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RISK MANAGEMENT PROCESS AT EARLY STAGE OF EOR OPPORTUNITIES DEVELOPMENT

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Background

- risk management implemented since early phase of EOR
- 1st EOR screening has just finished. Laboratory works and subsurface modeling in-progress
- Operator's perspective

Agenda

- Risk Management (ISO 31000)
- EOR Maturation Path
- Company's Governance
- EOR Opportunity - Study Case
- Risk Management Process
- Lesson Learned

RISK MANAGEMENT

ISO 31000:2018 Risk Management Guidelines

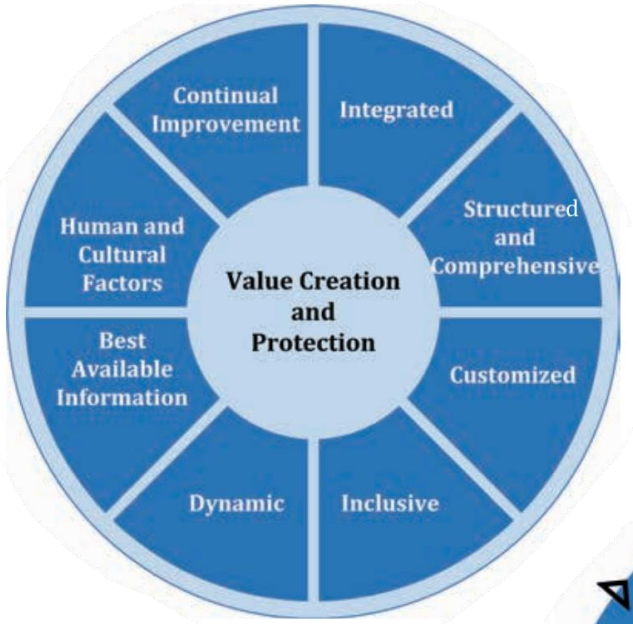
Risk - effect of uncertainty on objectives

Risk management - coordinated activities to direct and control an organization with regard to risk

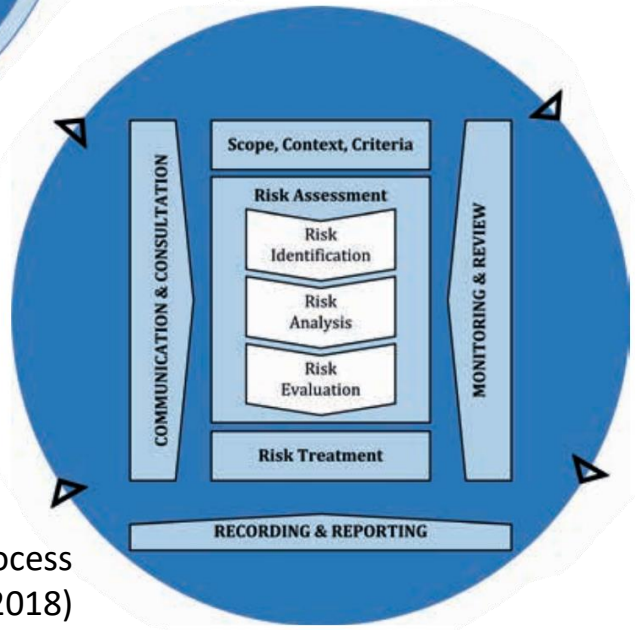
The purpose of risk management is the creation and protection of value. It improves performance, encourages innovation and supports the achievement of objectives

Governance guides the course of the organization, its external and internal relationships, and the rules, processes and practices needed to achieve its purpose.

Definition of "risk" implies that Organization would set its objectives, before exercising risk management



Risk management principle
(ISO 31000:2018)



Risk management process
(ISO 31000:2018)

