LG Electronics Development Project

* Source Code - GitHub Repository

Project	Program	Random Data Same function, no need data file	System Data Real use, need data file
Python Big Data Analysis	Service & Sales Trend	https://github.com/EunbiYoon/ServiceSales_RandomData.git	https://github.com/EunbiYoon/ServiceSales.git
	Product Realtime Monitoring	https://github.com/EunbiYoon/RealtimeMonitoring_RandomData.git	https://github.com/EunbiYoon/RealtimeMonitoring.git
	Product Cost Comparison	https://github.com/EunbiYoon/ProductCost.git	
	Automatic Notice to Technician	https://github.com/EunbiYoon/TechnicianNotice.git	
Quality Indicator	Quality Indicator	https://github.com/EunbiYoon/QualityIndicatorsRandomData.git	https://github.com/EunbiYoon/QualityIndicators.git
Vision System	Vision System	https://github.com/EunbiYoon/VIsionSystem.git	
	Vision Inspection Data Analyze	https://github.com/EunbiYoon/VisionData_RandomData.git	https://github.com/EunbiYoon/VisionData.git
	Product Defect Cause Analyze	https://github.com/EunbiYoon/ProductDefect.git	
Web Application	LG Website	https://github.com/EunbiYoon/LGVideoTutorial_Website.git	
	Portfolio Website	https://github.com/EunbiYoon/Portfolio_Website.git	

* Webs Application - HTTP Address

- LG Video Tutorial Website
  http://ec2co-ecsel-18wyuowhrfffe-499695824.us-east-1.elb.amazonaws.com:5000/

- Portfolio Website **(Please visit portfolio website, I posted all development detail in here.)**

Quality Indicator Automatic Calculator

Concept : By one click, calculate quality indicator (pivot table, hazard graph, PPM & AAR , FDR & FFR)

Analyze the quality data as matrix and build mathematics model for calculate quality indicator such as pivot table, hazard graph, PPM & AAR , FDR & FFR

Each step built with the mathematics model with random variable therefore can apply any svc data.

Improvement : 1) Don't need to use excel for make pivot table, hazard graph, PPM & AAR , FDR & FFR

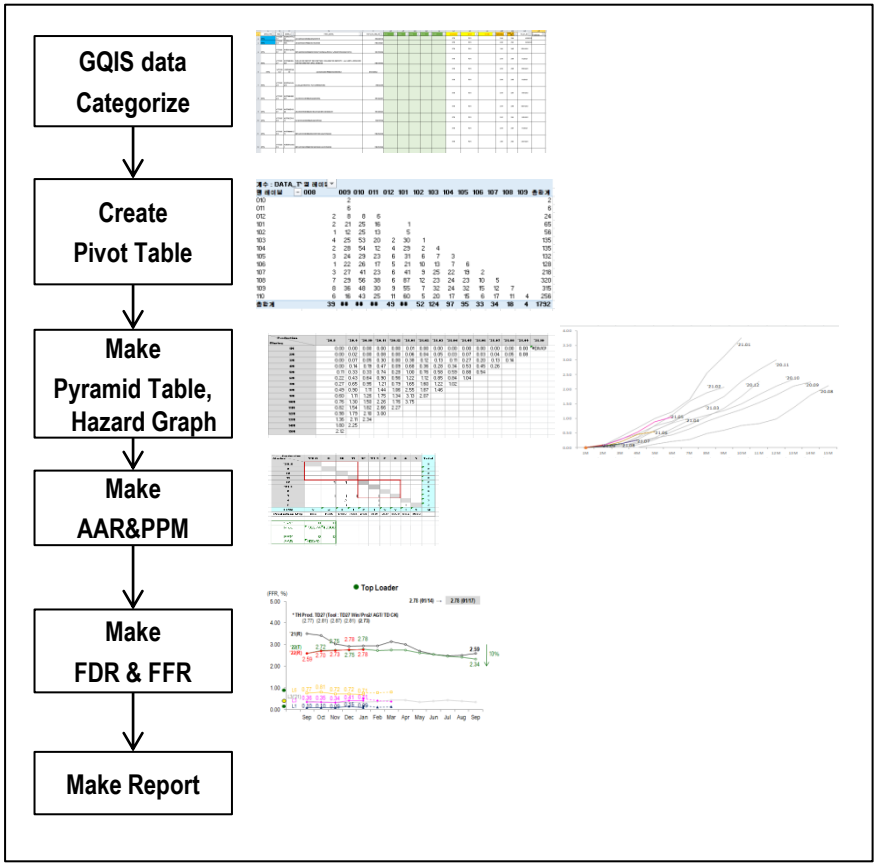
2) Save 50 minutes and effort since you can make the pivot table, hazard graph, PPM & AAR , FDR & FFR by click button once

Progress : 1) Build Mathematics model and demonstrate the valid model by substituting (i=0,1, ... i-1,i)

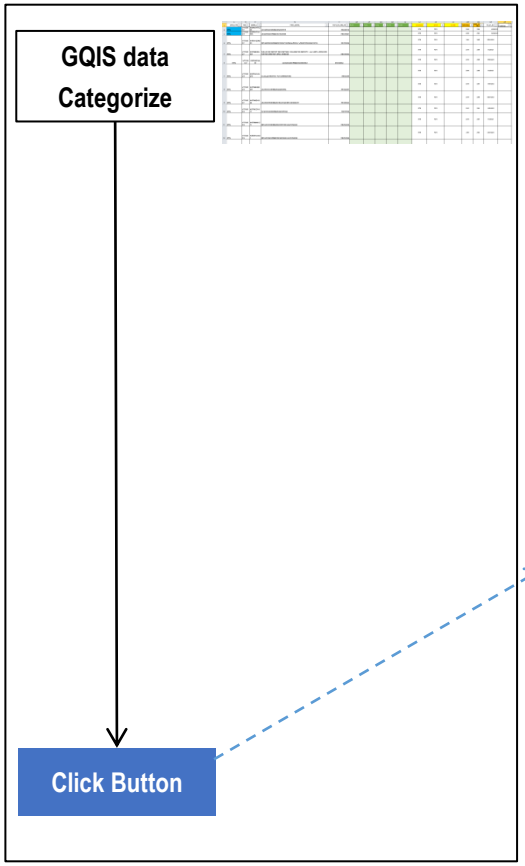
2) Based Mathematics model, build logic tree and create code

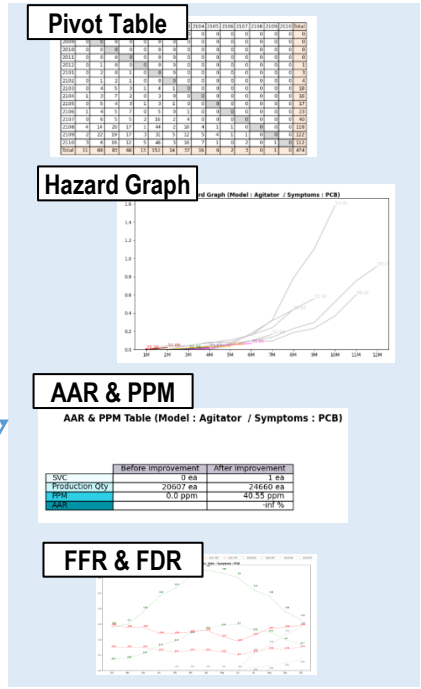
3) Assembled each code and make whole script

As - Is



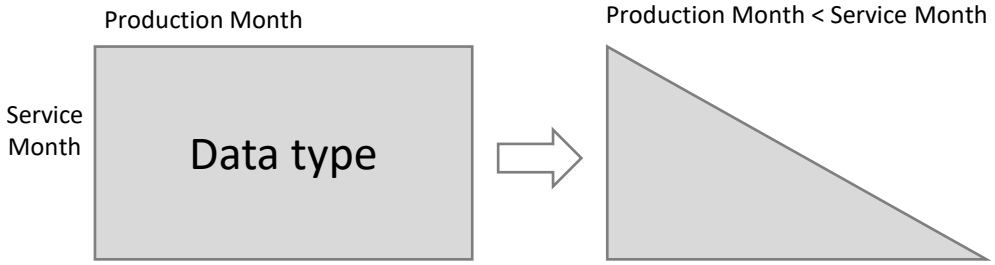
To - Be



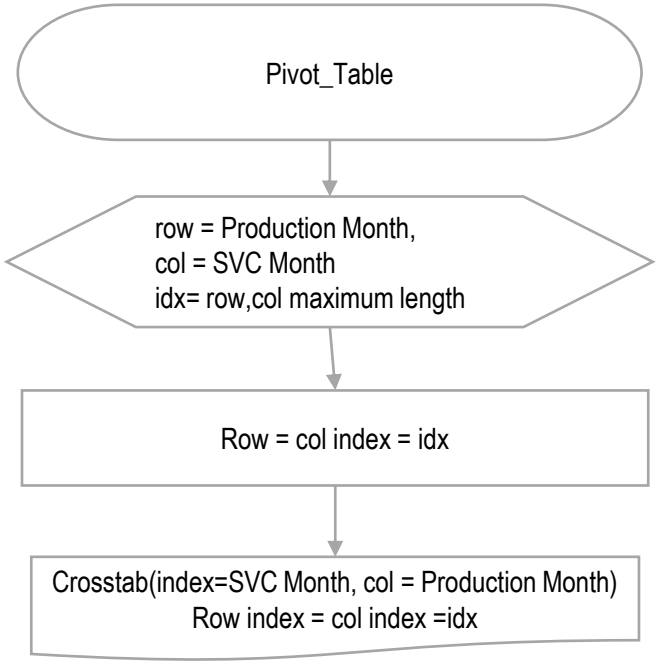


1. Quality Indicator Automatic Calculator – Pivot Table

Modeling



Logic Tree



Build Code

```
pivot_table = pd.crosstab(index=svc_data.GQISClosingMonth,
     columns=svc_data.ProductionMonth, margins=True, margins_name="Total")

idx = pivot_table.columns.union(pivot_table.index)
pyramid_table = pivot_table.reindex(index = idx, columns=idx, fill_value=0)

var = [ ]
for column in pyramid_table.columns.values:
    var.append ( pyramid_table [ column ].tolist () )
    numpy_array = np.array(var)
    transpose = numpy_array.T
    pyramid_vals = transpose.tolist()
```

1. Quality Indicator Automatic Calculator – Pivot Table

Excel Result

1. Agitator Model(WT7305C*), PCB SVC

	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
2008																				
2009																				
2010																				
2011																				
2012		1																		1
2101		2		1																3
2102		1	2	3		8	1													15
2103		4	5	4	1	7	1	4												26
2104	1	3	7	2		4	1	2	1											21
2105		7	4	3	1	3	1	1	2											22
2106	1	4	5	8		5		3		1										27
2107		6	5	5	2	16	2	4				3								43
2108	4	14	20	17	1	46	2	10	4	2	1									121
2109	2	22	19	17	3	31	5	13	5	4	1	2								124
2110	4	9	29	18	7	64	4	22	7	3		3		2						172
2111	3	5	21	24	10	63	12	41	13	2	1	5	2	3						205
2112	1	3	14	12	5	71	5	45	26	17	2	6	2	1	2					212
2201	5	1	15	6	7	50	6	40	25	9	3	3	1							171
2202		1	4	1	1	7		8	5	1		2								30
Total	21	83	150	121	38	375	40	193	88	39	8	24	5	6	2					1193

