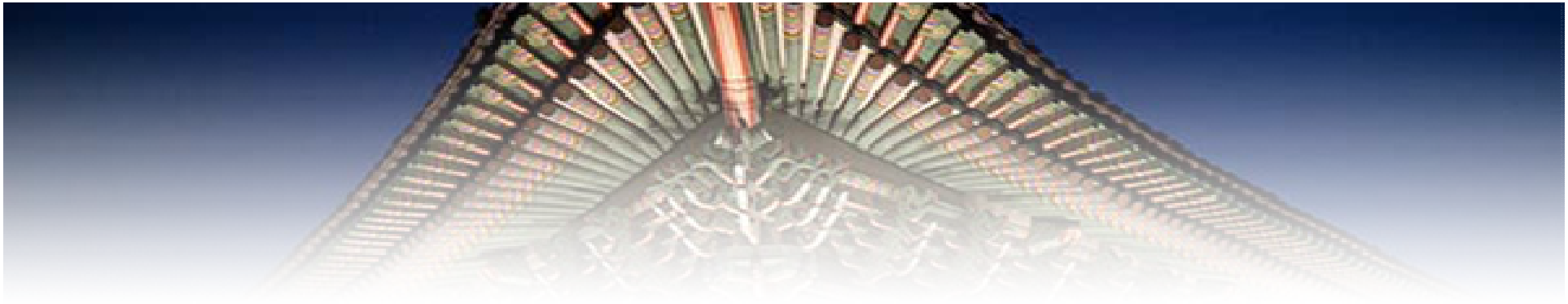

Process Rule Mining Technology in TRIZ Practice to Resolve the Parameters Inter-Correlated Complex Problems with an Industry Case

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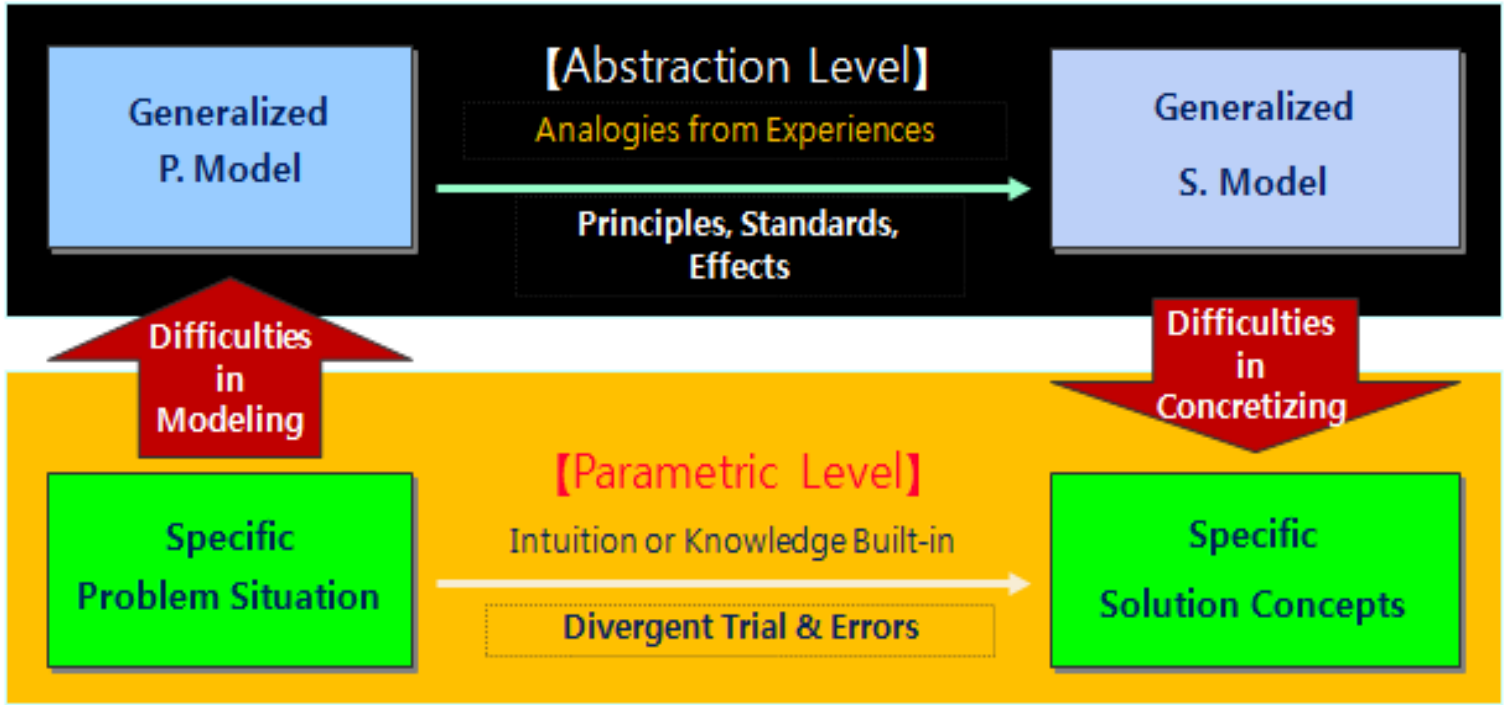
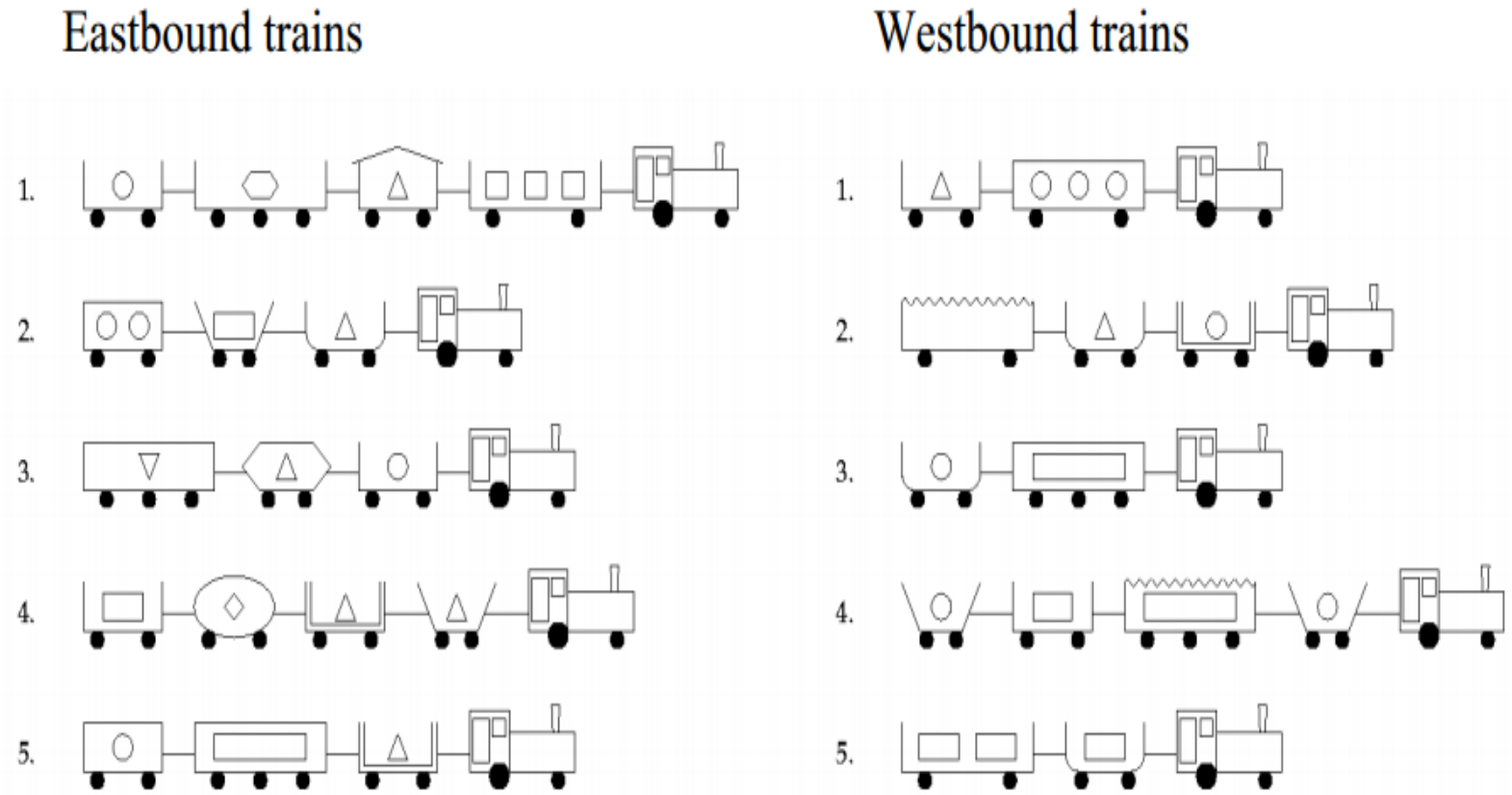
Problem Solving Approach in TRIZ

