendix A (continued)

Appendix A (continued)

Appendix A (continued)

Appendix A (continued)

Appendix A (continued)

Appendix A (continued)

Appendix B1 Selected Construction Resourses Indices

Year	Labour cost (1)	Site Overhead (1)	HQ Overhead (1)	Painting (4)	Excavate (4)	S M & L 1.5 BW	CPI (2)	Gasoline (3)	Cement (4)	Gloss paint (4)	Natural Brick (5)
1990	100	100	100	100	100	100	100	100	100	100	100
1991	100	100	100	150	100	171	214	350	208	240	110
1992	431	388	233	75	60	2143	436	667	625	560	120
1993	619	567	350	125	119	2557	888	2500	2083	1800	136
1994	1240	1170	731	500	476	2714	2086	6700	3500	4000	200
1995	1240	1170	731	2500	595	4286	3815	7200	3208	6000	280
1996	1650	1500	917	1500	714	7143	7016	25000	4792	8800	580
1997	2490	2190	1330	1450	1191	9714	14114	30000	18333	8000	1000
1998	7120	5930	3670	1500	1786	14286	18385	32300	18333	16000	1200
1999	11270	9280	5280	2500	1786	15143	20256	32300	20833	24000	1280
2000	13320	10800	6160	3000	2381	17143	23199	41700	25000	26000	1400
2001	13040	10260	5660	3750	2976	18000	24226	52500	29167	20000	1890
2002	16090	12760	7200	3750	3571	18571	26343	54200	30833	24000	2000

(reproduced by the researcher)

(1) ديوان شؤن الخدمة الاتحادية
(2) الجهاز المركزى للاحصاء
(3) ادارة الطاقة و التعدين
(4) نيالا (اسعار اسوق و المقاولين)
(5) اتحادالصناعات الصغيرة (الخرطوم بحرى)

Abbreviaattions

S M & L 1.5 BW	supply materials, labour and execute 1.5 brick work per m^2
Excavate	excavation for strip foundation per m^2
Painting	paint new walls as per m^2

Appendix B2 Plant Partial Indices Versus E. Bricks Index

Period	**f %**	**Plant Hire Index** ***(1)***	**Labour Index**	**Fuel Index**	**Others**	**Engineering Brick Index** ***(2)***
97	47	100	100	100	Depreciation,	100
98	18	100	286	120	Insurance ,	124
99	16	100	453	129	License,	179
00	8	100	535	129	….	235
01	5	100	524	167		258
02	11	100	646	210		258

Sources: ***(reproduced by the researcher)***

(1) Khartoum Costruction Company
(2) Building and Road research Institute (U of K)

Appendix B3 Worlidwide Inflation - Interest Rates

Year	Annual Inflation Rates %				Annual Interest Rates %	
	Brazil (1)	Sudan (2)	Turkey (3)	USA (4)	Turkey (5)	USA (6)
1990	2948	67	60	5.4	53	8.7
1991	477	123	66	4.2	80	8.2
1992	1023	119	70	3.0	87	7.5
1993	1927	101	66	3.0	87	6.5
1994	2075	116	104	2.6	158	7.4
1995	66	69	94	2.8	123	6.9
1996	16	130	80	2.9	134	6.8
1997	6.9	47	86	2.3	124	6.7
1998	3.2	17	85	1.6	116	5.6
1999	4.9	16	65	2.2	110	6.1
2000	7.0	8	55	3.4	38	6.4
2001	6.8	5	54	2.8	100	6.2
2002	6.1	11	45	1.6	64	5.8

Sources:

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Appendix B4 National Annual Monthly Inflation Rates

Month	Jan.	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1990	0.0437	0.0892	0.1368	0.1864	0.2382	0.2923	0.3487	0.4076	0.4691	0.5332	0.6001	0.6700
1991	0.0691	0.1430	0.2220	0.3065	0.3968	0.4933	0.5965	0.7069	0.8249	0.9510	1.0858	1.2300
1992	0.0675	0.139	0.2165	0.2986	0.3863	0.4799	0.5798	0.6864	0.8003	0.9218	1.0515	1.1900
1993	0.0599	0.1234	0.1907	0.2620	0.3376	0.4177	0.5027	0.5927	0.6881	0.7892	0.8964	1.0100
1994	0.0663	0.1370	0.2123	0.2927	0.3783	0.4697	0.5671	0.6710	0.7817	0.8998	1.0257	1.1600
1995	0.0447	0.0914	0.1402	0.1911	0.2444	0.3000	0.3581	0.4188	0.4822	0.5485	0.6177	0.6900
1996	0.0719	0.1489	0.2315	0.3200	0.4149	0.5166	0.6256	0.7424	0.8677	1.0019	1.1458	1.3000
1997	0.0326	0.0663	0.1011	0.1370	0.1741	0.2124	0.2520	0.2928	0.3350	0.3786	0.4236	0.4700
1998	0.0132	0.0265	0.0400	0.0537	0.0676	0.0817	0.0959	0.1103	0.1250	0.1398	0.1548	0.1700
1999	0.0124	0.0250	0.0378	0.0507	0.0638	0.0770	0.0904	0.1040	0.1177	0.1317	0.1457	0.1600
2000	0.0064	0.0129	0.0194	0.0260	0.0326	0.0392	0.0459	0.0526	0.0594	0.0662	0.1457	0.0800
2001	0.0041	0.0082	0.0123	0.0164	0.0205	0.0247	0.0289	0.0331	0.0373	0.0415	0.0457	0.0500
2002	0.0087	0.0175	0.0264	0.0354	0.0444	0.0536	0.0628	0.0721	0.0814	0.0909	0.1004	0.1100