PGM Result

Pyramid Table (Model : Agitator / Symptoms : PCB)

	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
2008																				
2009																				
2010																				
2011																				
2012		1																		1
2101		2		1																3
2102		1	2	3		8	1													15
2103		4	5	4	1	7	1	4												26
2104	1	3	7	2		4	1	2	1											21
2105		7	4	3	1	3	1	1	2											22
2106	1	4	5	8		5		3		1										27
2107		6	5	5	2	16	2	4				3								43
2108	4	14	20	17	1	46	2	10	4	2	1									121
2109	2	22	19	17	3	31	5	13	5	4	1	2								124
2110	4	9	29	18	7	64	4	22	7	3		3		2						172
2111	3	5	21	24	10	63	12	41	13	2	1	5	2	3						205
2112	1	3	14	12	5	71	5	45	26	17	2	6	2	1	2					212
2201	5	1	15	6	7	50	6	40	25	9	3	3	1							171
2202		1	4	1	1	7		8	5	1		2								30
Total	21	83	150	121	38	375	40	193	88	39	8	24	5	6	2					1193

2. CK Semi-Tub 5.0 Model(WT7150C*), Total SVC

Production / Closing	2109	2110	2111	2112	2201	2202	Total
2109							0
2110							0
2111			2				2
2112		8	6				14
2201		10	13	4			27
2202		2	4	3	1		10
Total	0	20	25	7	1	0	53
Production Q'ty	256	5,958	10,797	8,085	7,729	718	

Pyramid Table (Model : CK5.0 / Symptoms : All)

	2109	2110	2111	2112	2201	2202	Total
2109							
2110							
2111			2				2
2112		8	6				14
2201		10	13	4			27
2202	1	2	4	3			10
Total	1	20	25	7			53

1. Quality Indicator Automatic Calculator – Pivot Table

Excel Result

3. Plus Model(WT7800C*), Noise/Vibration SVC

	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
1903																																					
1904																																					
1905																																					
1906																																					
1907		1		2																																	3
1908		1	3	2																																	6
1909		2	4	1																																	7
1910		1	2		4	2																															9
1911	1	4	3	1	2	4	2	1																													18
1912	2	1	4	3	5	5	1	2																													23
2001	1	2	8	5	6	5	3	6	1	2																											39
2002		6	8	9	6	9	2	10	6	6	2	1																									65
2003		1	8	5	14	8	1	7	3		2	2	1																								52
2004		4	2	4	6	4	2	6	3	3	4	3	3																								44
2005	1	4	2	5	10	6	1	9	3	4	5	1	3																								54
2006	1	5	2	4	4	1	2	6	1	2	6	3	2	4	1																						44
2007		3	10	5	6	6	2	4	3	4	2	5	8	5	1	2																					66
2008		3	5	1	1	7	4	9	6	6	6	6	9	3	5	7	2																				80
2009	3	5	3	3	4	5	1	10	2	5	7	5	7	2	7	9	5	2																			85
2010	1	1	3	5	4	7	3	8	3	2	6	3	3	6	5	5	5	4	2																		76
2011		2		1	6	4	1	3	1	1	2	1	10	6	11	4	8	10	2																		73
2012		3		2	2	6	1	3	5	4	7	6	6	8	3	5	10	14	8	4		1															98
2101			3	1	2	1	1	2	1	1	6	9	3	4	4	10	3	11	2	5	4	2															75
2102		2	1	1	2	1	1		1		8	8	8	4	3	9	12	7	5	9	3	3	5														93
2103	1	1	1	2	1			1	1	2	1	6	7	8	8	9	10	9	6	5	9	3	5														96
2104			1	1	1							2	3	2	7	4	7	7	11	3	3	4	7	3													66
2105						1					1	2	1	3	5	5	1	7	3	2	3	1	8		2	1											46
2106														2	3	5	8	3	3	5	5	3	9	3	10	8	1										68
2107					1										2	3	3	4	5	5	9	6	7	3	10	3	4	1									66
2108		1		1							1		1		1			2	3	3	9	3	7	3	7	2	8	3	2								57
2109														1		1	3	3	4	3	3	5	9	5	12	4	3	2	1	1							60
2110		1	1								2						1	3	3	6	11	3	11	6	3	6	8	5	2	5	1						78
2111			1											1		1		1	1	8	3	2	11	1	10	15	3	8	6	8	5						85
2112															1			1	2	4	5	4	13	3	5	9	5	8	3	5	15	3	5	1			92
2201																		1	2	3	2		6	7	4	4	4	10	2	11	4	3					63
2202													1			1	1						2		2		3		1			1	2				14
Total	11	54	75	64	87	82	28	87	40	42	68	63	76	59	67	80	79	89	62	65	69	40	100	34	65	52	39	37	17	30	25	7	7	1			1801

1. Quality Indicator Automatic Calculator – Pivot Table

PGM Result

3. Plus Model(WT7800C*), Noise/Vibration SVC

Pyramid Table (Model : Plus / Symptoms : NOISE/VIBRATION)

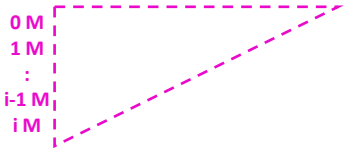
	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
1903																																					
1904																																					
1905																																					
1906																																					
1907		1		2																																	3
1908		1	3	2																																	6
1909		2	4	1																																	7
1910		1	2		4	2																															9
1911	1	4	3	1	2	4	2	1																													18
1912	2	1	4	3	5	5	1	2																													23
2001	1	2	8	5	6	5	3	6	1	2																											39
2002		6	8	9	6	9	2	10	6	6	2	1																									65
2003		1	8	5	14	8	1	7	3		2	2	1																								52
2004		4	2	4	6	4	2	6	3	3	4	3	3																								44
2005	1	4	2	5	10	6	1	9	3	4	5	1	3																								54
2006	1	5	2	4	4	1	2	6	1	2	6	3	2	4	1																						44
2007		3	10	5	6	6	2	4	3	4	2	5	8	5	1	2																					66
2008		3	5	1	1	7	4	9	6	6	6	6	9	3	5	7	2																				80
2009	3	5	3	3	4	5	1	10	2	5	7	5	7	2	7	9	5	2																			85
2010	1	1	3	5	4	7	3	8	3	2	6	3	3	6	5	5	5	4	2																		76
2011		2		1	6	4	1	3	1	1	2	1	10	6	11	4	8	10	2																		73
2012		3		2	2	6	1	3	5	4	7	6	6	8	3	5	10	14	8	4		1															98
2101			3	1	2	1	1	2	1	1	6	9	3	4	4	10	3	11	2	5	4	2															75
2102		2	1	1	2	1	1		1		8	8	8	4	3	9	12	7	5	9	3	3	5														93
2103	1	1	1	2	1			1	1	2	1	6	7	8	8	9	10	9	6	5	9	3	5														96
2104			1	1	1							2	3	2	7	4	7	7	11	3	3	4	7	3													66
2105						1					1	2	1	3	5	5	1	7	3	2	3	1	8		2	1											46
2106														2	3	5	8	3	3	5	5	3	9	3	10	8	1										68
2107					1										2	3	3	4	5	5	9	6	7	3	10	3	4	1									66
2108		1		1							1		1		1			2	3	3	9	3	7	3	7	2	8	3	2								57
2109														1		1	3	3	4	3	3	5	9	5	12	4	3	2	1	1							60
2110		1	1								2						1	3	3	6	11	3	11	6	3	6	8	5	2	5	1						78
2111			1											1		1		1	1	8	3	2	11	1	10	15	3	8	6	8	5						85
2112															1			1	2	4	5	4	13	3	5	9	5	8	3	5	15	3	5	1			92
2201																		1	2	3	2		6	7	4	4	4	10	2	11	4	3					63
2202													1			1	1						2		2		3		1			1	2				14
Total	11	54	75	64	87	82	28	87	40	42	68	63	76	59	67	80	79	89	62	65	69	40	100	34	65	52	39	37	17	30	25	7	7	1			1801