- Premises in Problem – Solution Regularities
- Discovered the Common Patterns of Creative Ideation from Legacy : 溫故知新
- Required to generalize into Models and to concretize Concepts



Rule Discovery Practice

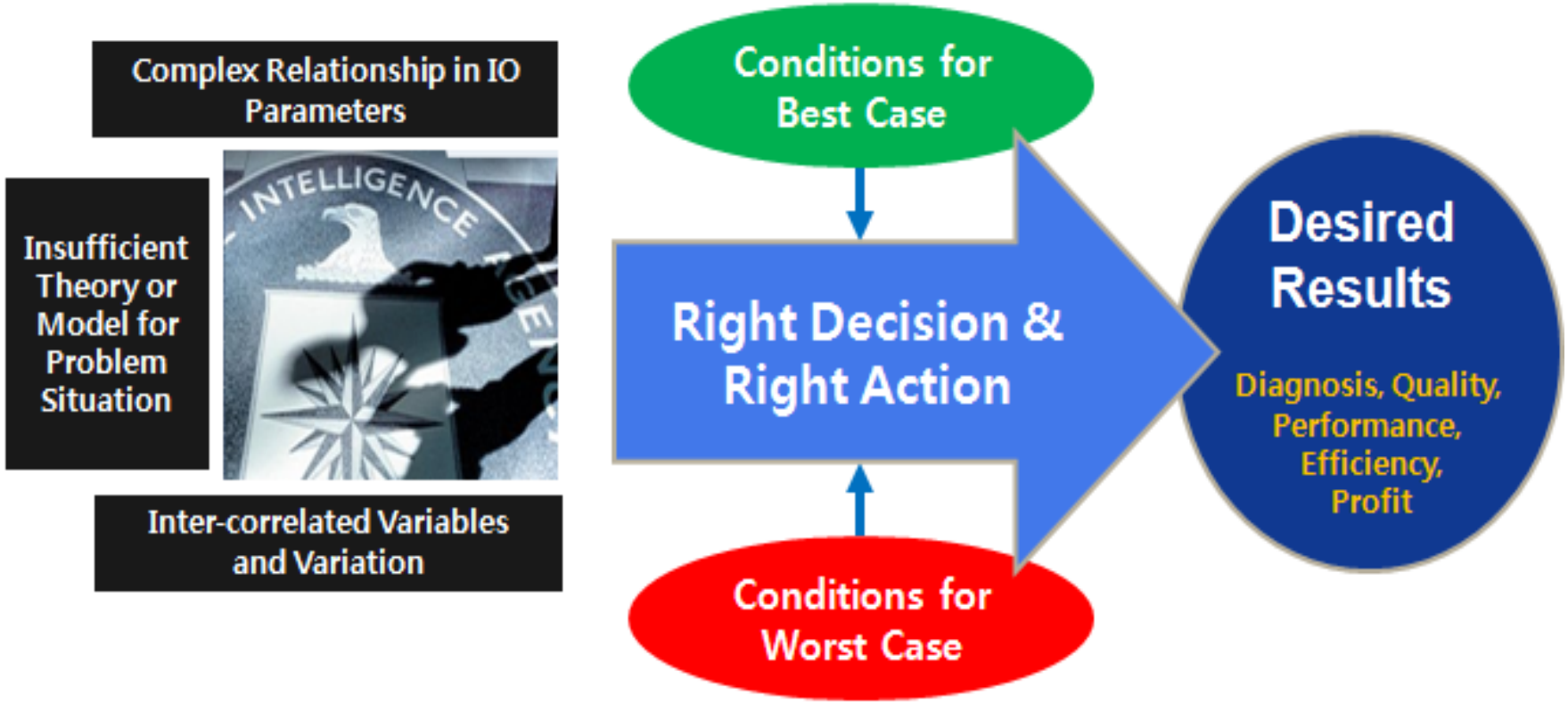
Michalski's Train Spotting



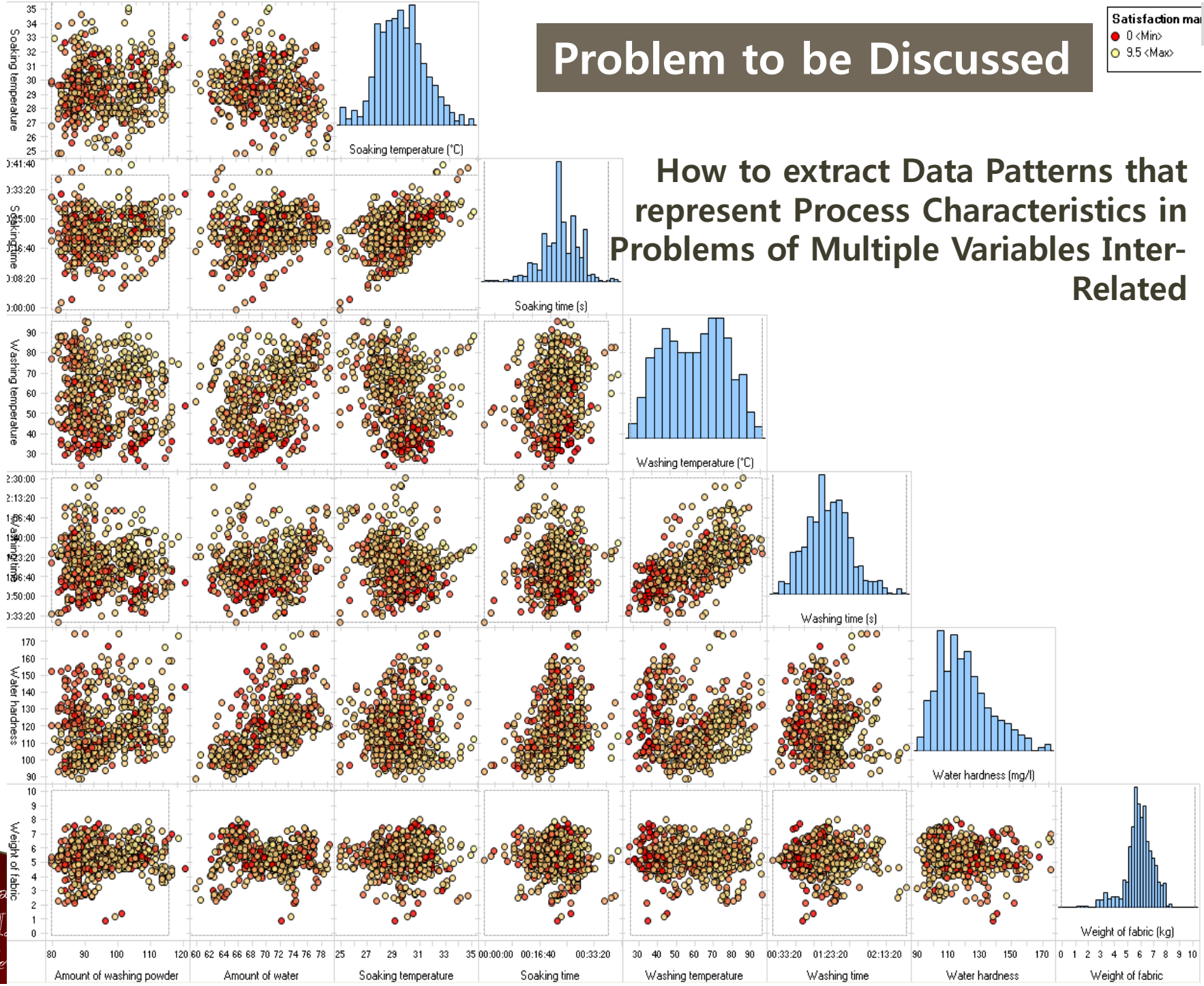
Meanings of Acquiring the Intelligence

"Intelligence is Knowledge and Foreknowledge of the world around us.
The prelude to Presidential Decision and Action."

