Risk Extraction of Technical Specifications Based on Machine-Learning

2021. 10 . 14

Minji Park , minjipark@postech.ac.kr
Pohang University of Science and Technology (POSTECH), Pohang, South Korea

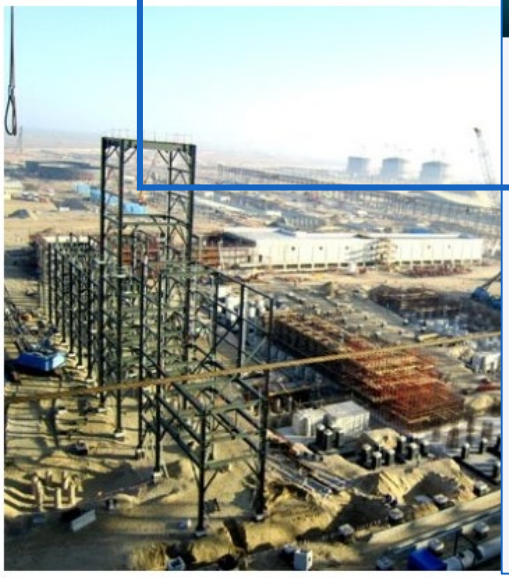
Value Creating University
POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

EPC Project Risk Analysis Technology

Technical limitations such as basic plant design... Leading to delays and losses

Shipbuilding's Big 3 Offshore Plant Losses Over 10 trillion

[ITB Analysis ②] Pohang University of Science and Technology Develops a Prototype That Can Even Semantic Analysis



It is pointed out that it is urgent to make a strict diagnosis on the overall overseas business of domestic construction companies and prepare measures to improve profitability. The UAE 'Ruwais Oil Refinery Plant' construction site, which provided the cause of the earnings shock in the 1st quarter of GS E& C . /Photo courtesy of GS Construction

EMAP
Engineering Machine learning Automation Platform

엔지니어링 머신러닝자동화 플랫폼

ITB Analysis

ITB문서의 NLP 분석을 통해 계약의 핵심사항과 독소조항을 분석할 수 있습니다.

Design Cost

엔지니어링 M/H, 투입 원가를 분석하여 설계견적 및 실행원가를 예측할 수 있습니다.

Design Error

설계오류보고서의 정보분석으로 설계오류 심각도를 분석할 수 있습니다.

Design Change

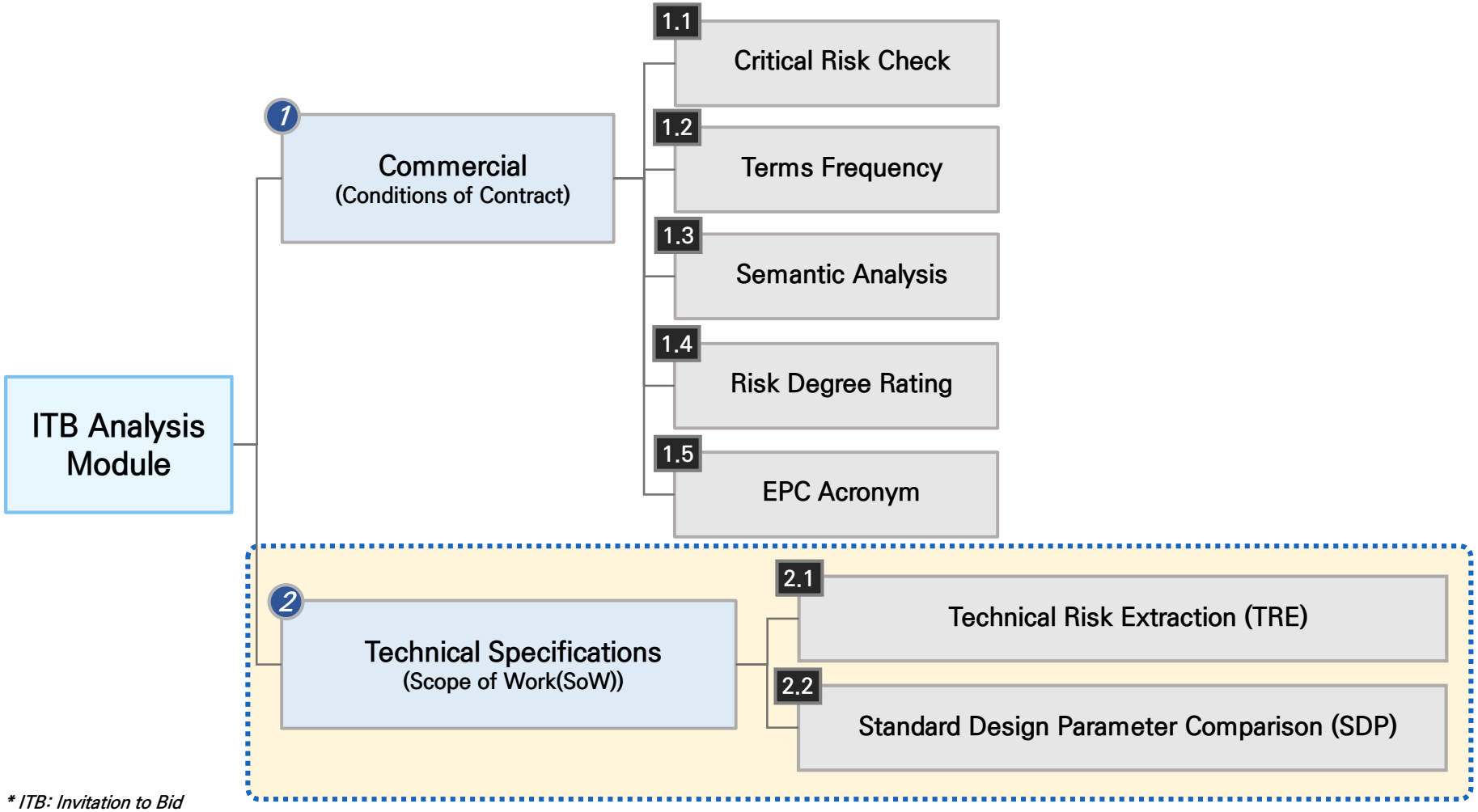
설계변경에 따른 설계 지연 심각도를 분석할 수 있습니다.