(reproduced by the researcher)

Appendix C1 Questionnaire

College of Graduate Studies

Sudan University of Science and Technology

Date: June 2005

Please fill below as accurate as to your documents

Date:

1) Client:	**Government**	□	**Private Sector**	□
2) Contractor:	**Public**	□	**Private Sector**	□
3) Type of Project:	**Civil**	□	**Building**	□
	Industrial	□	**Others (indicate)**	□

4) Contract Price Stating Currency:

5) Indicate if More than a Currency Was Employed:

6) Contract Duration:

7) Date of Contract Commence:

8) Contract Practical Completion Date:

9) % age Advance Payment:

00	□,	**10**	□,	**15**	□
20	□,	**30**	□,	**40**	□
50	□,	**60**	□,	**> 60 (indicate)**	□

10) Value of Advance Payment:

11) Advance Payment Bond Paid in:

Cash □, **Security** □

12) Date Advance Payment Bond Reimbursed:

13) Defect liability Period:

14) %age Maximum Retention:

Appendix C1 (continued)

15) %age Performance Bond:

16) Performance Bond Paid in:

Cash □**, Security** □

17) If extension time was granted:

Performance bond renewed □

Performance bond was not renewed □

18) Date performance bond reimbursed:

19) If contract conditions included escalation formula, give details:

20) Technique(s) or Schedule(s) employed to control Contract progress:

CPM □

Bar Chart □

Others (*indicate*) □

No schedule □

21) Number of variation orders:

22) Contract Substantial completion was:

Timely according to contract duration □

Extension time granted □

Contract terminated □

23) Briefly, Explain any liquidated damages Clauses included in the Contract:

Appendix C1 (continued)

24) Any deductions / additions from / to the Contract Value Due to Liquidated Damages compensated the:

Client □, **Liquidated damage value**

Contractor □, **Liquidated damage value**

25) Payment Certificates as per contract documents (fill table below):

No *	Date of Certificate	Certificate Value	If possible, Date(s) money received
00**			
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13	**Substantial Completion**		
14	**Final certificate**		

- *M*
- *o*
- *r*
- *e*
- *s*
- *h*
- *e*
- *e*

More sheets can be used

00** ***Advance payment certificate number***

Thanks for Responding Positively.

Appendix C2 استبيان

جامعة السودان للعلوم و التكنولوجيا :

كلية الدراسات العليا

يونيو 2005

أملا الاماكن الشاغرة ادناه مستعينا بمستندات العقد ما امكن ذلك

01) صاحب العمل : قطاع عام □ , قطاع خاص □

02) المقاول : قطاع عام □ , قطاع خاص □

03) تصنيف العمل :

مبانى □ , أعمال مدنية □

اعمال صناعية □ , أعمال اخرى(وضح) □

04) قيمة العقد الاساسية مع ذكر العملة (العملات) :

05) وضح ان استعمل اكثر من عملة و ما هى:

06) مدة العمل :

07) تاريخ بدء العمل :

08) تاريخ الانجاز الجوهرى (شهادة تسليم ابتدائية):

09) النسبة المئوية للدفعية المقدمة للمقاول:

10) قيمة الدفعية المقدمة :

11) كيفية دفع ضمان الدفعية المقدمة:

نقدا □

ضمان طرف اخر □

لا يوجد □

12) تاريخ استرداد ضمان الدفعية المقدمة:

13) مدة المسئولية عن اصلاح العيوب:

14) النسبة المئوية لكفالة اصلاح العيوب:

Appendix C2 (continued)

15) النسبة المئوية لضملن التنفيذ:

0 % □, **10** □, **15 %** □

20% □, **30%** □, **> 30%(وضح)** □

16) كيفية دفع ضمان التنفيذ:

نقدا □

ضمان طرف اخر □

17) اذا تم تمديد مدة العمل :

تم ايضا تمديد لضمان التنفيذ □

لم يتم تمديد لضمان التنفيذ □

18) تاريخ استرداد قيمة ضمان التنفيذ:

19) اذا تضمن شروط الاعمال بند لزيادة تكلفة الموارد بعد اخر موعد لتقديم العطاء , وضح ذلك (Escalation formula) :

20) ما هى البرامج المستعملة لتنفيذ و متابعة و الانجاز:

المخطط القضيبى (Bar chart) □

المخطط الشبكى (CPM) □

برامج اخرى (وضح) □

لا يوجد) □

21) كم عدد الاوامر التغييرية بالعقد:

22) الانجازالجوهرى للاعمال :

تم قبل او فى الفترة الزمنية المحددة لها □

تم تمديد مدة العمل □

تم فسخ العمل □

23 اذا فشل صاحب العمل او المقاول فى الالتزام بواجباته نحو الطرف الاخر، و بناء على شروط العمل بين الطرفين ، وضح كيف يتم تعويض الطرف الاخر:

اسس تعويض المقاول:

اسس تعويض صاحب العمل:

Appendix C2 (continued)

24) جملة المبالغ التعويضية ل:

المقاول :

صاحب العمل:

25) أملا الجدول ادناه و الذى يوضح تاريخ الصرفيات المرحلية للعقد:

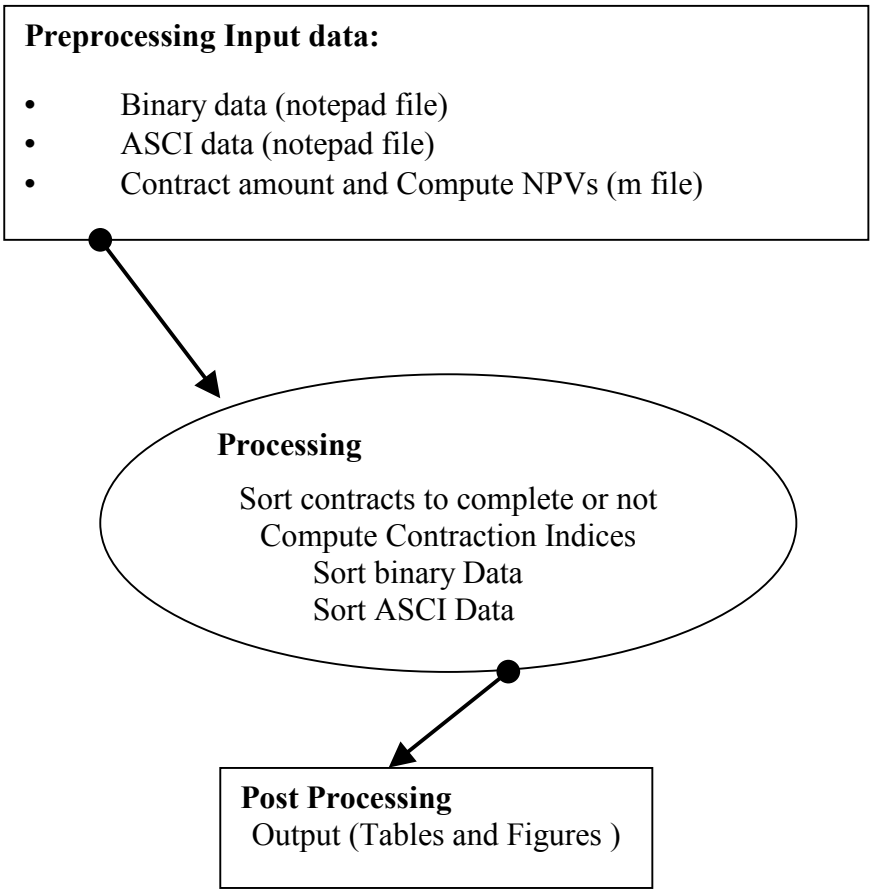
الرقم*	تاريخ اصدار الصرفية	قيمة الصرفية	تاريخد(تواريخ) سداد الصرفية ان امكن ذلك
00			
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13	صرفية الانجازالجوهرى		
14	الصرفية النهائية		

* رقم الصرفية المرحلية

** رقم الدفعية المقدم

شكرا للتعاون

Appendix D1 programme flow chart



Programme Flow Chart

Local abbreviations are illustrated as they are created in the programme

Using import wizard command, the following variables may be created on the command window:

- **starwars** % character array variable
- **NPV** % m file programme

These files must be created on the command window before running the main m file programme **untitled2**

Following above instructions, command window responses as underneath:

Import Wizard created variables in the current workspace starwars

[appears as cell array and the programme converts it to character array]

>> **NPV** (press Enter)

>> **untitled2** (press response)

output:

- In the form of tables in the command window
- Multi window graphs on command figure window