- Definition of CIA of USA

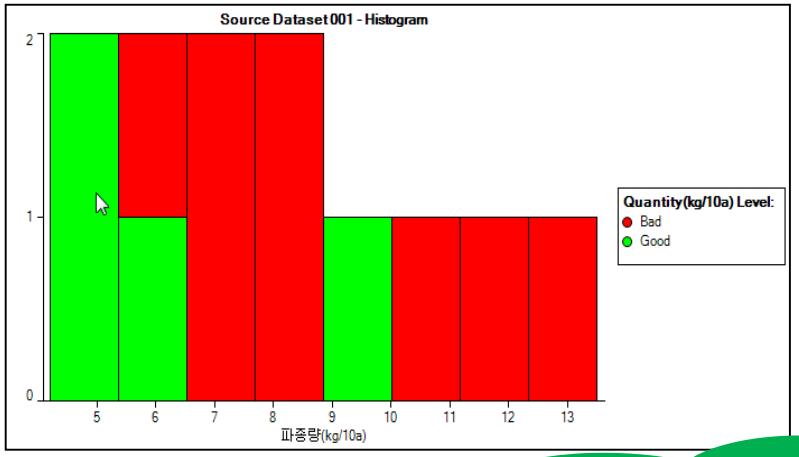


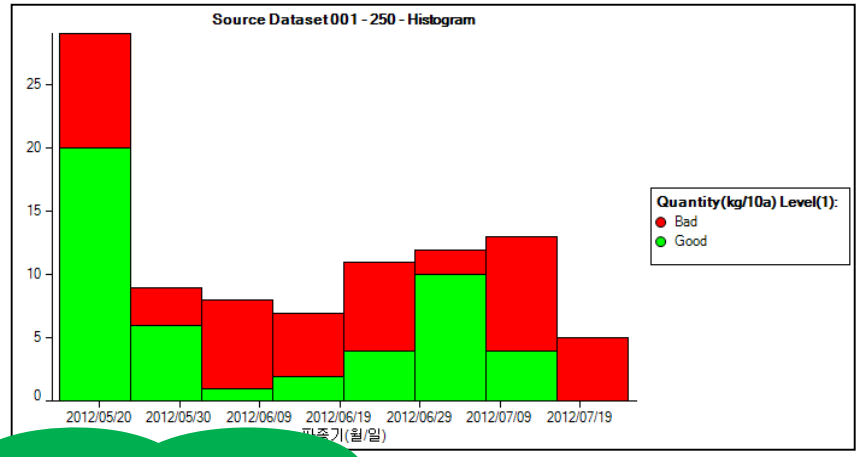
Problem to be Discussed



How to extract Data Patterns that represent Process Characteristics in Problems of Multiple Variables Inter-Related