2. Quality Indicator Automatic Calculator – Hazard Graph

1) Pyramid Table

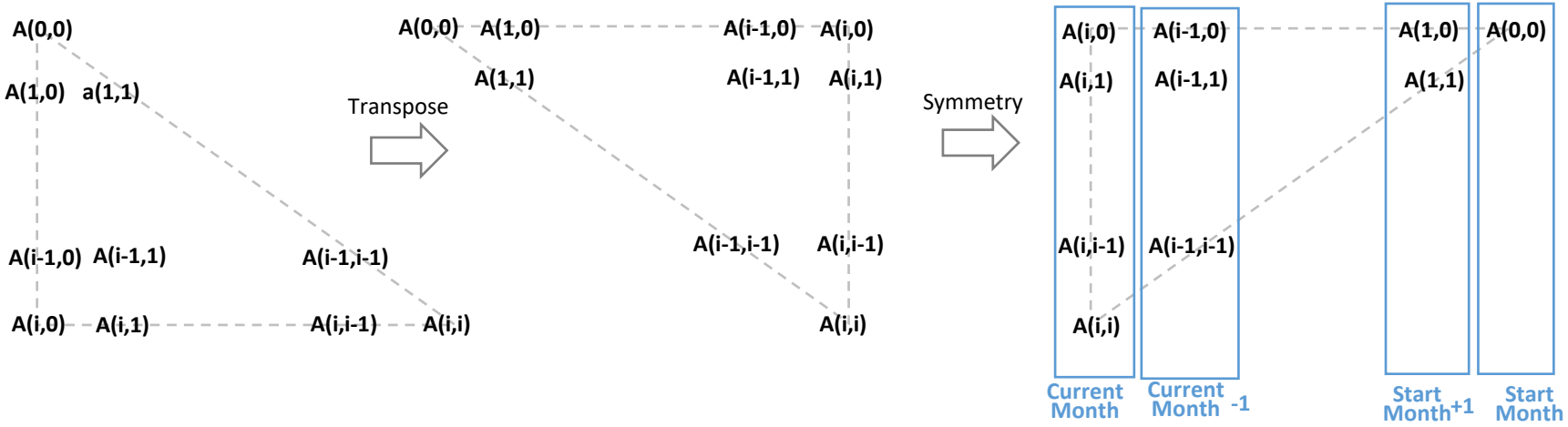
Modeling

Array of Matrix by months from production to service occurrence

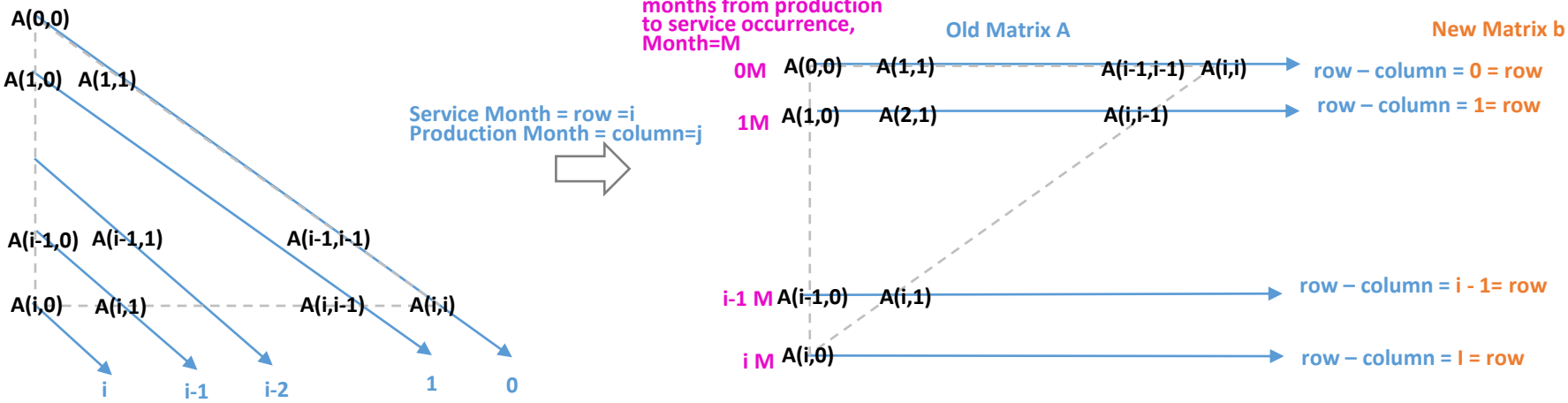


Production Month < Service Month → columns < row

Idea 1. Transpose → Symmetry ⇒ False



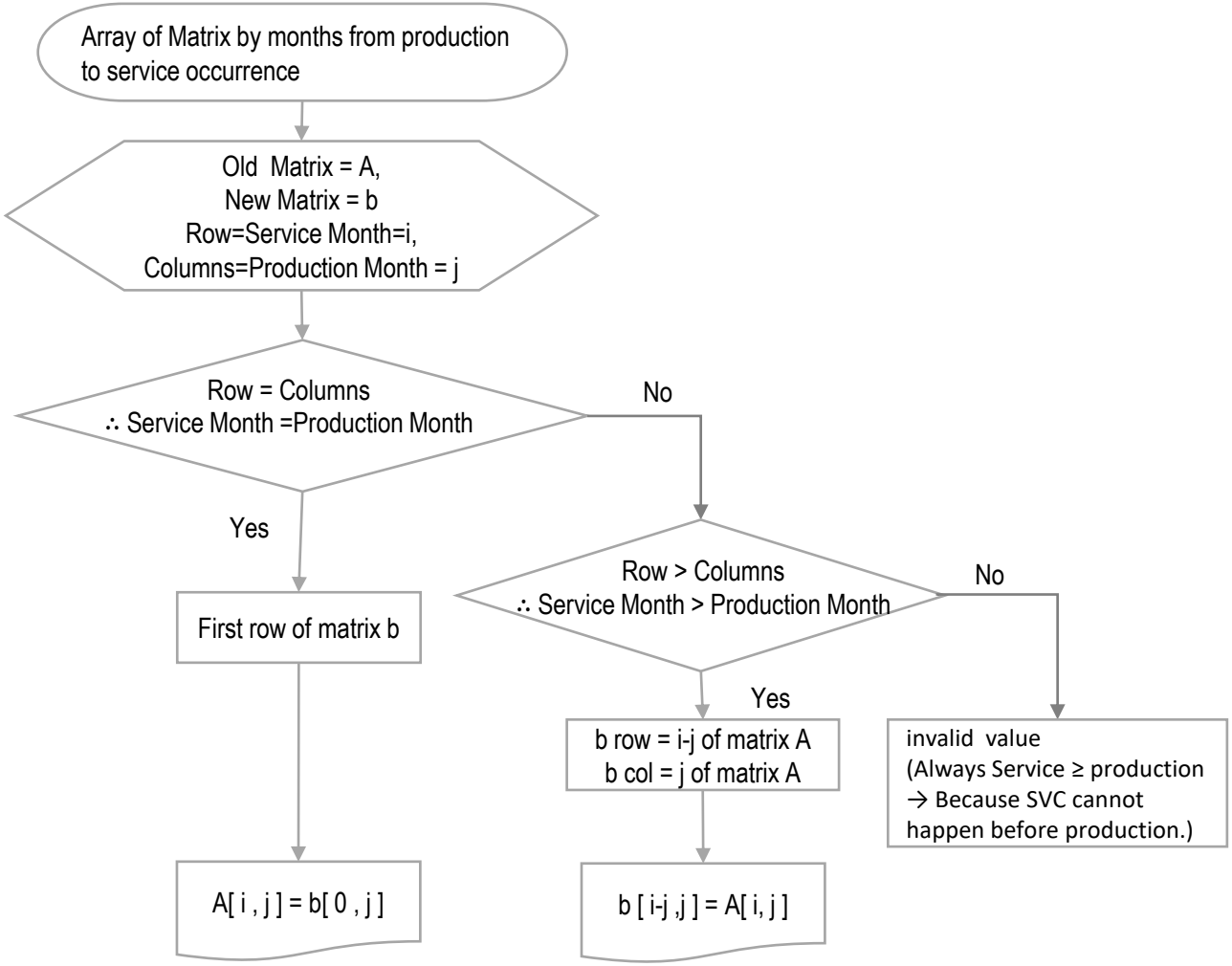
Idea 2. Sort Service Month – Production Month by Value ⇒ True



2. Quality Indicator Automatic Calculator – Hazard Graph

Logic Tree

Idea 2. Sort Service Month – Production Month by Value ⇒ True



Build Code

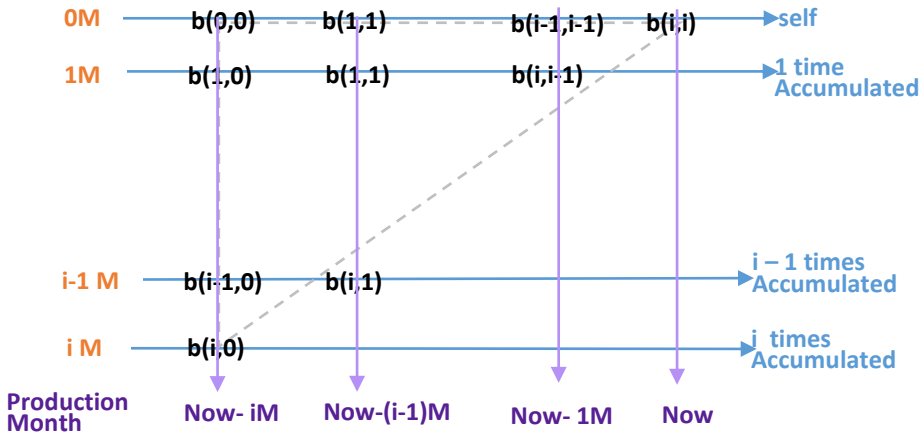
```
b=pd.DataFrame()
for i in range(len(A)):
   for j in range(len(A)):
      if i==j:    # service= production
         k=A.at[i,j]
         b.at[0,j]=k
         j=j+1

      elif i>j:    # service > production
         k=A.at[i,j]
         b.at[i-j,j]=k
         j=j+1
```

2. Quality Indicator Automatic Calculator – Hazard Graph

2) Accumulated Table

Modeling

Array of Matrix by months from production to service occurrence



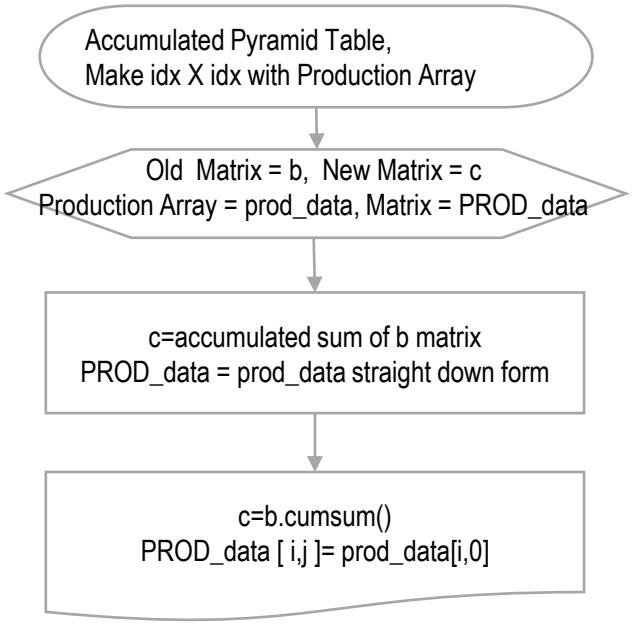
3) Production Table

Modeling

Production Month	Now- iM	Now- (i-1)M	···	Now-1M	Now
Production Qty	#,###	#,###	···	#,###	#,###

Production Month	Now- i Month	Now- (i-1)Month	···	Now- 1Month	Now
Production Qty	#,###	#,###	···	#,###	#,###
. . .					
Production Qty	#,###	#,###	···	#,###	#,###

Logic Tree



Build Code

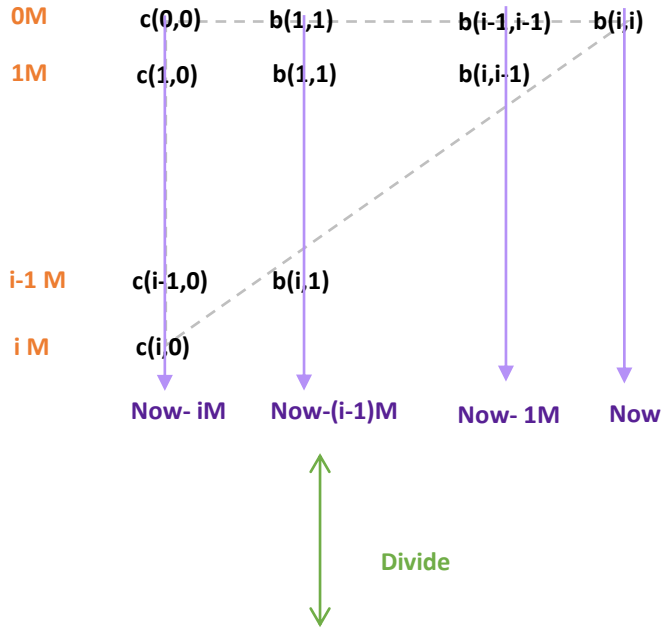
```
# Table Accumulated
 c=b.cumsum()

# Production idx X idx Matrix
for i in range(len(idx)):
      k=prod_data.at[i,0]
      for j in range(len(idx)):
         PROD_data.at[i,j]=k
         j=j+1
      i=i+1
PROD_data=PROD_data.T
PROD_data=PROD_data.reset_index()
PROD_data=PROD_data.drop(['index'],axis=1)
PROD_data.columns=PROD_data.index
```