Appendix D2 Programme

```
%feeds advance payment , performance bond , maximum retention
%number of varation orders, liability period and % liquidated damage
%remedy of damages or compensation ratio to any party
%cont ( contract ), const ( construction )
%per ( performance ) NPV ( net present value)
%adv ( advance ), ret ( retention ), var ( varation )
%contliabperiod (contract liability period )
%damageratio (as per liquidated damage clause)
%contract duration (as planned originally in schedules)
%construction time ( time elasped between contract commence and completion)
%saved in file onjob.dat and

m = load ('onjob.dat');          % as per contracts
[p,l] = size (m)

advance              = m(1,:);
performance          = m(2,:);
retention            = m(3,:);
variation            = m(4,:);
contduration         = m(5,:);
consttime            = m(6,:);
contliabperiod       = m(7,:);
damageratio          = m(8,:);
escalation           = m(9,:);
unsorted             = m(10,:);
n = l ;      % total number of +vely responsive questionare

%sort contracts to uncompleted and completed contracts
%calculate construction indices and rank them

C       = find(unsorted==1);  % successful or challenged contracts vector
NC      = find(unsorted==0);  % failed contracts vector
T       = length(C) ;  % counts successful or challenged projects
tt      = length(NC);  % counts failed projects

constperindex        = contamount./contprice;
conteconindex        = contNPV./contprice ; % may be greater than one
perbondindex         = perbondinflation.^(-1 ) ;
cc                   = find(perbondindex~=1 ) ;
consttimeindex       = consttime./contduration;
```

```
conteconindexc     = conteconindex(C );
consttimeindexc    = consttimeindex(C);

averconstperindex = mean(constperindex );
Stdconstperindex   = std(constperindex ) ;
Covconstperindex = Stdconstperindex/averconstperindex;

Averconsttimeindex       = mean(consttimeindex );
Stdconsttimeindex        = std(consttimeindex ) ;
Covconsttimeindex        = Stdconsttimeindex/averconsttimeindex;
Consmisind               = constperindex+consttimeindex;
Consmisindc              = constperindex(C)+consttimeindex(C);
Consmisindnc             = constperindex(NC)+consttimeindex(NC);
Advancec                 = advance(C);

figure(1)
   subplot(1,2,1)
   hold on
      plot(contrcomence(C),conteconindex(C),'b'* )
      hold on
      plot(contrcomence(NC),conteconindex(NC),'r '* )
      hold off
      xlabel('Date contract commence ' )
      ylabel('Contract NPV index' )
      axis([1990 2005 0 1.4])
      grid on

   subplot(1,2,2 )
      plot(contrcomence(cc),perbondindex(cc' ),'*' )
      xlabel('Date contract commence' )
      ylabel('Performance bond index' )
      axis([1990 2005 0 1])
      grid on

constcostoverrun    = round(100*(contamount-contprice)./contprice);
consttimeoverrun    = round(100*(consttime-contduration)./contduration);

figure (2)
   subplot(1,2,1)
      plot(contrcomence,constcostoverrun,  ' *' )
      xlabel('Date contract commence' )
      ylabel('Construction cost overrun'% )
```

```
    grid on
  subplot(1,2,2)
    plot(contrcomence,consttimeoverrun,'*')
    xlabel('Date contract commence')
    ylabel('Construction time overrun'% )

    grid on

%data statistics
%contractors to recieve an advance payment that difers in %age (expadvp)
%contractors to deposite a performance bond that difers in %age (expperb)
%engineer to retain defect liab period money that difers in %age (expretm)
%many variation orders to be issued (expvar in numbers)
%expected liability period as per contract documents ( expliabper in months)
%expected liquidated damage compensation in %age (exprat(

expadvp   = [0 10 15 30  ];
expperb   = [0 10 15 20];
expretm   = [0 2.5 5 10];
expvaro   = [0 1 2 3];
 %advance payment statistics
cadv1 = 0; cadv2 = 0; cadv3 = 0; cadv4 = 0; cadv5 = 0;
for k = 1 :n
        if    expadvp(1) == advance(k)          adv1 = cadv1+1;
        elseif expadvp(2) == advance(k)         cadv2 = cadv2+1;
        elseif expadvp(3) == advance(k)         cadv3 = cadv3+1;
        elseif expadvp(4) == advance(k)         cadv4 = cadv4+1;
        else                                    adv5 = cadv5+1;
        end;
end
 %performance bond statistics
cper1 = 0; cper2 = 0; cper3 = 0; cper4 = 0; cper5 = 0;
for k = 1 :n
        if    expperb(1) == performance(k)    cper1 = cper1+1;
        elseif expperb(2) == performance(k)   cper2 = cper2+1;
        elseif expperb(3) == performance(k)   cper3 = cper3+1;
        elseif expperb(4) == performance(k)   cper4 = cper4+1;
        else                                  cper5 = cper5+1;
        end;
end
%retension statisics
cret1 = 0; cret2 = 0; cret3 = 0; cret4 = 0; cret5 = 0;
for k = 1 :n
```

```
        if      expretm(1) == retention(k)      cret1 = cret1+1;