Predictive maintenance

플랜트 주요 설비의 정비를 예측합니다.

EMAP Module Configuration

EMAP: Engineering Machine-learning Automation Platform

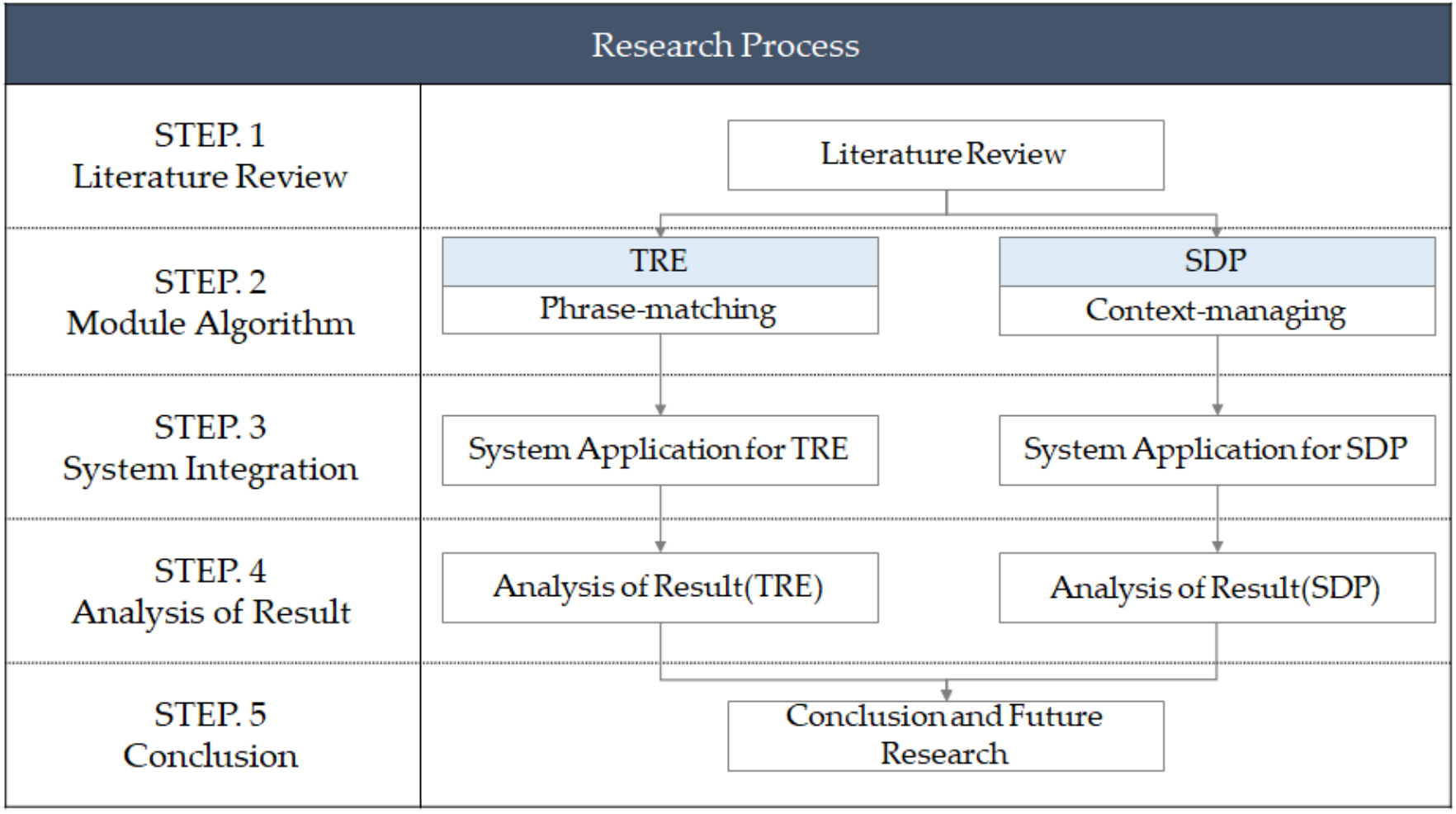


** ITB: Invitation to Bid*

***Commercial & Legal Risks from Conditions of Contract*

**** Technical Risks from Technical Specifications(SoW)*

Research Process



* TRE: Technical Risk Extraction Module
* SDP: Standard Design Parameter Module

Technical Risk Extraction (TRE)

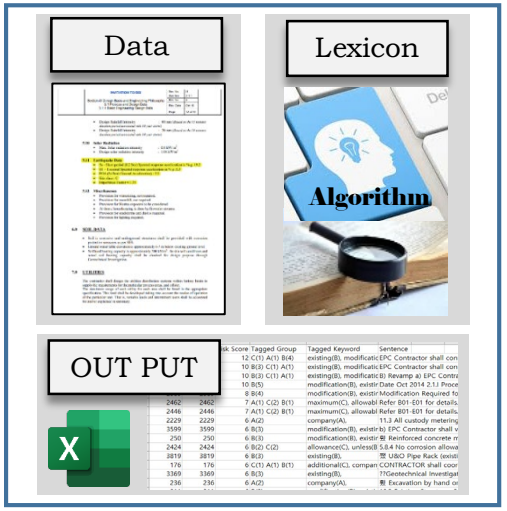
Technical Risk Extraction Process

Data Selection — INPUT the Technical Specifications PDF

Lexicon — Construction of Lexicon through collected data

Risk Impact — Calculate the impact score for Lexicon grouped

Result — The OUTPUT presents risk groups and scores



Analysis Results

	Ranking	Risk Score	Tagged Group	Tagged Keyword	Sentence
0	1	47	A(15) C(2)	in accordance with(C), all(A), company(A),	Summary Summary ~