2. Quality Indicator Automatic Calculator – Hazard Graph

4) Hazard Table

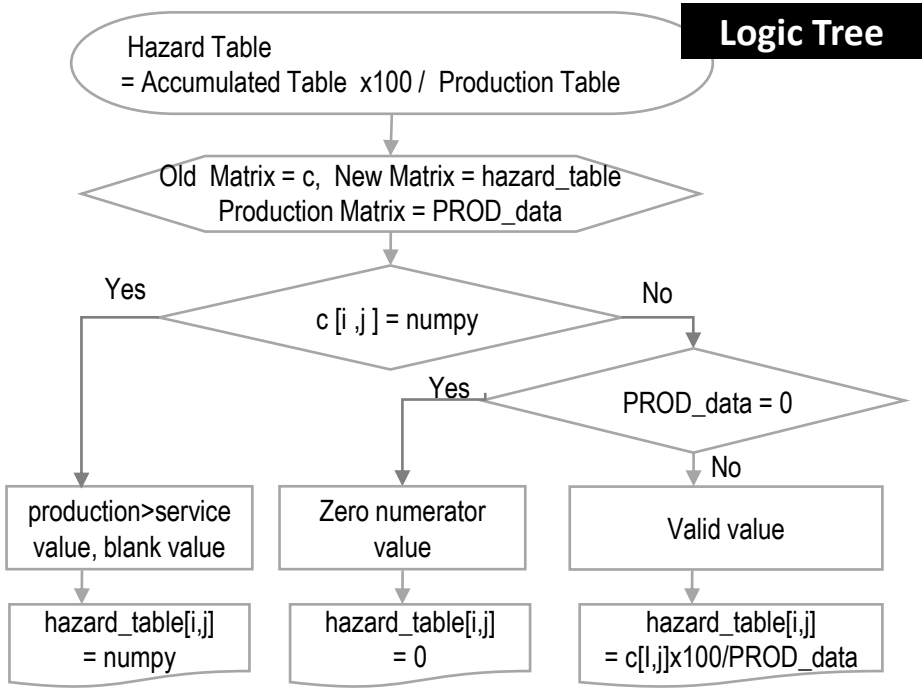
Modeling

Array of Matrix by months from production to service occurrence



Production Month	now- i Month	now- (i-1)Month	…	Now- 1Month	Now
Production Qty	#,###	#,###	…	#,###	#,###
. . .					
Production Qty	#,###	#,###	…	#,###	#,###

Logic Tree



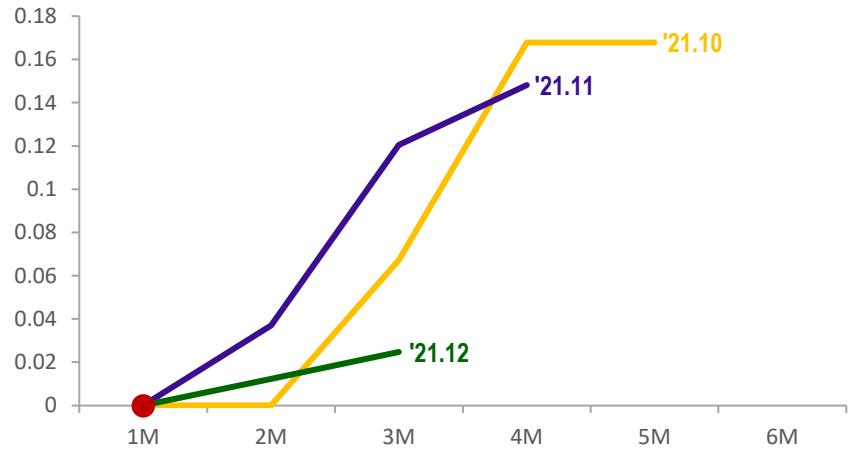
Build Code

```
hazard_table=pd.DataFrame()
 i=0
 j=0
 for i in range(len(idx)):
    for j in range(len(idx)-i):
        d=c.at[i,j]
        if d==np.nan:
            hazard_table.at[i,j]=np.nan
        else:
            e=PROD_data.at[i,j]
            if e==0:
               k=0
            else:
               k=d*100/e
               hazard_table.at[i,j]=k
                    j=j+1
```

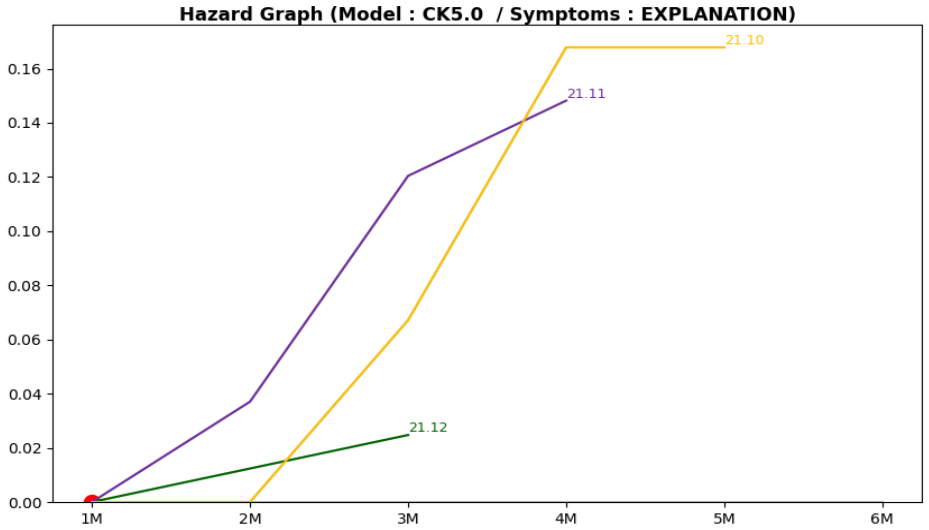
2. Quality Indicator Automatic Calculator – Hazard Graph

Excel Result

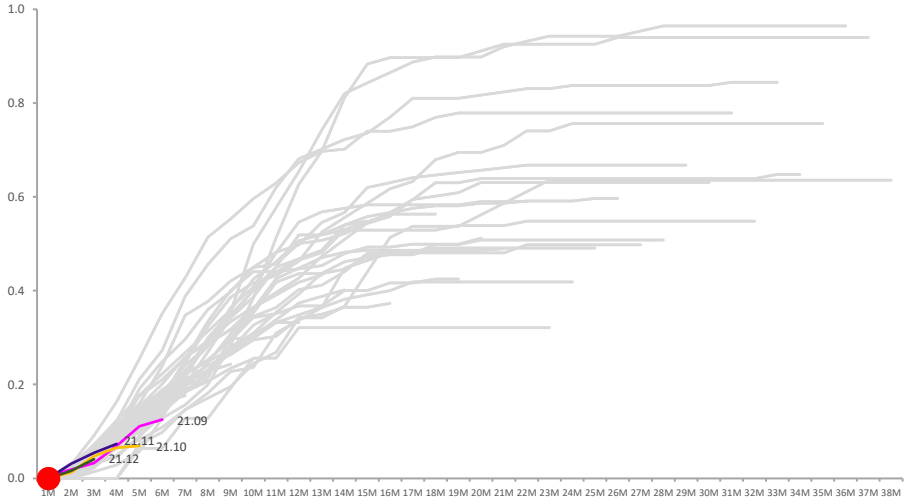
1. CK Semi-Tub Model(WT7150C*), Explanation SVC