        elseif  expretm(2) == retention(k)      cret2 = cret2+1;
        elseif  expretm(3) == retention(k)      cret3 = cret3+1;
        elseif  expretm(4) == retention(k)      cret4 = cret4+1;
        else                                    cret5 = cret5+1;
        end;
end

 %variation order statistics
cvar1 = 0; cvar2 = 0; cvar3 = 0; cvar4 = 0; cvar5 = 0;
for k = 1 :n
        if      expvaro(1) == variation(k)      var1 = cvar1+1;
        elseif expvaro(2) == variation(k)       var2 = cvar2+1;
        elseif expvaro(3) == variation(k)       var3 = cvar3+1;
        elseif expvaro(4) == variation(k)       var4 = cvar4+1;
        else                                    var5 = cvar5+1;
        end;
end
ww = [cadv1 ,cadv2,  cadv3 , cadv4 , cadv5];
xx = [cper1, cper2 , cper3 , cper4  ,cper5];
yy = [cret1 ,cret2,  cret3,  cret4  ,cret5];
zz = [cvar1, cvar2 , cvar3 , cvar4 , cvar5];

figure(3)
   subplot(2,2,1)
      bar(ww)
      xlabel('Advance Payment %age')
      ylabel('Number of Contracts('
   Subplot(2,2,2)
      bar(xx,(
      xlabel('Performance Bond %age')
      ylabel('Number of Contracts')
   Subplot(2,2,3,(
      bar(yy,(
      xlabel('Max Retention Money %age('
      ylabel('Number of Contracts('
   Subplot(2,2,4,(
      bar(zz,(
      xlabel('Number of Variation orders')
      ylabel('Number of Contracts')

 %Sort contract duration into <= 6month, 6 month <= duration
=> %one year, one year <= duration <= two year, duration
```

```
 %Sort contract liability period (noliability, 6month,9 month or one year)
expcontdur  = [60 90 182 365] ; % duration in days
expconsdur  = [60 90 182 365] ; % duration in days
expliabper  = [0 6 9 12]    ;  % months ( any period less than six month checked )
 %contract duration
cdur1 = 0; cdur2 = 0; cdur3 = 0; cdur4 = 0; cdur5 = 0;
for k = 1 :n
        if     expcontdur(1) >= contduration(k)        dur1 = cdur1+1;
        elseif expcontdur(2) >= contduration(k)       dur2 = cdur2+1;
        elseif expcontdur(3) >= contduration(k)       dur3 = cdur3+1;
        elseif expcontdur(4) >= contduration(k)       dur4 = cdur4+1;
        else                                          dur5 = cdur5+1;
  end;
end

 %construction duration
ccdur1 = 0; ccdur2 = 0; ccdur3 = 0; ccdur4 = 0; ccdur5 = 0;
for k = 1 :n
        if     expconsdur(1) >= consttime(k)    dur1 = ccdur1+1;
        elseif expconsdur(2) >= consttime(k)  cdur2 = ccdur2+1;
        elseif expcontdur(3) >= consttime(k)  ccdur3 = ccdur3+1;
        elseif expcontdur(4) >= consttime(k)  ccdur4 = ccdur4+1;
        else                                  cdur5 = ccdur5+1;
  end;
end
 %contract liability period
cliabper1 = 0; cliabper2 = 0; cliabper3 = 0; cliabper4 = 0;
for k = 1 :n
   if     expliabper(1) == contliabperiod(k)     liabper1 = cliabper1+1;
   elseif expliabper(2) == contliabperiod(k)   liabper2 = cliabper2+1;
   elseif expliabper(3) == contliabperiod(k)   liabper3 = cliabper3+1;
   else                                        abper4 = cliabper4+1;
  end;
end
 %compensation for damages
(1-) %for ignoring remedy clause,(0)for negotiable clauses and (>0)for a
 %definite %age compensation relative to daily average productivity
expdamagratio     = [-1 0 5 15 25] ;    %  ( with greater ratios nested)

cdam1 = 0; cdam2 = 0; cdam3 = 0; cdam4 = 0 ; cdam5 = 0 ; cdam6 = 0;
for k = 1 :n
 if     expdamagratio(1)== damageratio(k)     dam1 = cdam1+1;
 elseif expdamagratio(2)== damageratio(k)   cdam2 = cdam2+1;
```

```
        elseif
        expdamagratio(2)<damageratio(k))&(expdamagratio(3)>=damager
        atio(k))  cdam3 = cdam3+1;
 elseif
(expdamagratio(3)<damageratio(k))&(expdamagratio(4)>=damageratio(k))
cdam4 = cdam4+1;
 elseif
(expdamagratio(4)<damageratio(k))&(expdamagratio(5)>=damageratio(k))
cdam5 = cdam5+1;
 else                                    cdam6 = cdam6+1;
   end;
end

 %escalation clauses recognised or not
 %assign (-1) to contracts ruling out escalation and (0)for ignoring such a
 %clause. (1)for negotiable clauses and (2)for a definitive formulae
expesca = [-1 0 1 2[
cesca1 = 0; cesca2 = 0; cesca3 = 0; cesca4 = 0;
for k = 1 :n
        if     expesca(1)== escalation(k)cesca1 = cesca1+1;
        elseif expesca(2)== escalation(k)  cesca2 = cesca2+1;
        elseif expesca(3)== escalation(k)  cesca3 = cesca3+1;
        else                          cesca4 = cesca4+1;
   end;
end

 %challenged and successful projects
 % successful projects: expmisid = [(1.7<= consmisind) & (2.3 > consmisind[ (
 % failed projects    : expmisid = [(1.7>= consmisind) ! (2.3 < consmisind)]

cscp1 = 0; cchp2 = 0;
for k = 1:t
if (1.7> consmisindc(k))|(2.3<consmisindc(k))   cchp2 = cchp2+1 ;
   else                                  cscp1 = cscp1+1;
  end;
end

successfullprojects = (cscp1) ;   % number of successful contracts