1	2	18	A(6)	all(A), company(A),	External Interfaces ~
2	2	18	A(6)	throughout(A), all(A), company(A),	Contractor's Interface ~
3	3	13	A(4) C(1)	except(C), company(A),	Company Responsibil ~
4	4	12	A(4)	all(A), company(A),	Interfaces Contractor ~
5	4	12	A(4)	contractor shall provide(A), all(A), company(A),	Contractor shall ~
6	4	12	A(4)	all(A), company(A),	Companys HSE goal ~

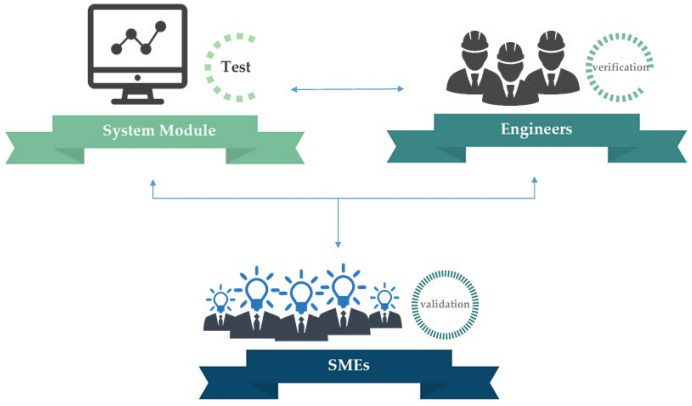
Technical Risk Extraction (TRE)

Construction of Technical Risk Lexicon

Clause Type		
High Impact/ High Probability (3)	High(Medium) Impact/ Medium(High) Probability (2)	Medium Impact/ Medium Probability (1)
all	unless otherwise specified	in compliance with
throughout	unless otherwise mentioned	in accordance with
owner	unless directed otherwise mentioned	according to
company	approved by	shall comply with
no additional cost	not exceed	shall submit
by the bidder	not applicable	discrepancy
⋮	⋮	⋮