Parameters Inter-related Complex Problem



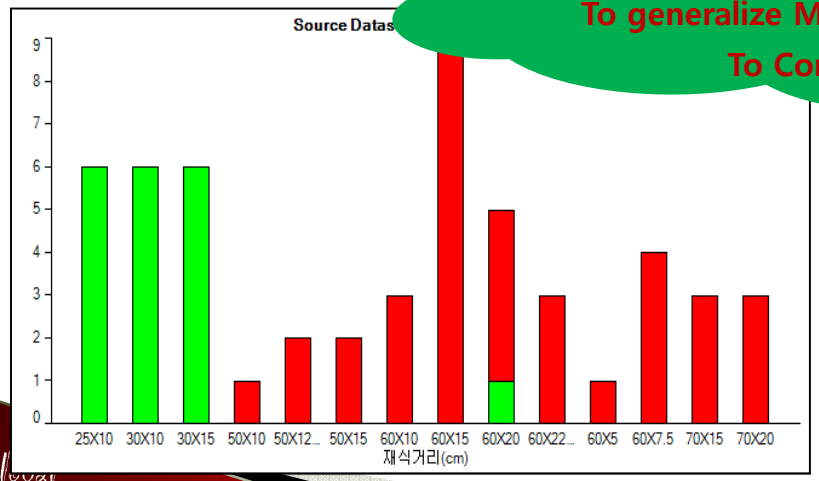


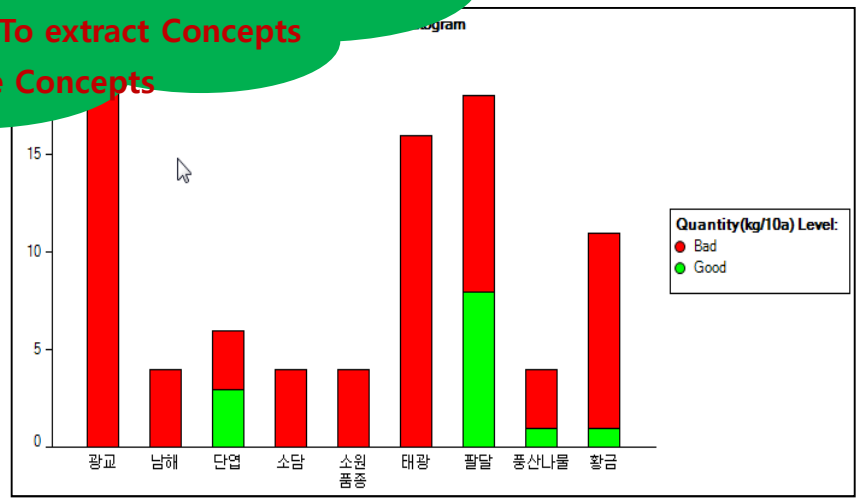
Many Contradictions are Inter-related

TRIZ may not helpful

To generalize Model / To extract Concepts

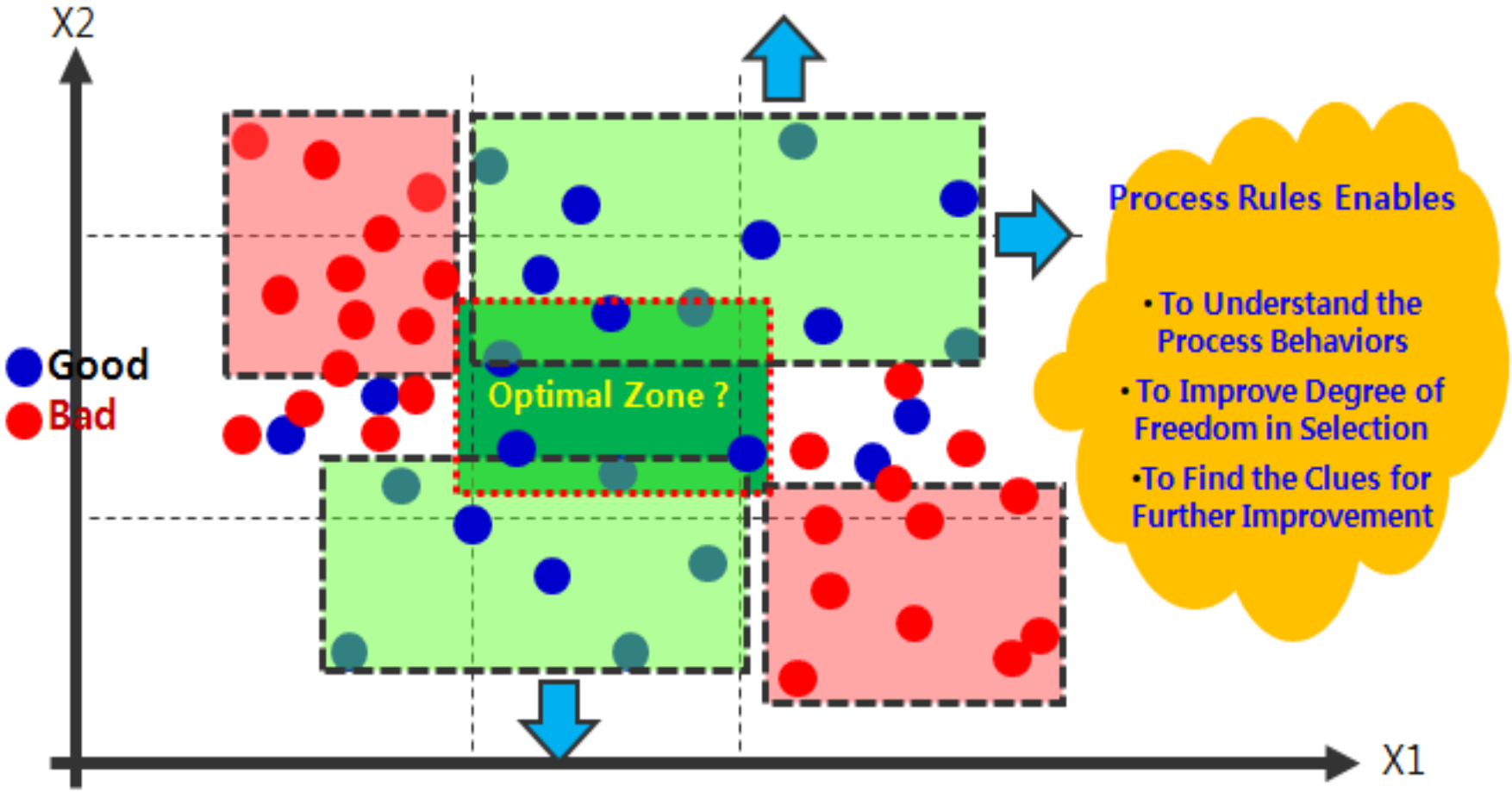
To Concretize Concepts



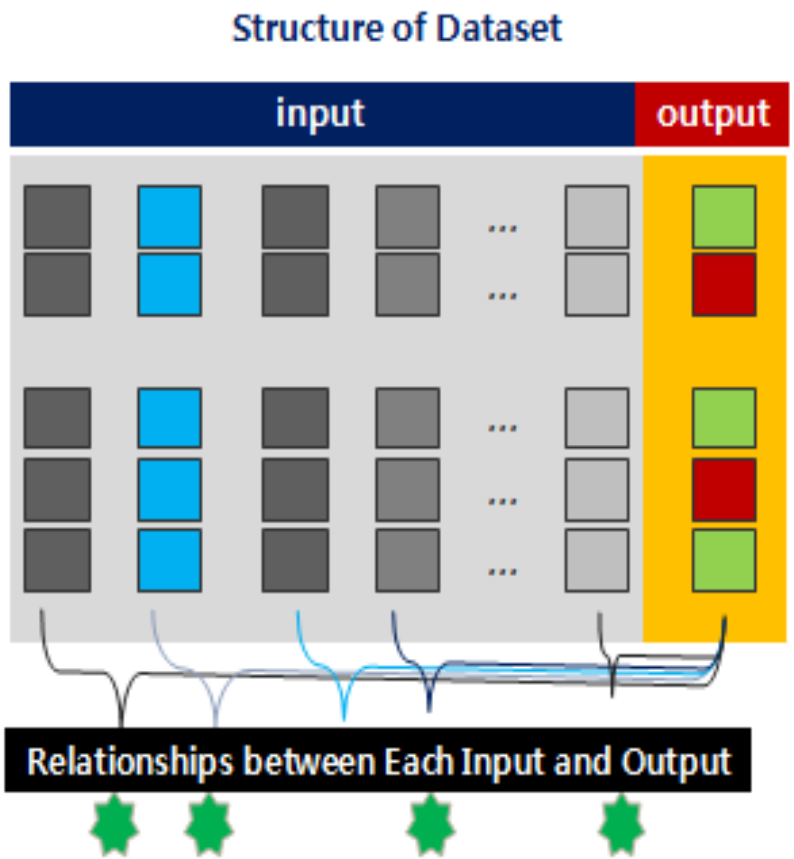


Process Regularities for Operations Intelligence

Recognizable Data Regularities : Knowledge for Decision Making



Traditional Data Analysis & Optimization Approach



X1	X2		Xn	Y
A	1		가	XX.X
B	2		나	YY.Y
C	3		다	ZZ.Z

Conventional Approach

① Identify the Causes & Effects Relationship

② Collect and Structure the Data Measured

③ Identify the Relation btwn. Result Values(Y) and Each Input(X) Combinations (ex. Correlation)

④ Select Vital Few (CTQ) (3~4 Parameters as maximum)