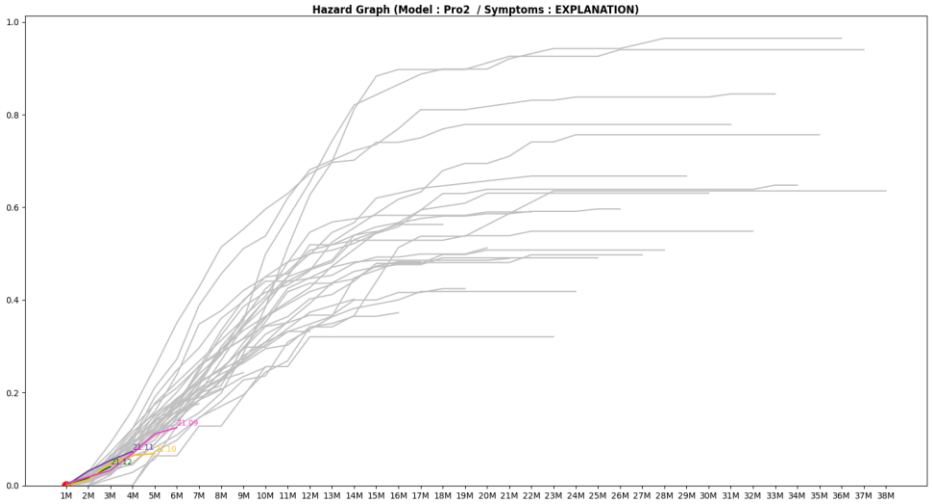


PGM Result



2. Pro2 Model(WT7300C*), Misassembly SVC

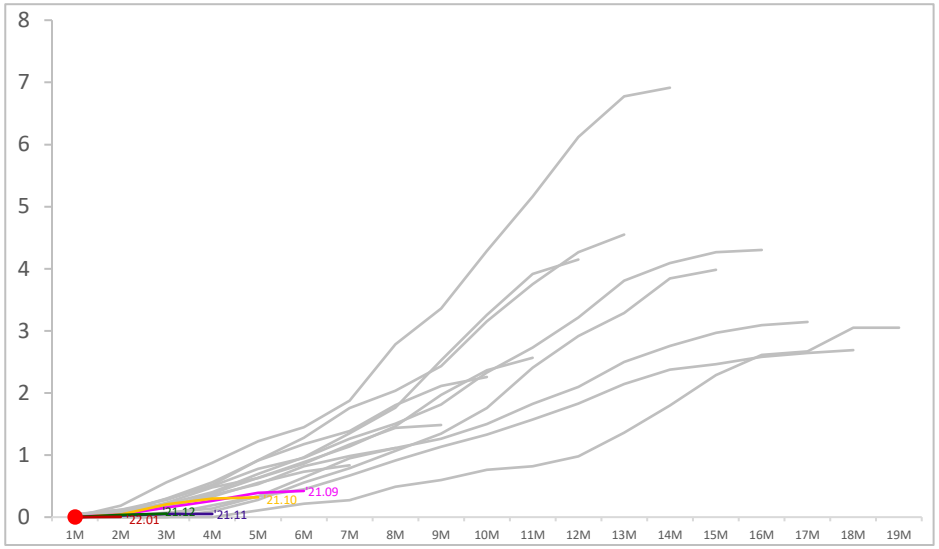




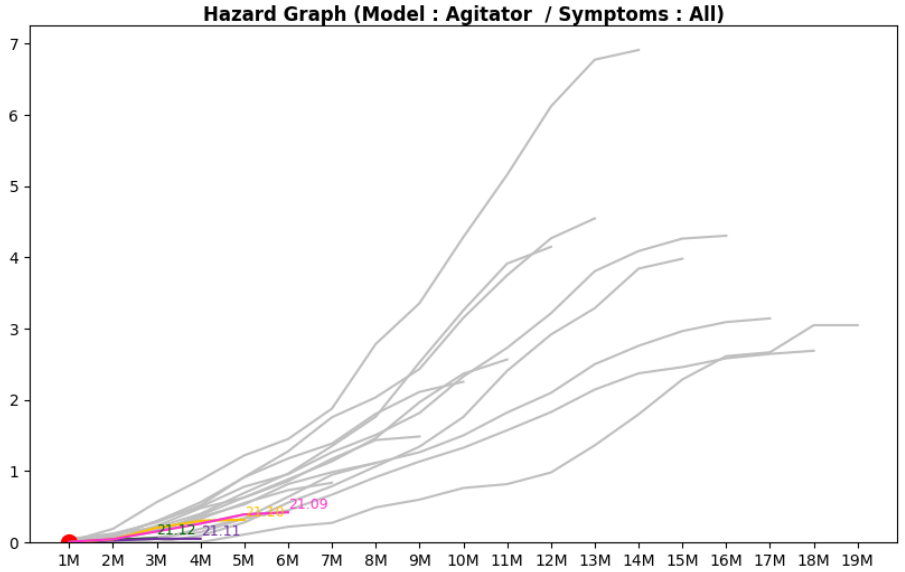
2. Quality Indicator Automatic Calculator – Hazard Graph

Excel Result

3. Agitator Model(WT7150C*), Total SVC



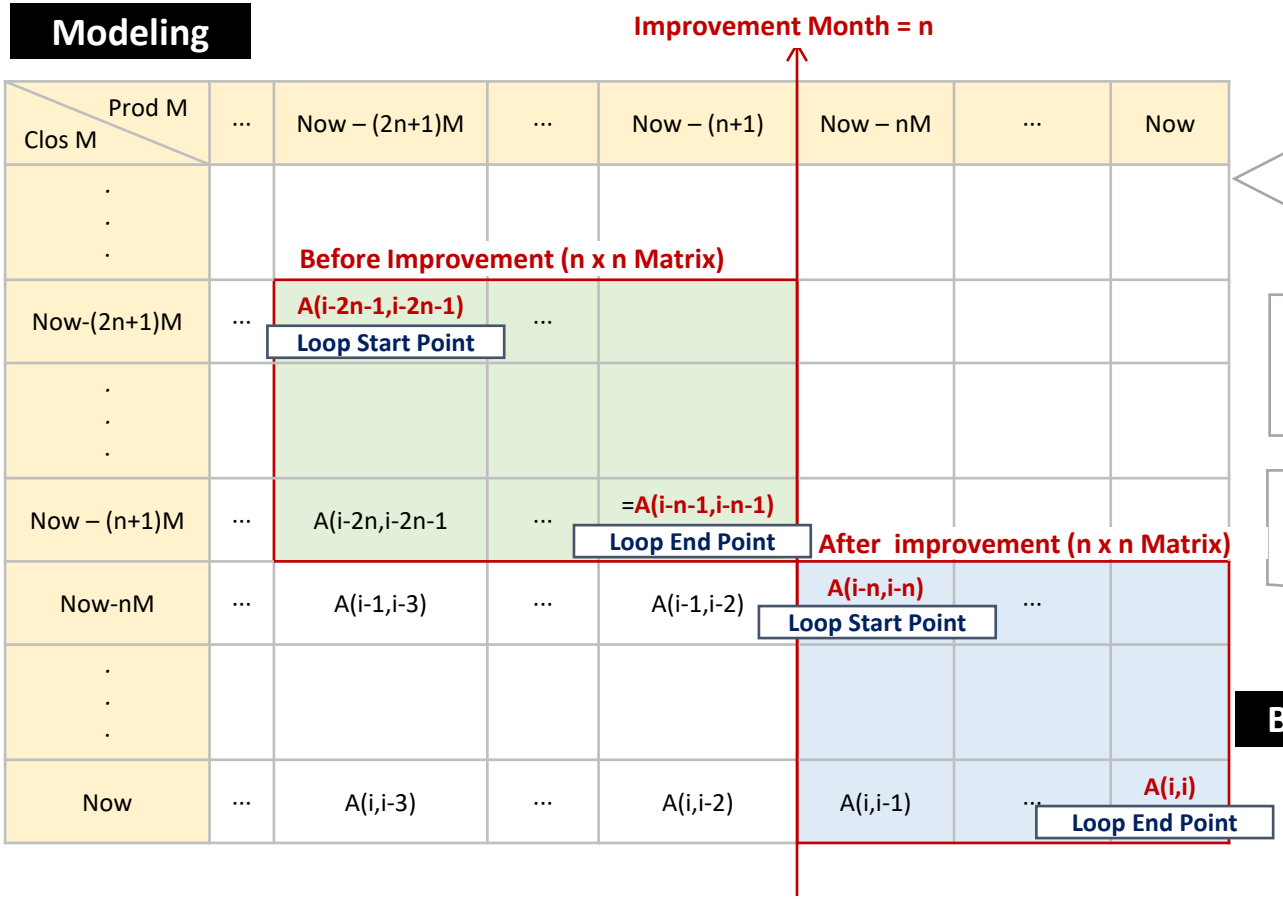
PGM Result



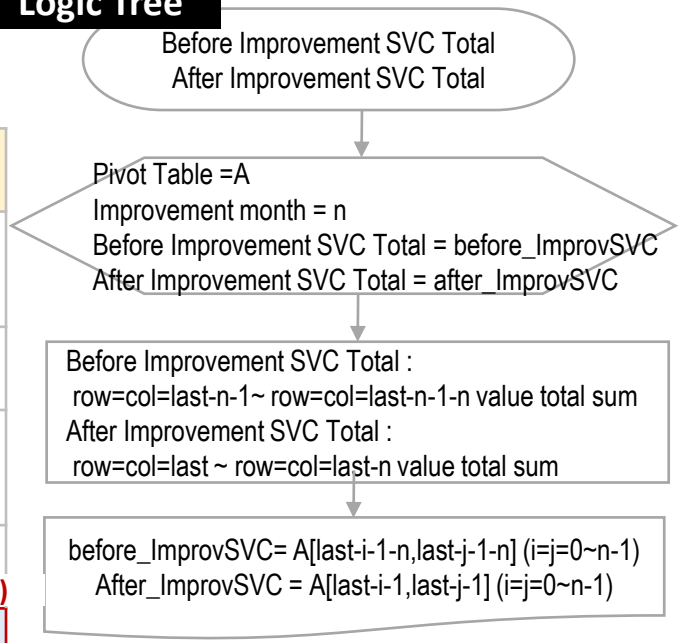
3. Quality Indicator Automatic Calculator – AAR & PPM

1) SVC Total Quantity (EA) - Before/ After Improvement

Modeling



Logic Tree



Build Code

```
#AAR개선전
 n=int(improving_month)
  for i in range(n+1):
     for j in range(n+1):
        k=A.at[len(A)-i-n-1,len(A)-j-n-1]+k
        j=j+1
  before_ImprovSVC=k

#AAR개선후
  for i in range(n+1):
     for j in range(n+1):
        k=A.at[len(A)-i,len(A)-j]+k
        j=j+1
  after_ImprovSVC=k
```

3. Quality Indicator Automatic Calculator – AAR & PPM

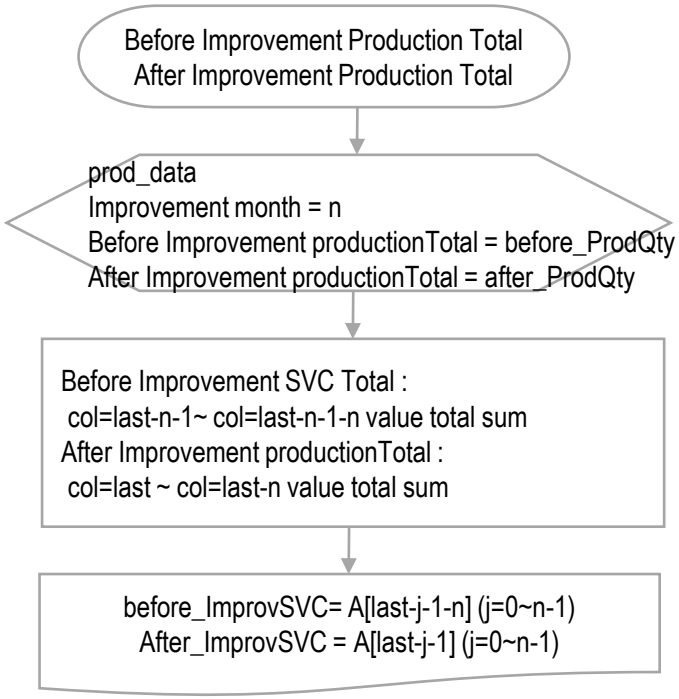
2) Production Total Quantity (EA) - Before/ After Improvement

Modeling

Improvement Month = n

Production Month	···	Now – (2n+1)M	···	Now – (n+1)	Now – nM	···	Now
Production Qty	···	prod_data [i–2n-1] **Loop Start Point**	···	prod_data[i –n+1] **Loop End Point**	prod_data [i-n] **Loop Start Point**	···	prod_data[i] **Loop End Point**

Logic Tree



Build Code

```
##Prod Qty 개선전
n=int(improving_month)
for j in range(n+1):
   k=prod_data[len(prod_data)-j-n-1]+k
   i=i+1
before_ProdQty=k

##Prod Qty 개선후
for j in range(n+1):
   k=prod_dta[len(prod_data)-j]+k
   i=i+1
after_ProdQty=k
```

3. Quality Indicator Automatic Calculator – AAR & PPM

Excel Result

PGM Result

1. Plus Model(WT7800C*), Filling SVC, 5 month Improvement

	Before Improvement	After Improvement
SVC	18	4
Prod	72165	65798
PPM	249.43	60.79
AAR		75.63%

AAR & PPM Table (Model : Plus / Symptoms : FILLING)

	Before Improvement	After Improvement
SVC	18 ea	4 ea
Production Qty	72165 ea	65798 ea
PPM	249.43 ppm	60.79 ppm
AAR		75.63 %