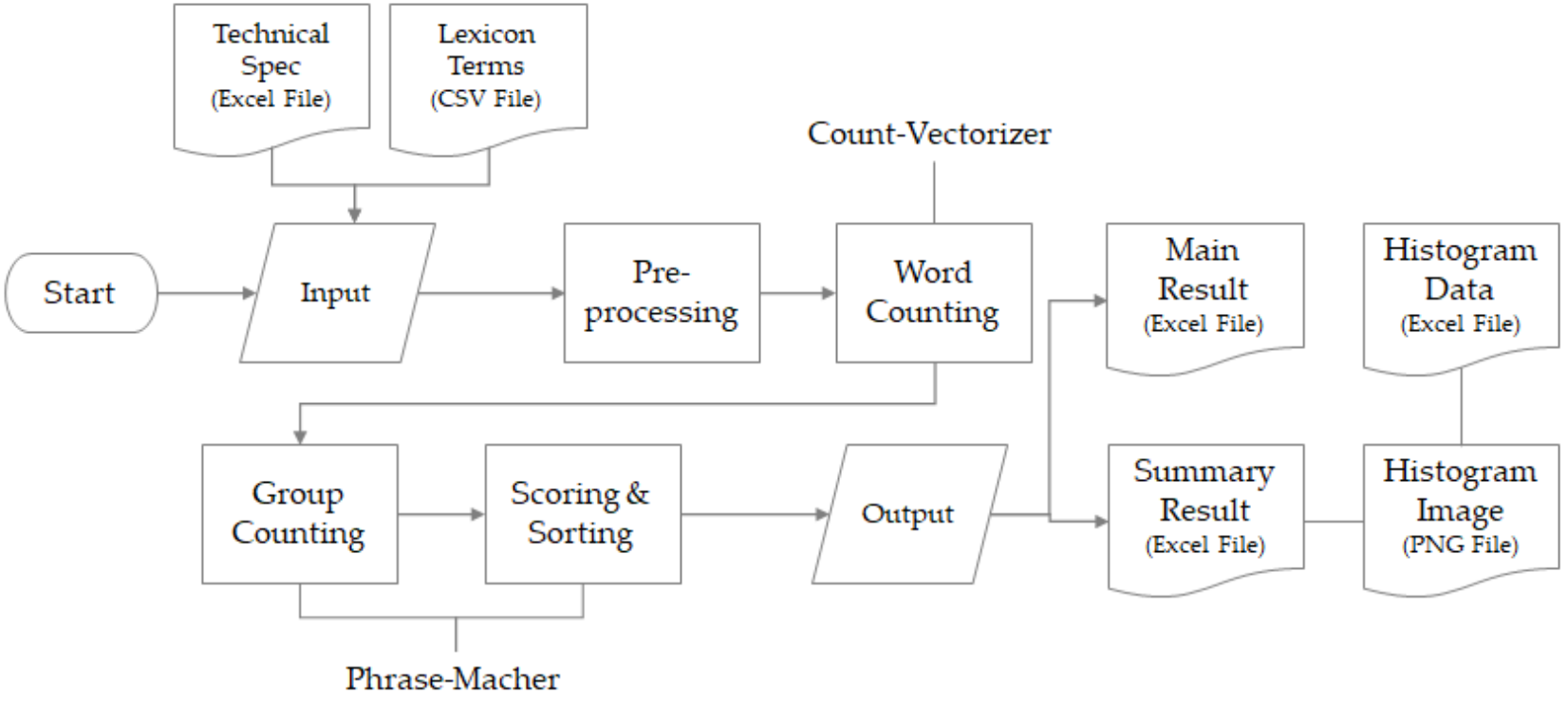
⋮ Keywords can be added according to the user's demand

		Impact: Medium (reasonable impact, to be monitored)	Impact: High (will have a significant impact)
Probability	Medium (may occur at a time)	C(1)	B(2)
Probability	High (likely to occur)	B(2)	A(3)