challengedprojects  = (cchp2) ;   % number of challenged contracts
failedprojects      = (tt)    ;   % number of failed contracts

yyyy    = [cdur1,cdur2,cdur3,cdur4,cdur5];        % contract duration
yyyv    = [ccdur1,ccdur2,ccdur3,ccdur4,ccdur5] ;  % construction duration
```

```
yyyx    = [ cliabper1, cliabper2, cliabper3,cliabper4 ] ;%liabilityperiod
yyxx        = [cdam1, cdam2, cdam3, cdam4, cdam5 ,cdam5]; % damage
compensations
yxxx    = [cesca1, cesca2, cesca3 ,cesca4] ;    % escalation clauses

figure(4(
   subplot(2,2,1)
      bar(yyyy)
      xlabel('Contract Duration Range (days('(
      ylabel('Number of Contracts('
   subplot(2,2,4(
      bar(yyyx(
      xlabel('Contract Liability Period (months('(
      ylabel('Number of Contracts('
   subplot(2,2,3(
      bar(yyxx(
      xlabel('Damage/ production Ratio('%
      ylabel('Number of Contracts('
   subplot(2,2,2(
       bar(yyyv(
      xlabel('Construction Duration Range (days('(
      ylabel('Number of Contracts('

 %sorts contract time scheduling. Expected barchart (barsched)
 %CPM (cpmsched), Others (osched) and No shedule nsched
 %sorts clients to govermental or private clients
 %%sorts contractors to govermental or private contractors
 %load data file (use imoprt data utility to import txt data (starwars))

starwars       = char(starwars );

contsched      = starwars(1  ;  (:,
clienttype     = starwars(2   ;  (:,
contractortype  = starwars(3;  (:,

barsched = findstr(contsched, 'b;('
cpmsched = findstr(contsched, 'c;('
  osched = findstr(contsched, 'o;('
  nsched = findstr(contsched, 'n;('

  va = length(barsched;(
  vb = length(cpmsched;(
  vc = length(osched;(
```

```
 vd = length(nsched;(

 vj=n

 if vj ~= va + vb + vc + vd;
    disp(va+vb+vc+vd)
    error('mistake, check contract scheduling feeding('
 end

 vaa = [va vb vc vd];

 %sort client types 'g'goverment and 'p' private
x = findstr(clienttype, 'g;('

y = findstr(clienttype, 'p;('
p = length(x;(
k = length(y;(
z = round(100* p./(p+k)) ;  % %goverment client
w =round(100 - z)  ; % %private client
wz = [z, w;[
if n ~= p+k;
   disp(p+k;(
   error('mistake ckeck client type feeding ('
end

 %sort contractor types 'g'goverment and 'p' private
x1 = findstr(contractortype, 'g;('
y1 = findstr(contractortype, 'p;('
p1 = length(x1;(
k1 = length(y1;(
z1 =round(100* p1./(p1+k1)) ;  % %goverment contractor
w1 =round(100 - z1)  ; % % private contractor
ww1 = [z1, w1;[

if n ~= p1+k1;
   disp(p1+k1;(
   error('mistake ckeck contractor type feeding ('
end

wz = [z, w]          ;                  sort client types
ww1 = [z1, w1]       ;                % sort contractor types
vaa = [va vb vc vd]  ;                schedule type used
yxyx    = [cscp1 cchp2 tt ];       % ranking projects
```

```
wzww = [wz' ww1;['
as = 'gov;       '
sa = 'priv'
sasa = [as sa;   [

figure(6(
   subplot(2,2,1(
   bar(wzww(
   xlabel('sasa('
   ylabel('% of the party('
   subplot(2,2,2(
   bar(yxxx(
   xlabel('Escalation('
   ylabel('Number of Contracts('
   subplot(2,2,3(
   bar(vaa (
   xlabel('schedule type used('
   ylabel('Number of Contracts('
   subplot(2,2,4          (
   bar(yxyx(
   xlabel('Project Ranking('
   ylabel('Number of Contracts('


 %faailed project criteria
  F = zeros(10,tt;(
   for k = 1:10
       i = 1:tt;
       F(1,i) = contrcomence(NC;(
       F(2,i) = constperindex(NC;(
       F(3,i) = consttimeindex(NC;(
       F(4,i) = consmisind(NC;(

       F(5,i) = advance(NC;(
       F(6,i) = performance(NC;(
       F(7,i) = retention(NC;(
       F(8,i) = conteconindex(NC;(
       F(9,i) = contduration(NC;(
       F(10,i)= damageratio(NC;(
   end
```

```
 %Successful project criteria

contrcomencec   = contrcomence(C;(
constperindexc  = constperindex(C;(
consttimeindexc = consttimeindex(C;(
consmisindc     = consmisind(C(

advancec        = advance(C;(
performancec    = performance(C;(
retentionc      = retention(C;(
conteconindexc  = conteconindex(C;(
contdurationc   = contduration(C;(
damageratioc    = damageratio(C;(

SS = find((1.7<= consmisindc) & 2.3 >= consmisindc); % successful vector
CH = find((1.7 > consmisindc) | 2.3 < consmisindc) ; % challenged projects
vector
   S = zeros(10,cscp1;(
    for k = 1:10;
      i = 1:cscp1;
      S(1,i) = contrcomencec(SS;(
      S(2,i) = constperindexc(SS;(
      S(3,i) = consttimeindexc(SS;(
      S(4,i) = consmisindc(SS;(

      S(5,i) = advancec(SS;(
      S(6,i) = performancec(SS;(
      S(7,i) = retentionc(SS;(
      S(8,i) = conteconindexc(SS;(
      S(9,i) = contdurationc(SS;(
      S(10,i)= damageratioc(SS;(
 end

  Chp = zeros(10,cchp2;(
    for k = 1:10;
      i = 1:cchp2;
      Chp(1,i) = contrcomencec(CH;(
      Chp(2,i) = constperindexc(CH;(
      Chp(3,i) = consttimeindexc(CH;(
      Chp(4,i) = consmisindc(CH;(

      Chp(5,i) = advancec(CH;(
      Chp(6,i) = performancec(CH;(