2. Agitator Model(WT7150C*), Drain SVC, 9 month Improvement

	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
2008																				0
2009																				0
2010		1																		1
2011																				0
2012																				0
2101		2	3																	5
2102			1	5		2														8
2103		1	6	2		1	1													11
2104		4	2	3		1	1													11
2105	1	1	3	2		2	1													10
2106		2	2			3		3		1										11
2107		2	5	1	1		2	7		2										20
2108		1	5	5	1	7	4	2	1	1		1								28
2109	3	1	5			4			4	3	1		1							22
2110	1	3	6	1		3	1	2	2	2	1		2							24
2111		1	4	2		4	1	5	2	2	1	3		1						26
2112			3	1		2	2	4	3	2	5	3	3		1					29
2201		2	1		1				3	1	2	4		3	1					18
2202										1		2		1						6
Total	5	21	46	22	3	29	13	25	15	15	10	13	6	5	2	0	0	0	0	230

	Before Improvement	After Improvement
SVC	45	36
Prod	77581	88827
PPM	580.04	405.28
AAR	30.13%	

AAR & PPM Table (Model : Agitator / Symptoms : DRAIN)

	Before Improvement	After Improvement
SVC	45 ea	36 ea
Production Qty	77581 ea	88827 ea
PPM	580.04 ppm	405.28 ppm
AAR		30.13 %

3. Quality Indicator Automatic Calculator – AAR & PPM

Excel Result

1. Pro2 Model(WT7800C*), Filling SVC

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
1901																																							
1902																																							
1903																																							
1904																																							
1905																																							
1906																																							
1907																																							
1908																																							
1909																																							
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1911																																							
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2101																																							
2102																																							
2103																																							
2104																																							
2105																																							
2106																																							
2107																																							
2108																																							
2109																																							
2110																																							
2111																																							
2112																																							
2201																																							
2202																																							
Total																																							

PGM Result

Pyramid Table (Model : Pro2 / Symptoms : FILLING)

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	Total
1901																																							
1902																																							
1903																																							
1904																																							
1905	1			1	1																																		3
1906		2	1																																				3
1907	1			1	1																																		3
1908		2	2	2		2																																	8
1909	1		1	1			1																																4
1910	2	1	1					2																															6
1911	1	1			1			1		2																													6
1912	2	1		2	1	3	4	1	3	1																													18
2001	2	1	6		3	5	1	1	1				1																										21
2002	1	1	1	1		2	1	1	3	2	1	1	2																										17
2003	2	2		1	1	2	2	6	2	3		4	2																										27
2004			1	1	2	2	2	2	8	2			2	2																									24
2005	1			1		3	1	3	1	1	3	1	2	2	1																								20
2006		1	1	2		1	1	5	4	2	2	1		5	1																								26
2007		2	1	1		2	1	1	2	3	4		3	6	2		5	8																					41
2008					1	1	1	6	2	2		2	6	5	4	1	1	6	1																					39
2009		1			1	2	4	4	1	4	1	2	4	2			1	7	2																				36
2010				1		1	2	1		2			1	6	4	2	7	7	4		1																		39
2011				2			1	2	1	5			2	2	2		2	8	2		4	3																		36
2012			1					4	2		1		4	6	3	1	3	4	1	3	2	1																	36
2101					1							1	2	4	4		3	2	1		2	4																	24
2102					1	1			3		3		2	5	4		1	8	2	4	2	1	3	5	1														46
2103	1						1	1	2	2	1	1	3	5	1		3	11		2	2	4	7	9	2														58
2104			2				1	1						2	1		5	11	1	1	1	2	5	6	4	3	2												48
2105						1							1		1	1		4	4	1	5		3	7	3	3	2												36
2106	1									1		2		1			3	5	1	1	1	2	1	6	3	3	3	3	4										41
2107			1				1							1				6	1	4	1	4	3	3	3	7	7	5	7	2								56
2108								1															2	2	1	4	7	6	7	5	1								36
2109																	1	2			1		3	4	3	4	4	3	10	6	3	1							45
2110																		1	1	1		1	3	6	4	5	4	4	8	6		4	1						49
2111																							1	5		4	4	4	10	2	2	1	4		1				38
2112																		1			1	2	1	1		7	5	5	11	10	8	7	3	3	1				66
2201																	1	1		1				3	5	3	2	5	9	5	4	7	3	3		1			53
2202																				1		1	1	2	2	4		5	5	3	2	4	2	2	2	1			37
Total	16	15	21	17	11	27	23	43	38	29	19	14	35	56	30	5	36	92	21	19	24	25	33	60	31	49	40	41	72	41	21	29	17	9	5	2			1066

AAR & PPM Table (Model : Pro2 / Symptoms : FILLING)

	Before Improvement	After Improvement
SVC	81 ea	33 ea
Production Qty	181649 ea	146869 ea
PPM	445.91 ppm	224.69 ppm
AAR		49.61 %

4. Quality Indicator Automatic Calculator – FDR & FFR

1) L12 SVC : SVC Total for recent 12 months

SVC Table =A / Accumulated Table = Acc / L12 SVC Table =B

Modeling

Prod / Clos M	Now- iM	Now- (i-1)M	Now- (i-2)M	…	Now- (i-12)M	Now- (i-13)M	Now- (i-14)M	…
Now-i M	A(0,0)							
Now-(i-1)M	A(1,0)	A(1,1)						
Now – (i-2) M	A(2,0)	A(2,1)	A(2,2)					
…								
Now-(i-12)M					A(12,12)			
Now-(i-13)M					A(13,12)	A(13,13)		
Now – (i-14) M					A(14,12)	A(14,13)	A(14,14)	
…								
L12 SVC	B(0)	B(1)	B(2)	…	B(12)	B(13)	B(14)	…

* Before 12 month → Accumulated

B[0] = A[0,0]

B[1] = A[0,0] + A[1,0] + A[1,1]

B[2] = A[0,0] + A[1,0] + A[1,1] + A[2,0] + A[2,1] + A[2,2]

…

B[11] = A[0,0] + A[1,0] + A[1,1] + ⋯ + A[11,10] + A[11,11]

Loop Start Point : 0

Loop End Point : B Matrix row value

* After 12 month → Accumulated recent 12 months

B[12] = A[1,1]+A[2,1]} + ⋯ + A[12,11] + A[12,12]

B[13] = A[2,2]+A[3,2]} + ⋯ + A[13,12] + A[13,13]

B[14] = A[3,3]+A[4,3]} + ⋯ + A[14,13] + A[14,14]

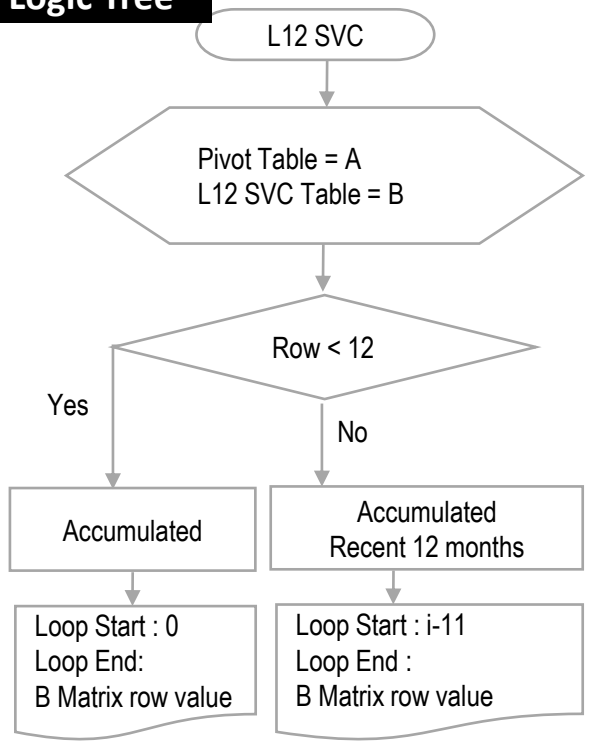
…

B[i] = A[i-11,i-11] + A[i-10,i-11] + ⋯ + **A[i ,i-1] +A[i , i]**

Loop Start Point : i-11

Loop End Point : B Matrix row value

Logic Tree



Build Code

```
for i in range(len(idx)):
    if i<12:
        for j in range(i+1):
            k=A.at[i,j]+k
            j=j+1
    else:
        k=0
        for m in range(12):
            for n in range(12):
                k=A.at[i-m,i-n]+k
                j=j+1

    L12_SVC.at[i,'L12_SVC']=k
    i=i+1
```

4. Quality Indicator Automatic Calculator – FDR & FFR

2) L12 Sales / Weight Sales

Modeling

1. Sales Data

Sales	C(0)	C(1)	C(2)	…	C(12)	C(13)	C(14)	…

2. Accumulated Data

Accumulated Sales	Acc(0)	Acc(1)	Acc(2)	…	Acc(12)	Acc(13)	Acc(14)	…

3. Accumulated Data → L12 Sales

L12 Sales	Acc(0)	Acc(1)	Acc(2)	…	Acc(12) – Acc[1)	Acc(13) – Acc[2)	Acc(14) – Acc(3)	…

4. L12 Sales

L12 Sales	D(0)	D(1)	D(2)	…	D(12)	D(13)	D(14)	…

Modeling Fomula

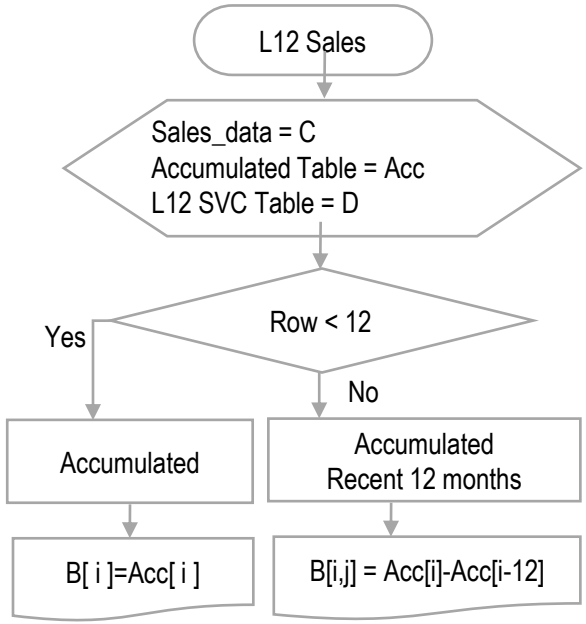
* Before 12 month → Accumulated

D[0] = C[0] = Acc[0]
D[1] = C[0] + C[1] = Acc[1]
D[2] = C[0] + C[1] +C[2] = Acc[2]
…
D[i] = C[0] + C[1] + C[2] + ⋯ + C[i] = Acc[i]

* After 12 month → Accumulated recent 12 months

D[12] = C[1]+C[2] + ⋯ + C[12] = **Acc[12] – Acc[0]**
D[13] = C[2]+C[3] + ⋯ + C[13] = **Acc[13] – Acc[1]**
D[14] = C[3]+C[4] + ⋯ + C[14] = **Acc[14] – Acc[2]**
…
D[i] = C[i-11] + C[i-10} +C[i-9} + ⋯ + C[i] = **Acc[i] – Acc[i-12]**