Technical Risk Extraction Algorithm

Module Algorithm for TRE

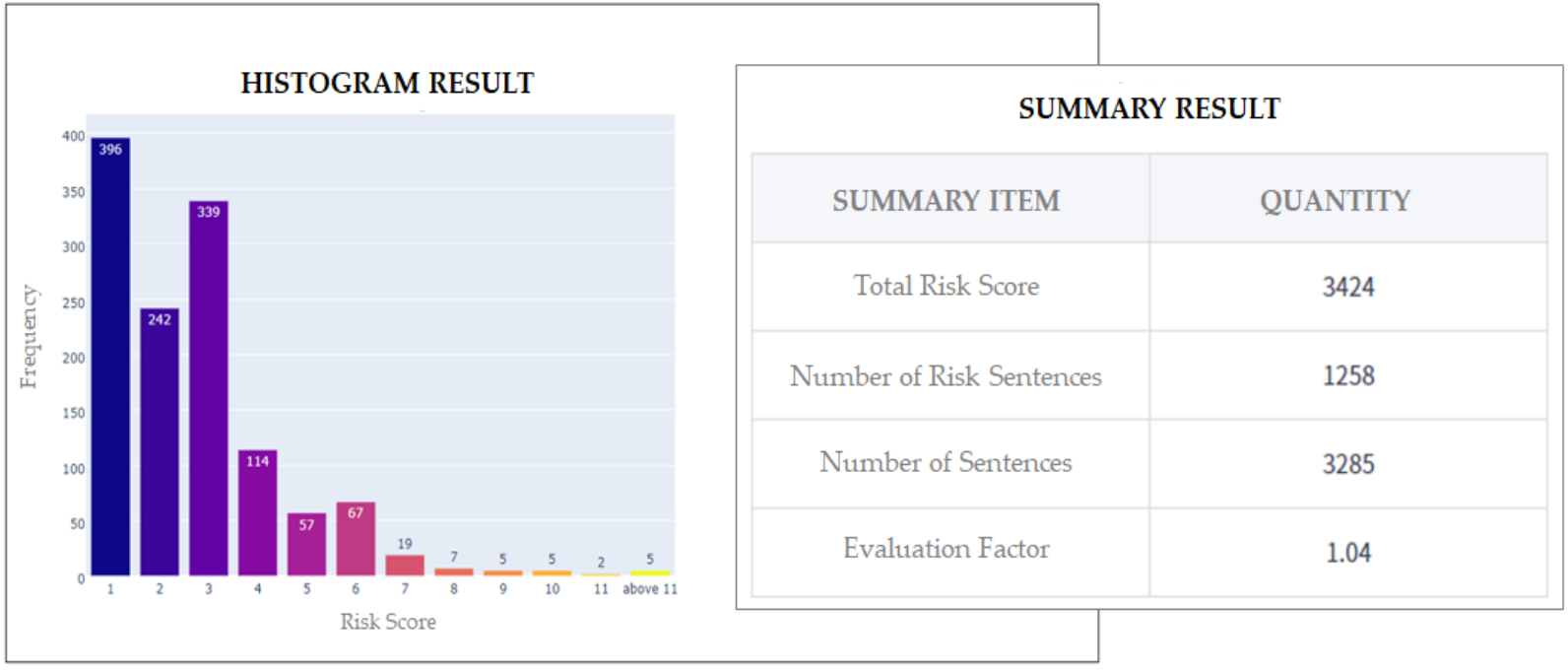


TRE Module Performance

Rank	Total Risk Score	Group	Extraction Keywords	Position Number	Position Name	Risk Sentences
1	21	A(4) B(4) C(1)	(A) all (A) company (A) no additional cost (B) existing (B) modification (C) additional	4.11	ENVIRONMENT, HEALTH, SAFETY & SECURITY	EPC Contractor shall confirm the required modification with the existing boiler vendor and existing burner manufacturer so all required modification can be implemented on all five boilers at no additional cost to COMPANY.
2	19	A(4) B(3) C(1)	(A) all (A) company (A) no additional cost (B) existing (B) modification (C) additional	4.11	ENVIRONMENT, HEALTH, SAFETY & SECURITY	EPC Contractor shall confirm the required modification with the existing incinerator vendor so all required modification can be implemented on all two incinerator packages at no additional cost to COMPANY.
3	13	A(2) B(3) C(1)	(A) company (A) no additional cost (B) existing (B) modification (C) additional	4.11	ENVIRONMENT, HEALTH, SAFETY & SECURITY	B) Revamp a) EPC Contractor to verify the existing pump capability with existing pump manufacture that doesn't need any modification or needs some modifications based on the followings at no additional cost to COMPANY: i).
			(A) all			All such modifications to the extent possible shall match the respective existing facilities

- A model that uses Phase-Matching technology to detect risks in technical specifications
- Match Technical Risk Keywords and Technical Risk Sentences in document to extract risk score

TRE Module Performance



SUMMARY RESULT

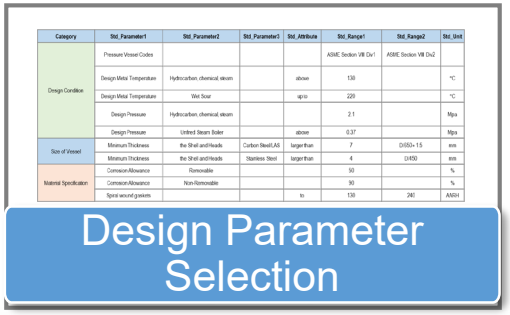
SUMMARY ITEM	QUANTITY
Total Risk Score	3424
Number of Risk Sentences	1258
Number of Sentences	3285
Evaluation Factor	1.04

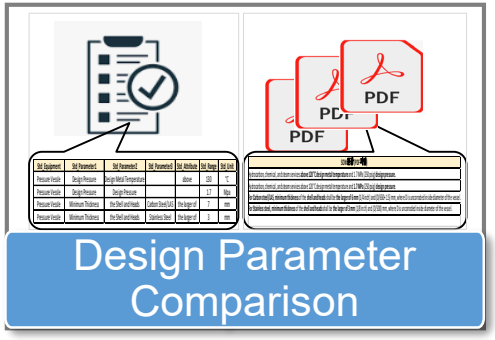
- A model that uses Phase-Matching technology to detect risks in technical specifications
- Match Technical Risk Keywords and Technical Risk Sentences in document to extract risk score