```

```
    Chp(7,i) = retentionc(CH;(
    Chp(8,i) = conteconindexc(CH;(
    Chp(9,i) = contdurationc(CH;(
    Chp(10,i)= damageratioc(CH;(
end

sub1 = find(contrcomence < 1994) ; % first subperiod contracts vector
sub2 = find(contrcomence >= 1994 &contrcomence < 1998) ; % first subperiod
sub3 = find(contrcomence >=1998) ; % last subperiod contract vector
r1 = length(sub1; (
r2 = length(sub2; (
r3 = length(sub3; (

SUBPeriod1 = zeros(3,r1;(
SUBPeriod2 = zeros(3,r2;(
SUBPeriod3 = zeros(3,r3;(

  for k = 1:3;
    i = 1:r1;
  SUBPeriod1(1,i) = contrcomence(sub1;(
  SUBPeriod1(2,i) = constperindex(sub1;(
  SUBPeriod1(3,i) = consttimeindex(sub1;(
end

for k = 1:3;
    i = 1:r2;
  SUBPeriod2(1,i) = contrcomence(sub2;(
  SUBPeriod2(2,i) = constperindex(sub2;(
  SUBPeriod2(3,i) = consttimeindex(sub2;(
end
for k = 1:3;
    i = 1:r3;
  SUBPeriod3(1,i) = contrcomence(sub3;(
  SUBPeriod3(2,i) = constperindex(sub3;(
  SUBPeriod3(3,i) = consttimeindex(sub3;(
end

%count failed projects/ period
r11 = 0; r12 = 0 ; r13 = 0;
for i = 1:tt
  if F(1,i) <1994     r11 = r11+1;
  elseif (F(1,i)>= 1994)&(F(1,i)<1998)  r12 = r12 +1;
  else r13 =r13+1;
```

```
   end
end

 %count successful projects/ period
r21 = 0; r22 = 0 ; r23 = 0;
for i = 1:cscp1
   if S(1,i) <1994      r21 = r21+1
   elseif (S(1,i)>= 1994) &(S(1,i)<1998) r22 = r22 +1;
   else r23 =r23+1;
   end
end


figure(5(
   plot(constperindexc(SS),consttimeindexc(SS),'g('*
   hold on
   plot(constperindexc(CH),consttimeindexc(CH),'b('*
   hold on
   plot(constperindex(NC),consttimeindex(NC),'r('*
   hold on
   plot (averconstperindex, averconsttimeindex, 'bs('
   hold off
   xlabel('Construction performance index('
   ylabel('Construction time index;('
   axis([0 10 0 10([
   title('Construction time v. cost Indices('
   grid on

 noconsperiods = [r1 r2 r3]  ;     % no. of conrtacts per period
failedprojperiod = [r11 r12 r13] ; % no. of failed projects per period
succesproperiod  = [r21 r22 r23] ; % no. of successful projects per period

 %contract subperiod statistics
 av1 = mean(SUBPeriod1')     ; % per period
 av2 = mean(SUBPeriod2')     ; % per period
 av3 = mean(SUBPeriod3')     ; % per period

 avconprfoindex4  =  (av1(2).*r1  +  av2(2).*r2  +  av3(2).*r3)/n    ;  %  average
construction performance index
 avcontimeindex4 = (av1(3).*r1+ av2(3).*r2 + av3(3).*r3)/n;

 %Variation analysis
 avervar  = mean(variation; (
```

```
totalvar = sum(variation)    ;  % count number of variaion in all contracts
DVrSS = variation(SS)        ;  % vector of var orders in each successful contract
cssnovar = 0   ;csswithvar = 0 ; % counter for successul projects with no vararions

for i = 1:cscp1
    if DVrSS(i)== 0    cssnovar = cssnovar+1;
    else   csswithvar= csswithvar+1;
    end
end

novarrationSS = (cssnovar/cscp1)*100   ; % percent free variation successful contracts

averadvance = mean(advance; (
NoVO = find(variation(SS) == 0)  ; % ssuccessful contracts with no variation vector
NoVoss = length(NoVO)                ; % count ssuccessful contracts with no variation

figure(7(
plot(consmisindc(SS),advancec(SS),'g('*
   hold on
   plot(consmisindc(CH),advancec(CH),'b('*
   hold on
   plot(consmisind(NC),advance(NC),'r('*
   hold on
   hold off
   xlabel('Construction Misery Index('
   ylabel('Advance Payment;'(%)
   axis([0 20 0 75)]

   grid on

    figure(8)
plot(consmisindc(SS),conteconindexc(SS),'g('*
   hold on
   plot(consmisindc(CH),conteconindexc(CH),'b('*
   hold on
   plot(consmisind(NC),conteconindex(NC),'r('*

   hold off
   xlabel('Construction Misery Index('
```

```
   ylabel('Contract NPV Index;('
   axis([0 20 0 1.4([

figure(9)

subplot(1,2,1)
hist(conteconindexc,14)
   ylabel('Number of Contracts  ;('
   xlabel('Contract Amount NPV('

   subplot(1,2,2(
   hist(consttimeindexc,20(
   xlabel('Construction Time Index('
   ylabel('Number of Contractss  ;('

 aaaa        = mean(conteconindexc)
 aaaa1       = std(conteconindexc)
aaaaaa       = mean(consttimeindexc)
aaaaaa1      =std(consttimeindexc)


%Out puts
%nine figures will be drawn on Matlab figure comand window
wzww = wzww        % sort client types and contractor types
ww = ww  % advance payment distribution
xx = xx    % performance payment distribution
yy = yy    % retention payment distribution
zz = zz     % variationorder distribution


yyyy = yyyy        % contract duration
yyyv = yyyv        % construction duration
yyyx = yyyx        % liability period
yyxx = yyxx        % damage compensations
yxxx = yxxx        %escalation clauses

vaa    = vaa         % schedule type used to control programme
yxyx  = yxyx        % ranking projects

S       = S          % successful projects group indicators
Chp   = Chp      % challenged projects group indicators
F=      F           % failed projects group indicators
```