Logic Tree



Build Code

```
### L12 Sales
# Accumulate Sales
 Acc=sales_data.cumsum()

 # Accumulate 한 것 빼기
 i=0
 k=0
 for i in range(len(idx)):
    if i>=12:
       L12_Sales.iloc[i]=Acc.iloc[i]-Acc.iloc[i-12]
    else:
       L12_Sales.iloc[i]=Acc.iloc[i]
    i=i+1
```

4. Quality Indicator Automatic Calculator – FDR & FFR

3) Weight Sales

Modeling

1. Sales Data

Sales	C(0)	C(1)	C(2)	…	C(12)	C(13)	C(14)	…

2. Weight Sales Data

Weight Sales	$C(0)\times\frac{1}{12}$	$C(1)\times\frac{1}{12} + C(0)\times\frac{2}{12}$	$C(2)\times\frac{1}{12} + C(1)\times\frac{2}{12} + C(0)\times\frac{3}{12}$	…	$C(12)\times\frac{1}{12} + C(11)\times\frac{2}{12} + C(10)\times\frac{3}{12}+\cdots + C(3)\times\frac{10}{12} + C(2)\times\frac{11}{12} + C(1)\times\frac{12}{12}$	$C(13)\times\frac{1}{12} + C(12)\times\frac{2}{12} + C(11)\times\frac{3}{12}+\cdots + C(4)\times\frac{10}{12} + C(3)\times\frac{11}{12} + C(2)\times\frac{12}{12}$	$C(14)\times\frac{1}{12} + C(13)\times\frac{2}{12} + C(12)\times\frac{3}{12}+\cdots + C(5)\times\frac{10}{12} + C(4)\times\frac{11}{12} + C(3)\times\frac{12}{12}$	…

Specific Modeling

*** Before 12 month**

$\mathbf{C[\,j\,]\times\frac{j+1-i}{12}}$

$D[0] = C[0]\times\frac{1}{12}$

$D[1] = C[1]\times\frac{1}{12} + C[0]\times\frac{2}{12}$

$D[2] = C[2]\times\frac{1}{12} + C[1]\times\frac{2}{12} + C[0]\times\frac{3}{12}$

…

$D[11] = C[11]\times\frac{1}{12} + C[10]\times\frac{2}{12} + C[9]\times\frac{3}{12} + \cdots + C[2]\times\frac{10}{12} + C[1]\times\frac{11}{12} + C[0]\times\frac{12}{12}$

*** After 12 month**

$\mathbf{C[\,t+i-11\,]\times\frac{12-t}{12}}$

$D[12] = C[12]\times\frac{1}{12} + C[11]\times\frac{2}{12} + C[10]\times\frac{3}{12} + \cdots + C[3]\times\frac{10}{12} + C[2]\times\frac{11}{12} + C[1]\times\frac{12}{12}$

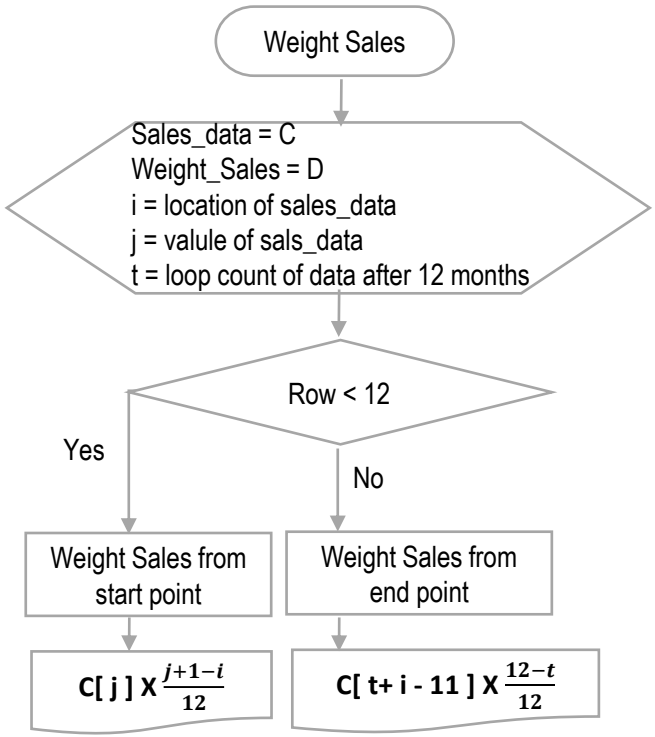
$D[13] = C[13]\times\frac{1}{12} + C[12]\times\frac{2}{12} + C[11]\times\frac{3}{12} + \cdots + C[4]\times\frac{10}{12} + C[3]\times\frac{11}{12} + C[2]\times\frac{12}{12}$

$D[14] = C[14]\times\frac{1}{12} + C[13]\times\frac{2}{12} + C[12]\times\frac{3}{12} + \cdots + C[5]\times\frac{10}{12} + C[4]\times\frac{11}{12} + C[3]\times\frac{12}{12}\cdots$

…

$D[i] = C[i]\times\frac{1}{12} + C[i-1]\times\frac{2}{12} + C[i-2]\times\frac{3}{12} + \cdots + C[i-3]\times\frac{10}{12} + C[i-4]\times\frac{11}{12} + C[i-5]\times\frac{12}{12}\cdots$

Logic Tree



Build Code

```
### Weight Sales
for i in range(len(idx)):
    if i<12:
        j=0
        k=0
        for j in range(i+1):
            k=sales_data.iloc[j]*(i+1-j)/12+k
            j=j+1
    else:
        k=0
        for t in range(12):
            k=sales_data.iloc[t+i-11]*(12-t)/12+k
            t=t+1
    Weight_Sales[i]=k
    i=i+1
Weight_Sales.index=["Weight_Sales"]
Weight_Sales=Weight_Sales.T
```

4. Quality Indicator Automatic Calculator – FDR & FFR

Excel Result

1. Agitator Model(WT7305C*), ExteriorSVC

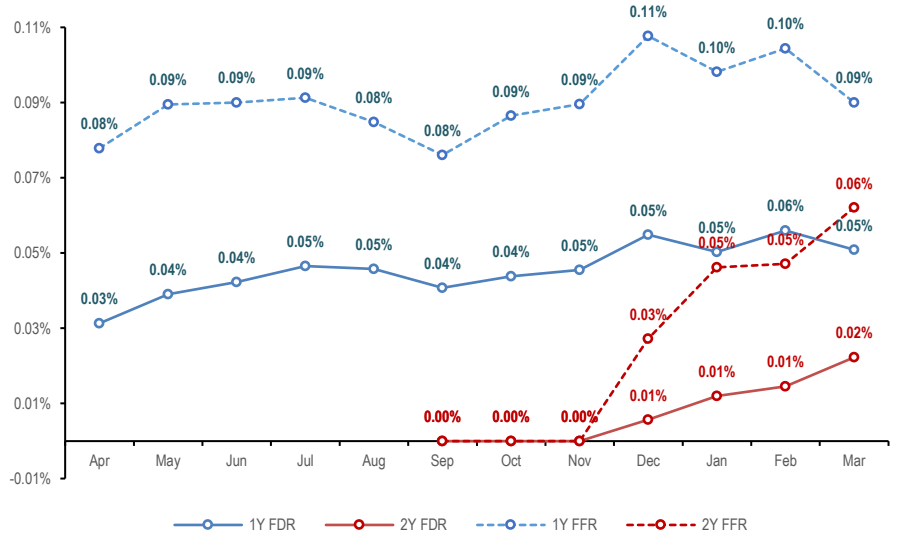
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
		08	09	10	11	12	`21.01	02	03	04	05	06	07	08	09	10	11	12	22.01	02	03	Total
0	2008																					0
1	2009																					0
2	2010																					0
3	2011																					0
4	2012		1	1																		2
5	2101		2	1																		3
6	2102			1	1																	2
7	2103		2	2			1															5
8	2104	1	1	3	1		1															7
9	2105		3		2		2		1													8
10	2106		1	2	1	1			1													6
11	2107			1	2		2			2												7
12	2108						1	1		1	1		1									5
13	2109			1	1		1		1		1	2										7
14	2110		1	1	2	2	2			1	2		1	3								15
15	2111			3			1		3	2		1	4		1							15
16	2112		2	2					1	2	1	1	1	3	1	2						16
17	2201								1	2			1	2	1	1						8
18	2202		1											1	2	3						7
19	2203																					0
Total	Total	1	14	18	10	3	11	1	8	10	5	4	8	9	5	6	0	0	0	0	0	113
Sales	Sales	0	6365	13334	7482	7948	6579	6440	5758	6896	8344	9005	7876	10243	10782	8569	8219	7966	9412	5183	0	
L12 SVC	L12 SVC	0	0	0	0	2	5	7	12	19	27	33	40	44	41	42	44	53	50	55	47	
L12 Sales	L12 Sales	0	6365	19699	27181	35129	41708	48148	53906	60802	69146	78151	86027	96270	100687	95922	96659	96677	99510	98253	92495	
FDR	FDR	#DIV/0!	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.03%	0.04%	0.04%	0.05%	0.05%	0.04%	0.04%	0.05%	0.05%	0.05%	0.06%	0.05%	
W.Sales	W.Sales	0	530	2172	4437	7365	10840	14853	19345	24412	30174	36686	43855	51878	53903	48563	49136	49244	50958	52705	54655	
New FFR	New FFR	#DIV/0!	0.00%	0.00%	0.00%	0.03%	0.05%	0.05%	0.06%	0.08%	0.09%	0.09%	0.09%	0.08%	0.08%	0.09%	0.09%	0.11%	0.10%	0.10%	0.09%	

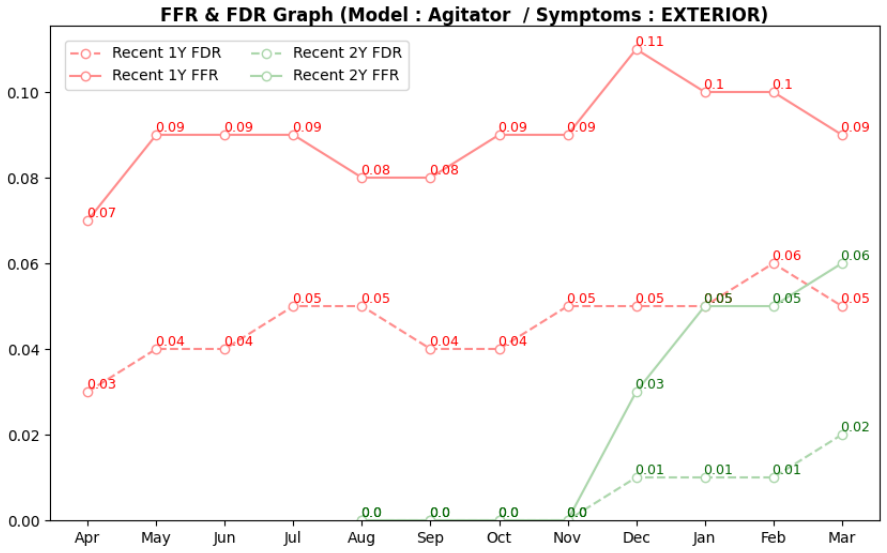
PGM Result

Pyramid Table (Model : Agitator / Symptoms : EXTERIOR)