⑤ Design of Experiments

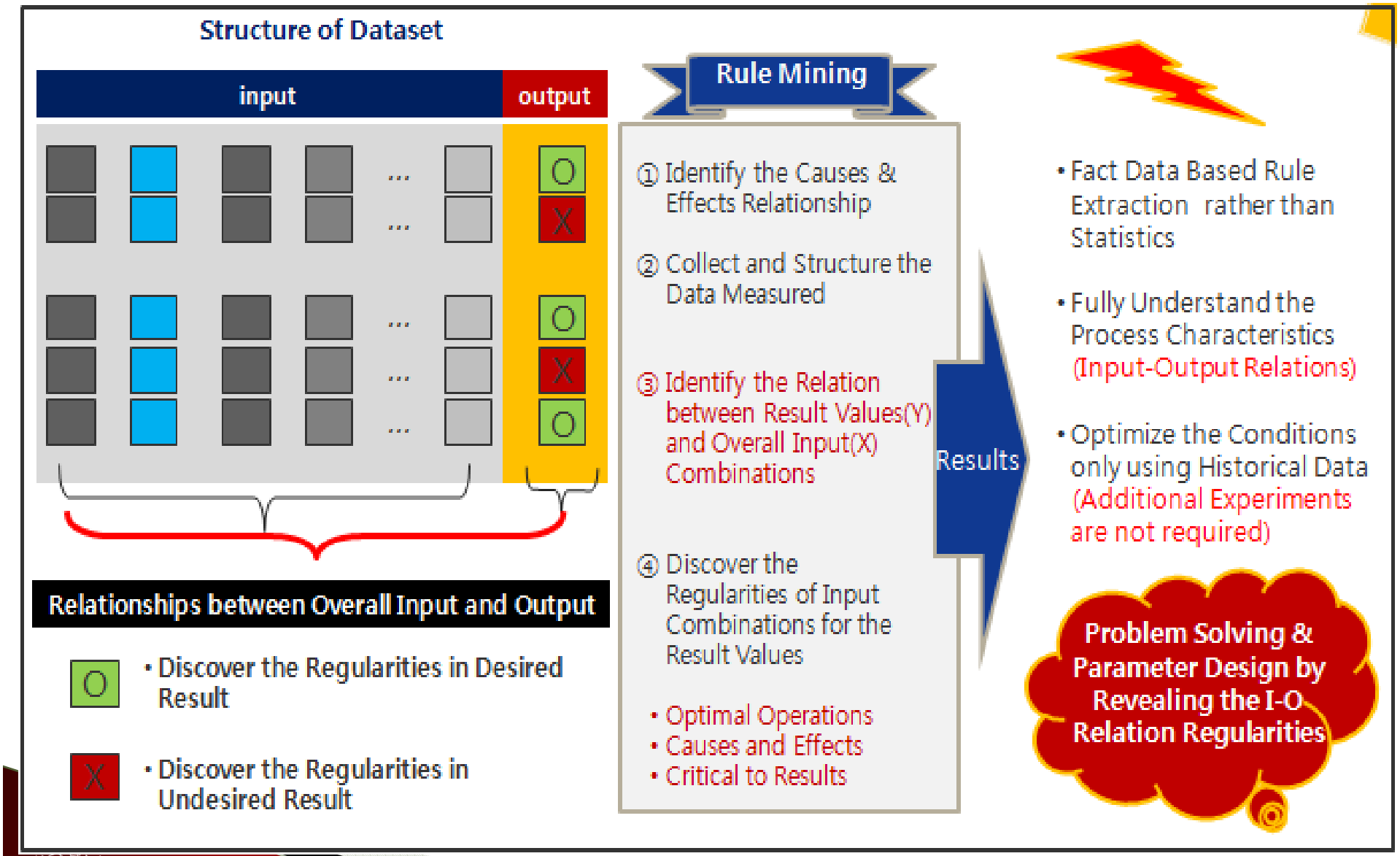
⑥ Analyze Results for Optimization

Limitation

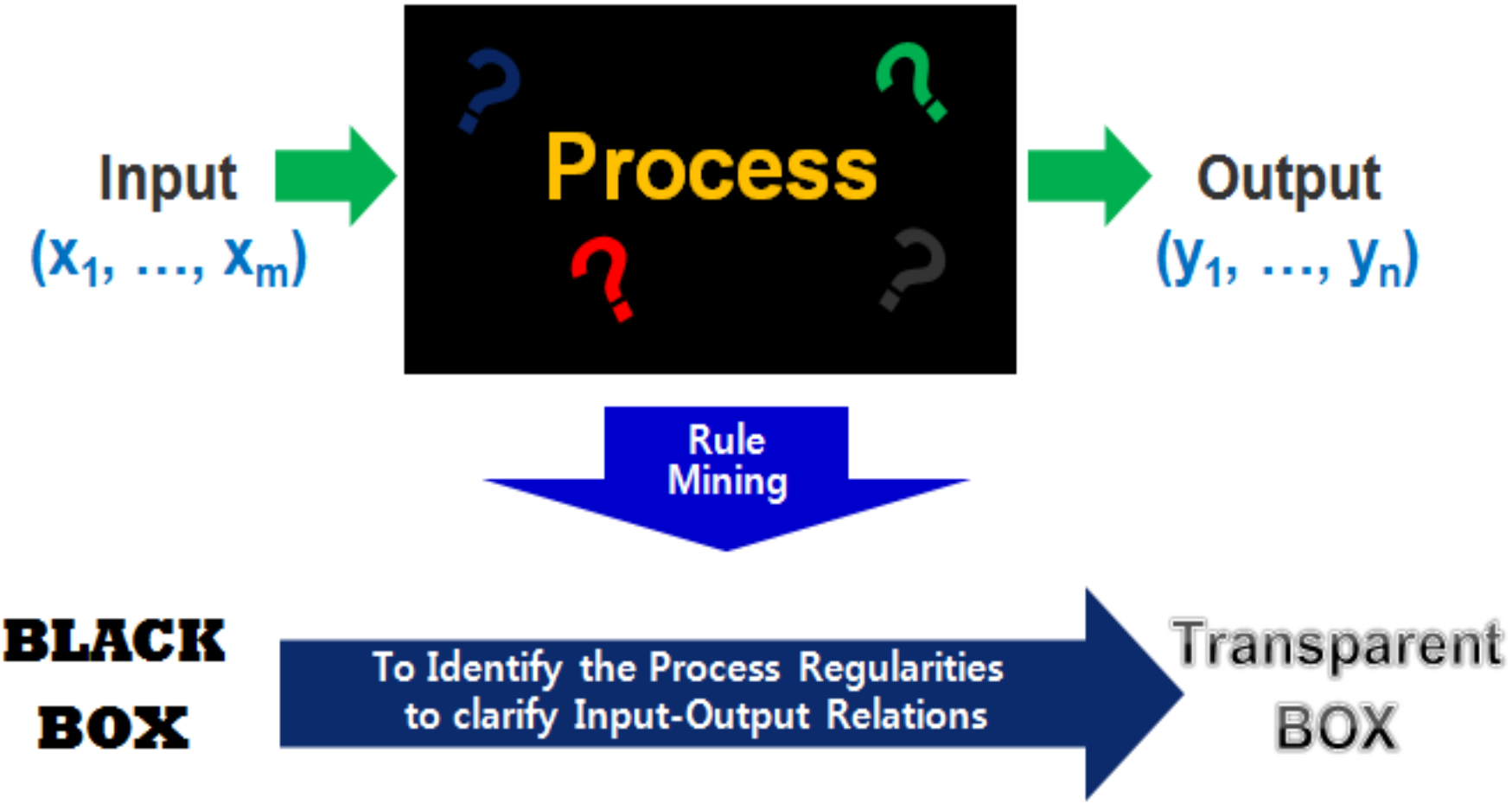
- Limitation in Identifying Relationships using 1:1 Input-Output Analysis
- Vital-Fews are insufficient to represent the Process Output Characteristics
- Limitation in Improvement of Output Value