Appendix F Selected Equations' Details

Interest Rate Factors

$(1 + i)^N$ Future worth factor

$(1 + i)^{-N}$ Present worth factor

$\frac{i(1+i)^N}{[(1+i)^N - 1]}$ Capital recovery factor

$\frac{i}{[(1+i)^N - 1]}$ Sinking fund factor

Continuously Compounded Interest Rates

$F = P\left(1 + \frac{i}{m}\right)^m$ the principal P compounded m times a year.

$1 + a = \left(1 + \frac{i}{m}\right)^m$ a is the effective annual interest rate.

$a = \left(1 + \frac{i}{m}\right)^m - 1$ i is the nominal annual interest rate. As m and / or i increase, the value of a increases as well.

$$a = \left(1 + \frac{i}{m}\right)^m - 1$$

$$= \left[\left(1 + \frac{1}{k}\right)^{ki}\right] - 1$$

$= e^i - 1$ k = m/i and when $m \to \infty$

Inflation and Future Cash with Returns

Consider a single value P with interest rate i and inflation f for N periods:

$$F = P(1+i)^N (1+f)^N$$

$$= P[(1+i)(1+f)]^N$$

$$= P(1+i+f+if)^N$$

$$= P\ (1\ +\ a)^{\ N} \qquad \textit{Fisher's equation}$$

Where a = i + f+ if (apparent or nominal rate of return)

$i = \dfrac{(a\ -\ f)}{(1\ +\ f)}$ Real, effective or inflation free interest rate

If the expected inflation rate is small, then the part if ≈ 0

$a = i+f$ nominal or apparent rate of return

Depreciation Costs Equations

Let P initial total plant cost (present value)

S salvage value (estimate)

N depreciable life

d_j annual depreciation in year j (j =1, 2, …,N)

Dj year j depreciation

B_{vj} book value at year j

Annual rate of deprecation d_j

The straight-line method

$$dj = \frac{1}{N} \qquad \text{(Constant value)}$$

$$Dj = \frac{(P\ -\ S)}{N}$$

$$B_{vj} = P - jD_j$$

The declining balance method

$$dj=1-\sqrt[N]{\left(\frac{S}{P}\right)}$$

$$S = P\,(1-d)^{N}$$

$$Dj = Pd\ (1 - d)^{j-1}$$

$$Bvj = P(1 - d)^{j}$$

The sum of year's digits method (SYDM)

$$dj = \frac{2(N+1-j)}{[N(N+1)]}$$

$$Dj = \frac{2(P-S)(N+1-j)}{[N(N+1)]}$$

$$Bvj = \frac{(P-S)(N+1-j)(N-j)}{[N(N+1)]+S}$$

The sinking fund method

$$F - S = \sum_{1}^{j}(A, N, i)$$

$$Dj = A + \sum_{1}^{j}(A, j, i)$$

$$Bvj = F - \sum_{1}^{j}(A, j, i)$$