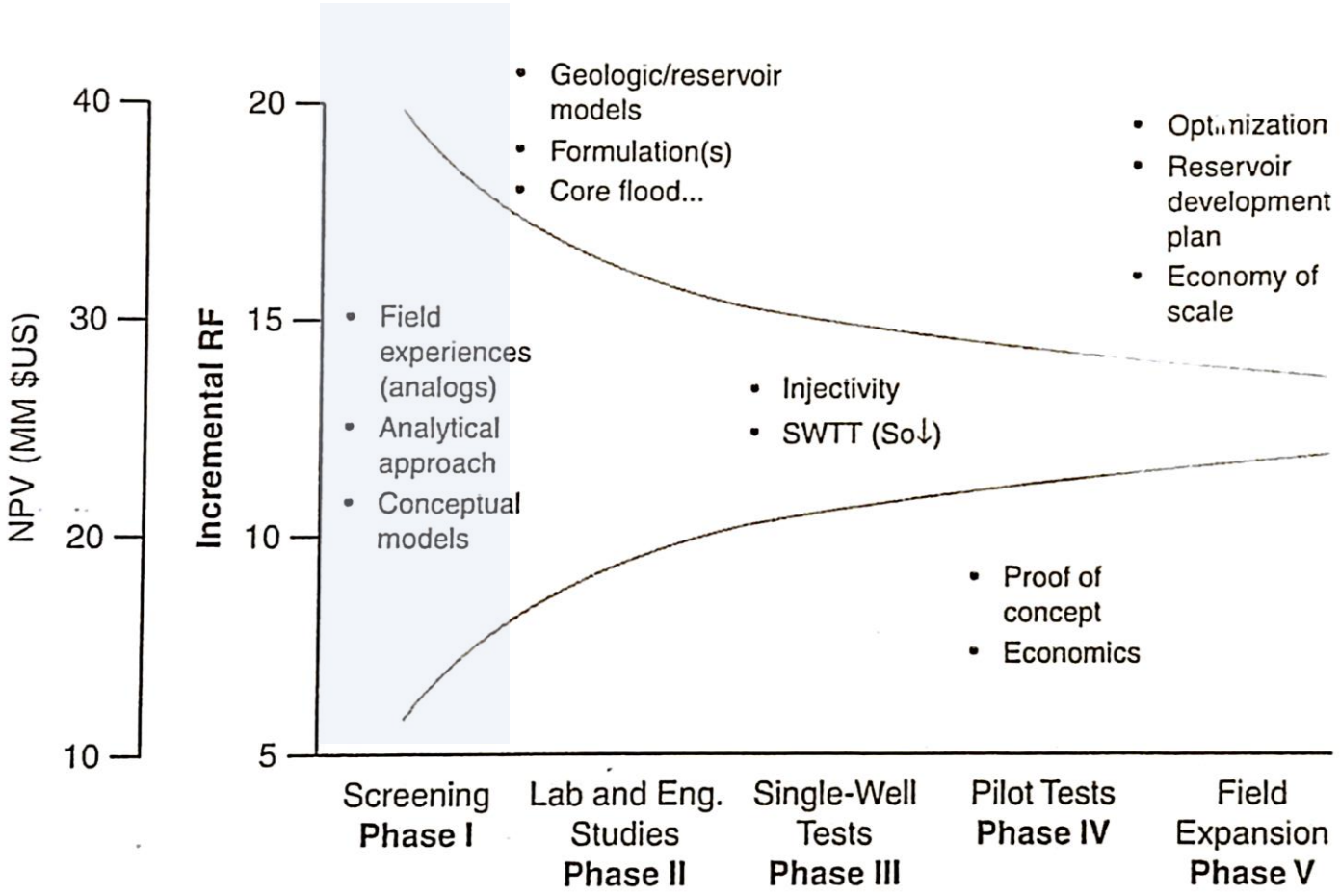
EOR MATURATION PROCESS

Alvarado (2010) suggested a rather strategic approach for EOR screening stage, before stepping into more costly and time-consuming works

Reservoir do not remain static, time allotted for EOR decision is constrained.
Avoid over-analysis