Process Output may not be Fully explained by each parameters or Vital-Fews

Proposed Optimization Approach

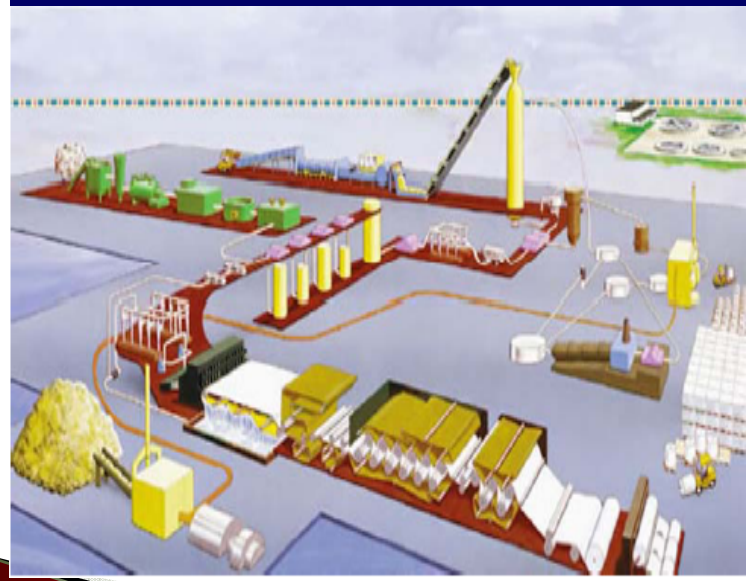


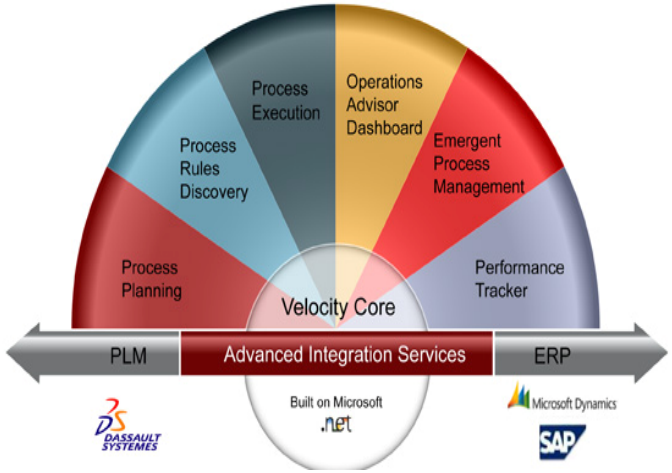
Benefits using Mining Tools in TRIZ



An Application Case Study

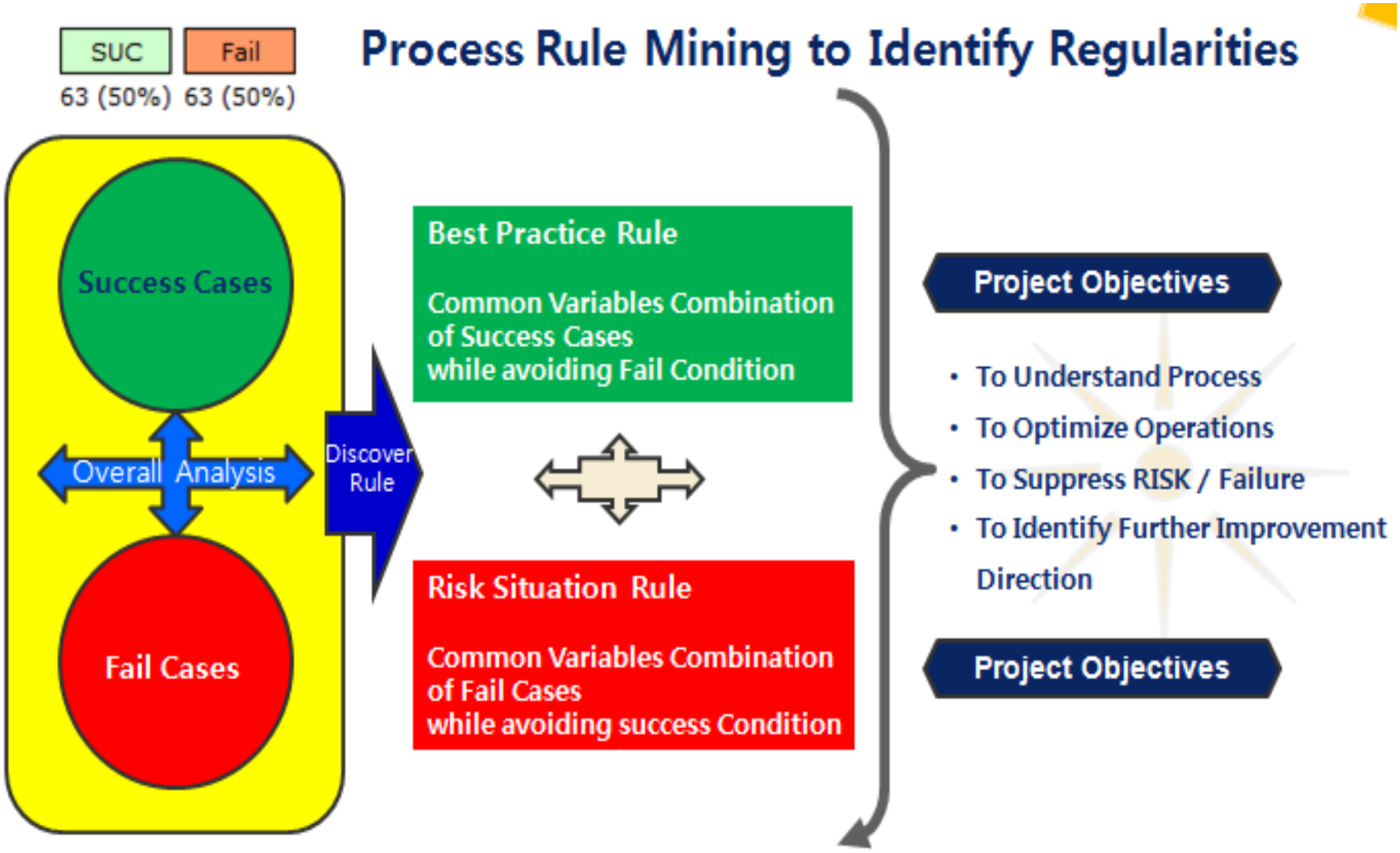
Data Rule Mining
In TRIZ Practice
Industrial Process