Standard Design Parameter Comparison

Standard Design Parameter Comparison Analysis Process

[SDP Analysis Process]





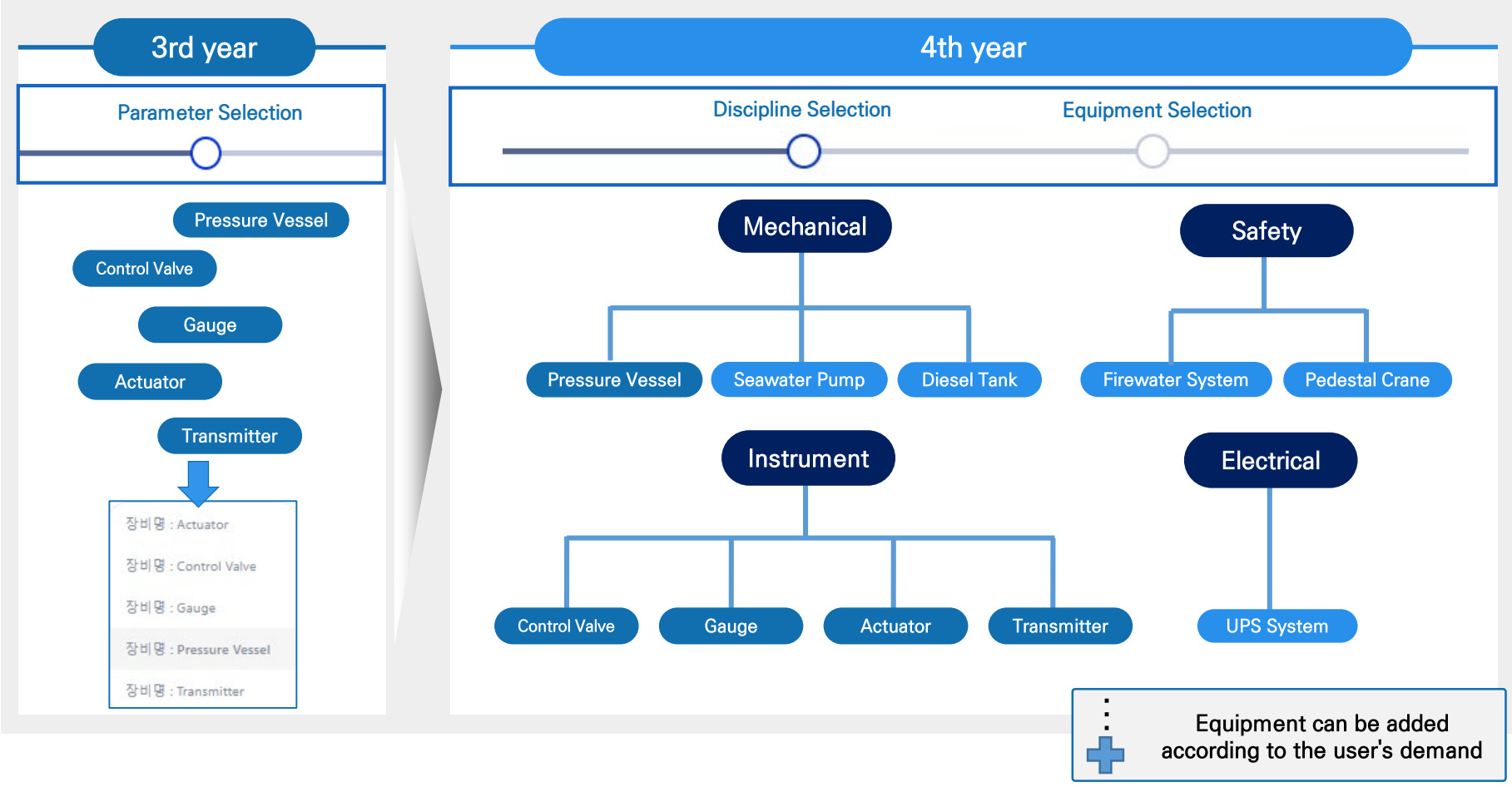
Module Analysis

결과 화면 예시

Standard Paremeter			Standard Range			comparison Range				
Parameter1	**Parameter2**	**Parameter3**	**Attribute**	**Range**	**Unit**	**Attribute**	**Range**	**Unit**	**Check**	**Sentence**
Design Pressure	Design Metal Temperature		above	130	°C	above	120	°C	False	Hydrocarbon, chemical, and steam services above 120 °C design metal temperature and 1.7 MPa (250 psig) design pressure.
Design Pressure	Design Pressure			1.7	Mpa		1.7	Mpa	True	~
Minimum Thickness	the Shell and Heads	Carbon Steel/LAS	the larger of	7	mm	the larger of	6	mm	False	~
Minimum Thickness	the Shell and Heads	Stainless Steel	the larger of	3	mm	the larger of	3	mm	True	~