	2008	2009	2010	2011	2012	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2201	2202	2203	Total
2008																					
2009																					
2010																					
2011																					
2012		1	1																		2
2101		2	1																		3
2102			1	1																	2
2103		2	2			1															5
2104	1	1	3	1		1															
2105		3		2		2		1													
2106		1	2	1	1			1													
2107			1	2		2			2												
2108						1	1		1	1											
2109			1	1		1		1		1											
2110		1	1	2	2	2			1	2											
2111			3			1		3	2												
2112		2	2					1	2	1											
2201								1	2												
2202		1																			
2203																					
Total	1	14	18	10	3	11	1	8	10	5											

	L12_SVC	L12_Sales	Weight_Sales	FDR	FFR
0	0 0	0 0	0.0 0	0.00	0.00
1	0 1	6365 1	530.0 1	0.00	0.00
2	0 2	19699 2	2172.0 2	0.00	0.00
3	0 3	27181 3	4437.0 3	0.00	0.00
4	2 4	35129 4	7364.0 4	0.01	0.03
5	5 5	41708 5	10840.0 5	0.01	0.05
6	7 6	48148 6	14852.0 6	0.01	0.05
7	12 7	53906 7	19344.0 7	0.02	0.06
8	18 8	60802 8	24411.0 8	0.03	0.07
9	26 9	69146 9	30173.0 9	0.04	0.09
10	32 10	78151 10	36686.0 10	0.04	0.09
11	39 11	86027 11	43855.0 11	0.05	0.09
12	44 12	96270 12	51877.0 12	0.05	0.08
13	41 13	100687 13	53903.0 13	0.04	0.08
14	42 14	95922 14	48562.0 14	0.04	0.09
15	44 15	96659 15	49135.0 15	0.05	0.09
16	53 16	96677 16	49244.0 16	0.05	0.11
17	50 17	99510 17	50957.0 17	0.05	0.10
18	55 18	98253 18	52705.0 18	0.06	0.10
19	47 19	92495 19	54655.0 19	0.05	0.09



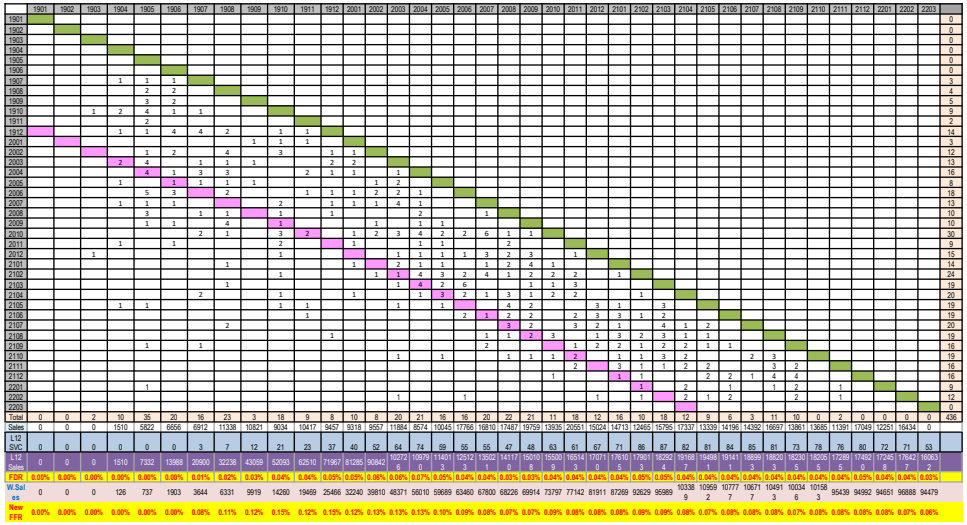


4. Quality Indicator Automatic Calculator – FDR & FFR

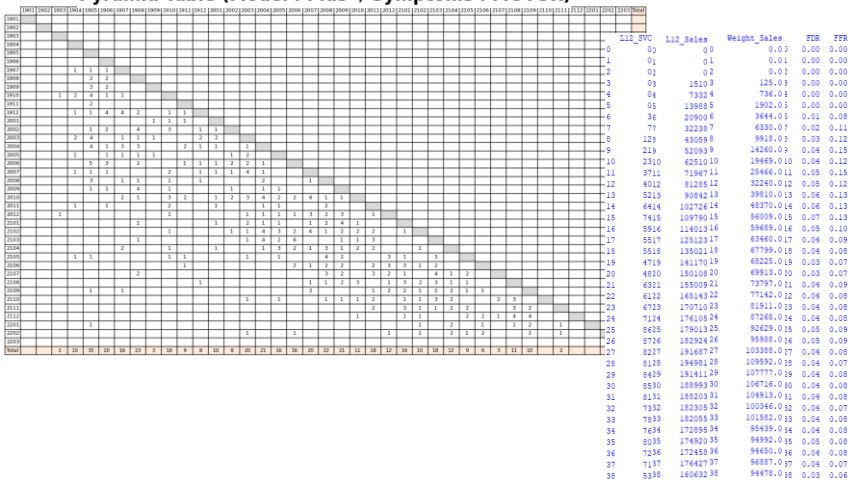
Excel Result

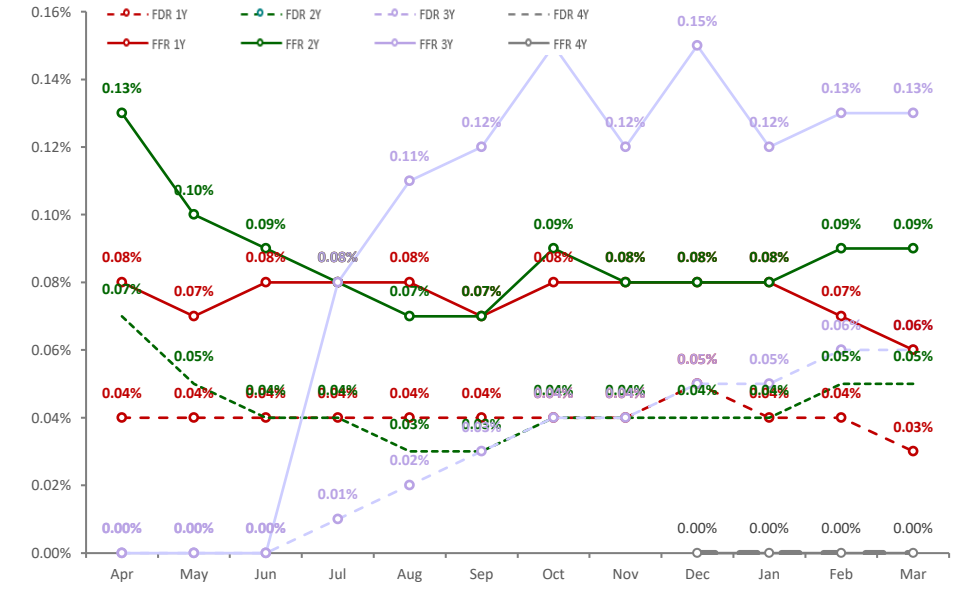
PGM Result

2. Plus Model(WT7800C*), Motor SVC

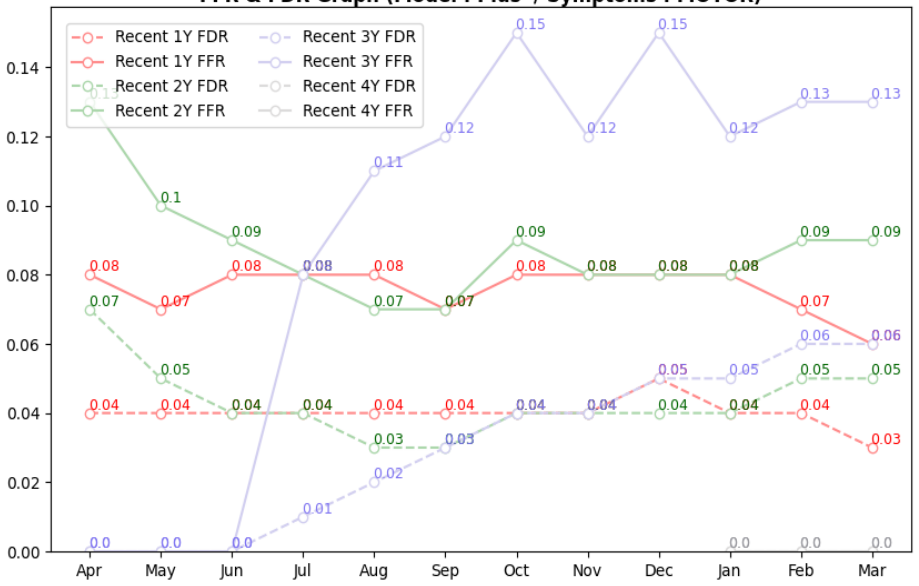


Pyramid Table (Model : Plus / Symptoms : MOTOR)





FFR & FDR Graph (Model : Plus / Symptoms : MOTOR)



4. Quality Indicator Automatic Calculator – FDR & FFR

Excel Result

3. CK Semi Model(WT7305C*), Total SVC

	2109	2110	2111	2112	2201	2202	2203	Total
2109								0
2110								0
2111			2					2
2112		8	6					14
2201		10	13	4				27
2202	1	9	18	16				44
2203								0
Total	1	27	39	20	0	0	0	87
Sales	0	4105	4938	5613	8424	7011	0	
L12 SVC	0	0	2	16	43	87	87	
L12 Sales	0	4105	9043	14656	23080	30091	30091	
FDR	0.00%	0.00%	0.02%	0.11%	0.19%	0.29%	0.29%	
W.Sales	0	342	1096	2317	4240	6748	9256	
New FFR	0.00%	0.00%	0.18%	0.69%	1.01%	1.29%	0.93%	

PGM Result

Pyramid Table (Model : CK5.0 / Symptoms : All)

	2109	2110	2111	2112	2201	2202	2203	Total
2109								
2110								
2111			2					2
2112		8	6					14
2201		10						
2202	1	9						
2203								
Total	1	27						

	L12_SVC	L12_Sales	Weight_Sales	FDR	FFR
0	0	0	0.0	0.00	0.00
1	0	4105	342.0	0.00	0.00
2	2	9043	1095.0	0.02	0.18
3	16	14656	2317.0	0.11	0.69
4	43	23080	4240.0	0.19	1.01
5	86	30091	6747.0	0.29	1.27
6	86	30091	9255.0	0.29	0.93