Case Study
&
Demonstration

An Application Case Study



An Application Case Study

R002.001 : SUC Size: 19 Fail: 0% SUC: 100%

Interest	Purity	Adjusted purity
54.7%	100%	88.5%

Process Rule for Product B Group

SUC 63 (50%) Fail 63 (50%)

			Purity loss	Safety margin	Coverage	Size gain
If	인장강도(MD)	in [7.87 ; 9.17]	13%	-	27%	4
And	수분(%)	in [3.4 ; 3.9]	9.5%	-	81.7%	2
And	지종	= TITAN아트 or TITAN아트ECO(FSC) or 에이플러스아트	8.3%	-	70.6%	5
And	ASH (%)	in [16.6 ; 25.5]	5%	-	84.1%	1
And	인열강도(MD)	in [2.86 ; 3.53]	0%	-	69%	0
And	인장강도(CD)	in [2.32 ; 3.12]	0%	-	42.9%	0
And	투기도(sec)	in [16 ; 33]	0%	-	90.5%	0
And	평활도W (sec)	in [35 ; 55]	0%	-	88.9%	0
And	평활도T (sec)	in [32 ; 49]	0%	-	91.3%	0
And	평량	in [80 ; 180]	0%	-	100%	0
then	Result	= SUC			?	

<Index>	E	지종	평량	기준평량(gsm)	평량(gsm)	두께(㎛)	Bulk	평활도T (sec)	평활도W (sec)	수분(%)	사이즈도(sec)	ASH (%)	투기도(sec)	지합지수	Scott I.B	양성전분투입량(%)	인장강도(MD)	인장강도(CD)	인열강도(MD)	Result
000019		TITAN아트	80	48	48.2	61	1.27	48	52	3.68	1	17.4	17	57			7.91	2.32	3.41	SUC
000030		TITAN아트	90	55	55.1	70	1.27	32	35	3.8	2	19.3	19	66	711	0.12	9.04	2.6	3.47	SUC
000031		TITAN아트	90	55	54.6	70	1.28	37	38	3.8	3	18	16	68	579	0.07	9.17	2.77	3.32	SUC
000032		TITAN아트	90	55	54.5	70	1.28	40	42	3.4	4	19.1	16	65	557	0.06	8.8	2.49	3.53	SUC
000033		TITAN아트	90	55	54.7	71	1.3	36	44	3.7	2	16.6	17	66	978	0.14	8.52	2.79	3.06	SUC
000034		TITAN아트	90	55	56.3	71	1.26	45	48	3.8	0	19.4	19	61	635	0.14	8.92	2.91	3.07	SUC
000044		플러스아트	95																	
000066		플러스아트	100																	
000072		TITAN아트	100																	
000074		TITAN아트	100																	
000084		ㅌECO(FSC)	105																	
000086		ㅌECO(FSC)	105																	
000087		ㅌECO(FSC)	105																	
000091		TITAN아트	115	69	70	88	1.26	36	37	3.5	1	21.9	22	57.4	300	0.38	8.68	2.89	3.01	SUC
000103		플러스아트	120	73	73.7	91	1.23	36	35	3.4	2	23.2	28	56	313	0.27	8.42	2.77	3.04	SUC
000104		플러스아트	120	73	72.9	90	1.23	45	49	3.8	4	19.5	28	62	357	0.85	8.95	2.92	3.07	SUC
000108		TITAN아트	128	77	77.2	95	1.23	42	40	3.78	1	21.7	20	54	249		9.09	3	3.03	SUC
000113		TITAN아트	135	86	83.7	105	1.25	32	35	3.5		22.4	22	54	160	0.79	8.71	2.98	2.93	SUC
000120		플러스아트	150	94	94.2	113	1.2	46	49	3.83		25.5	33	62	180	0.74	8.55	2.99	2.86	SUC

- **19 Process Data are explained with discovered Process Rule (Variable Combination)**
- **Output Value of selected 19 Data is all “Success Case”**
- **88.5% Quality are assured by using suggested Combination**

An Application Case Study

[Summary of Project Result]

SUC	Fail
63 (50%)	63 (50%)

- Process Quality Improvement 35%↗: [50% ▶ 85%]
- By using Data Analysis only without Any Experiments

- Process Operational Condition Setting for Products
  - Products A Group : (Quality Improvement 56% ▶ 84%)
  - Products A Group : (Quality Improvement 47% ▶ 89%)
  - Main Products Group : (Quality Improvement 41% ▶ 87%)

- To Identify Critical Process Parameters using Parameter Sensitivity Analysis

- To Identify Causes of Product Fail and Defectives

- To Suggest the Directions of Further Improvement

- To Motivate the Importance of Data Management in Innovation Process

Conclusion

- Providing innovator with the capability to...

  - **Understand** (I-O, Cause-Effect) Behaviors of Complex System
  - **Extract** Process Rules from Historical Dataset without Experiments
  - **Simulate** Input-Output Sensitivity to Optimize Process
  - **Improve** Operational Performance of System
  - **Parameterize** Conceptual Idea into Practical Solutions

→ To Facilitate the Innovation Process more Accelerated