Standard Design Parameter Comparison

- Establishing 10 types of analysis equipment by Discipline



Standard Design Parameter Comparison

- Establish parameter criteria (Definition → Component → Subelement)

Present a clear definition of the parameter to the user

3rd year SDP

Std_Equipment	Std_Parameter1	Std_Parameter2	Std_Parameter3	Std_Attribute	Std_Range	Std_Unit
Pressure Vessle	Minimum Thickness	the Shell and Heads	Carbon Steel/LAS	the larger of	7	mm

4th year SDP

DISCIPLINE	EQUIPMENT	PRM1_DEFINITION	PRM2_COMPONENT	PRM3_SUBELEMENT	STD_ATTRIBUTE	STD_RANGE1	STD_RANGE2	STD_UNIT
Mechanical	Pressure Vessel	Minimum Thickness	Shell	Carbon Steel/LAS	greater than	7	D/650+ 1.5	mm
Mechanical	Pressure Vessel	Minimum Thickness	Shell	Stainless Steel	greater than	7	D/650+ 1.5	mm
Mechanical	Pressure Vessel	Minimum Thickness	Head	Carbon Steel/LAS	greater than	4	D/500	mm
Mechanical	Pressure Vessel	Minimum Thickness	Head	Stainless Steel	greater than	4	D/500	mm

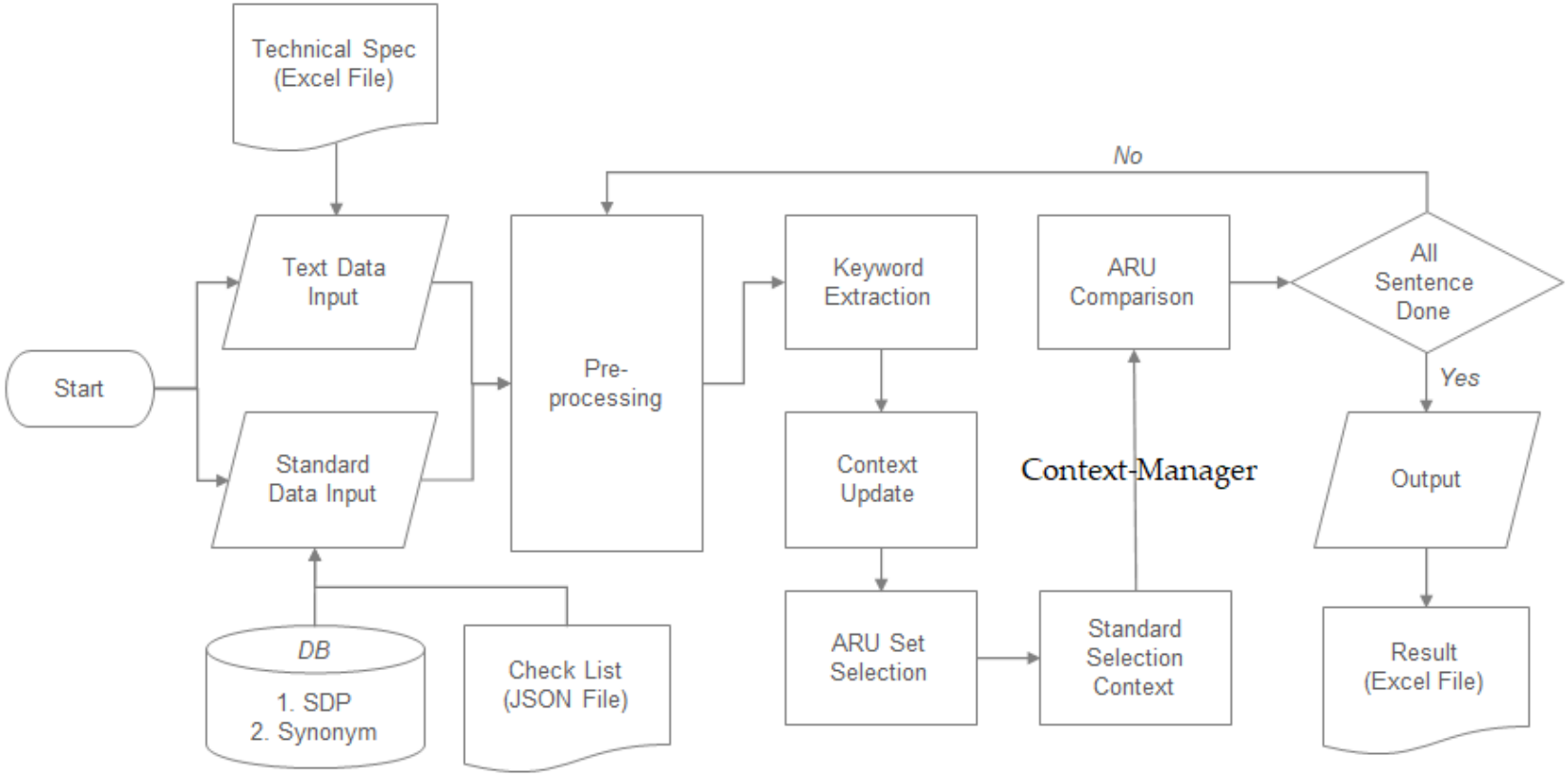
☑ Add DISCIPLINE
: UI configuration by adding Discipline, which is a Hierarchy of Equipment

☑ PRM1: Definition
– Definition of numerical requirements (Range)
PRM2: Component
– Name of equipment, elements of equipment
PRM3: Sub Element
– Additional information on equipment condition

☑ ATTRIBUTE Organization
:One word that represents the Attribute scope
(ex: the large of → grater than)

Standard Design Parameter Algorithm

Module Algorithm for SDP



SDP Module Performance

Standard Design Parameter Management

Technical Specifications → **Manage Parameter** → Upload Data → Select Equipment → Analysis Result

Standard Design Parameter(SDP) 조회 | SDP 유의어 조회

Discipline	Equipment	PRM 1	PRM 2	PRM 3	Range	Figure 1	Figure 2	Unit
Instrument	Gauge	Accuracy	Local Gauge	Full Scale	max	1		%
Instrument	Transmitter	Accuracy	Electronic Transmitter	Full Scale	at least	0.25		%
Instrument	Transmitter	Accuracy	Pneumatic Transmitter	Full Scale	at least	1		%
Mechanical	Pressure Vessel	Corrosion Allowance	Pressure Component	Removable		50		%
Mechanical	Pressure Vessel	Corrosion Allowance	Pressure Component	Non-Removable		100		%
Mechanical	Pressure Vessel	Design Metal Temperature	Service	Hydrocarbon	greater than	120		°C
Mechanical	Pressure Vessel	Design Metal Temperature	Service	Chemical	greater than	120		°C
Mechanical	Pressure Vessel	Design Metal Temperature	Service	Steam	greater than	120		°C
Mechanical	Pressure Vessel	Design Metal Temperature	Service	Wet Sour	max	200		°C
Mechanical	Pressure Vessel	Design Pressure	Service	Hydrocarbon	greater than	1.7		Mpa

< 1 2 3 4 5 6 7 >

- The SDP module uses Context-managing technology to analyze technical specifications
- Check the synonym of the standard design parameter

SDP Module Performance

RESULT of SDP Module

Technical Specifications → Manage Parameter → Upload Data → Select Equipment → Analysis Result

EQUIPMENT	PRM 1	PRM 2	PRM 3	A	R1	R2	RESULT	SENTENCE
Gauge	Accuracy	Local Gauge	Full Scale	+	1.0		FALSE	Accuracy Unless otherwise stated, the minimum accuracy of instruments shall be: + 1.0% of full scale Electronic Transmitters
Control Valve	Noise Level	Control Valve		not be greater than	85		TRUE	Predicted noise level at 1m downstream shall not be greater than 85dBA.
Control Valve	Pressure Drop	Control Valve	Normal Flow Condition	or more	50		TRUE	Valve Characteristic When 50% or more of the dynamic pressure drop is to be sustained by the control valve at normal flow conditions.
Control Valve	Pressure Drop	Control Valve	Maximum Flow	maximum	1.1		TRUE	Valve sizing shall be based on 1.1 times maximum flow at the given pressure drop.
Control Valve	Nominal Size	Globe And Ball Valve Body		minimum	1		TRUE	The minimum nominal size of globe and ball valve bodies shall be DN25 (1").
Control Valve	Nominal Size	Globe And Ball Valve Body		minimum	4		TRUE	The minimum nominal sizes of eccentric plug valves shall be DN50 (2") and of butterfly valves DN100 (4").

- Parameters of equipment by discipline are shown and ARU are compared
- Comparative analysis results are expressed as TRUE and FALSE

Result of Module Validation

Module Algorithm for TRE				
		Risk Extraction (Q'ty)	**Extraction Validation (by SME)**	**Extraction Rate (%)**
TRE	System Module	342	314	92%
	Engineer	311	264	85%

Module Algorithm for SDP				
		Risk Extraction (Q'ty)	**Extraction Validation (by SME)**	**Extraction Rate (%)**
SDP	System Module	187	168	90%
	Engineer	172	151	88%

- SMEs excluded mutual discussion on the validation so that independent verification could be made
- The TRE extraction accuracy result is 92%, and the SDP comparison accuracy result is 90%

End of Document