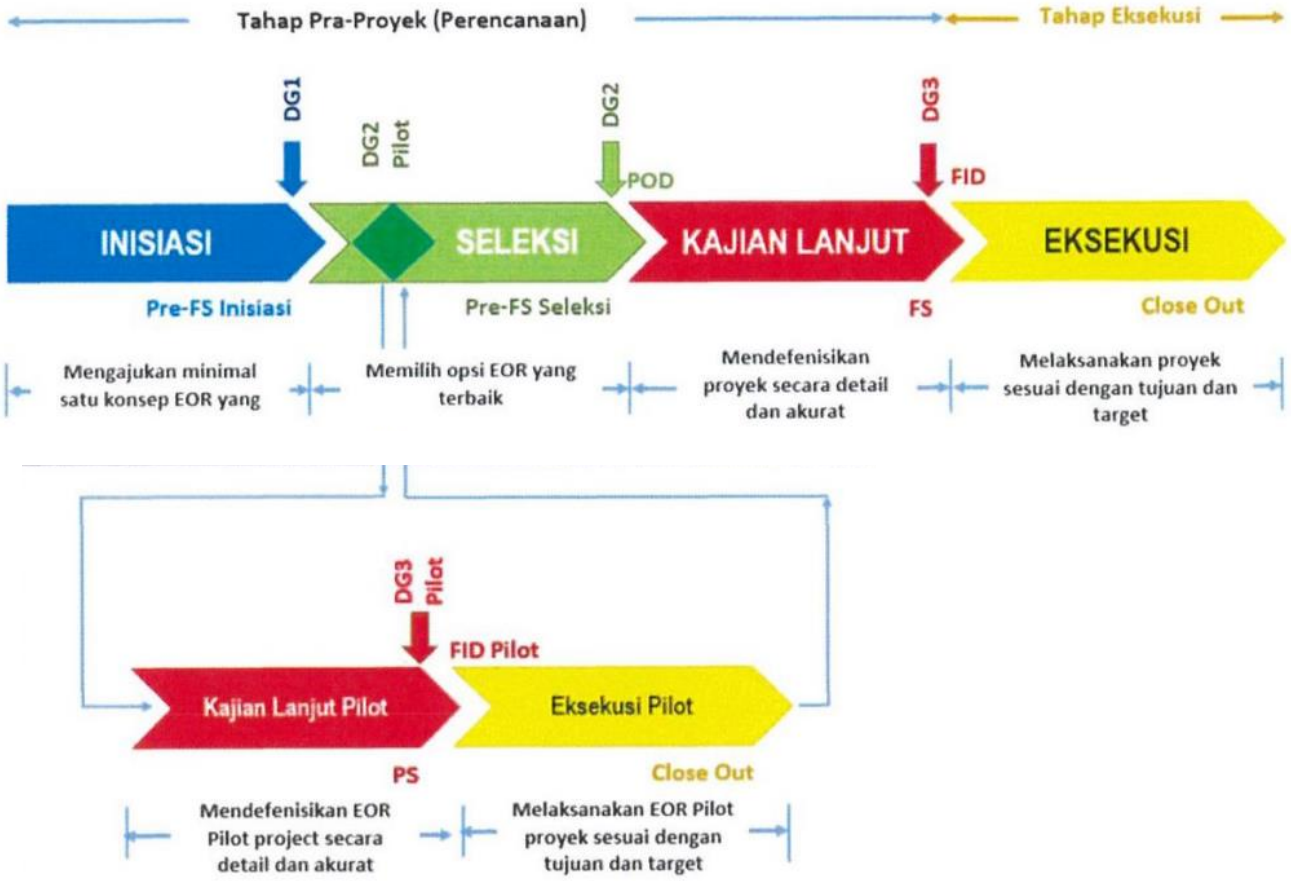
Economic analysis and appropriate framing.
Balanced analysis of "**hard**" and "**soft**" issues.

"Soft issues" to be taken into account : scale up process from lab to pilot to full field, logistic/supply chain, CO_2 or EOR chemical long term supply, environmental, regulation/lease/permit, public perception



GOVERNANCE

PERTAMINA UPSTREAM DEVELOPMENT WAY



Source : Pedoman PUDW, Subholding Upstream

Stage Gated process (opportunity maturation and realization)

Decision hierarchy in the organization

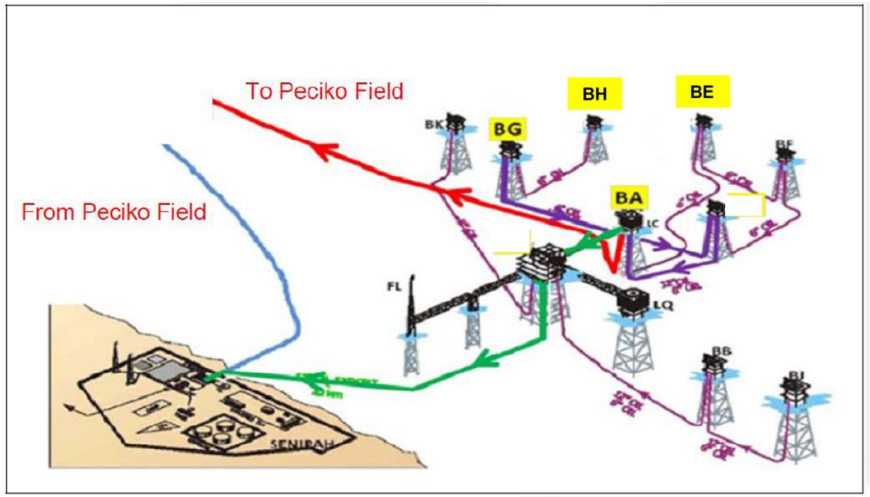
Risk Management process is integral part

Stage Initiation :

- EOR Screening
- suggest 1 scheme : consistent, integrated subsurface and non subsurface, can be demonstrated to be economic

EOR OPPORTUNITY – STUDY CASE

- Offshore oil field 45-55km off the coast, 30-40m water depth in Makassar Strait, East Kalimantan
- Producing since 1974, natural flow and gas lifted



EOR OPPORTUNITY – STUDY CASE

- Subsurface EOR screening, comparing reservoir characteristic with sets of benchmarks
  - Method suggested by literature (Taber Martin 1997)
  - Software EORGUi and PertaEOR

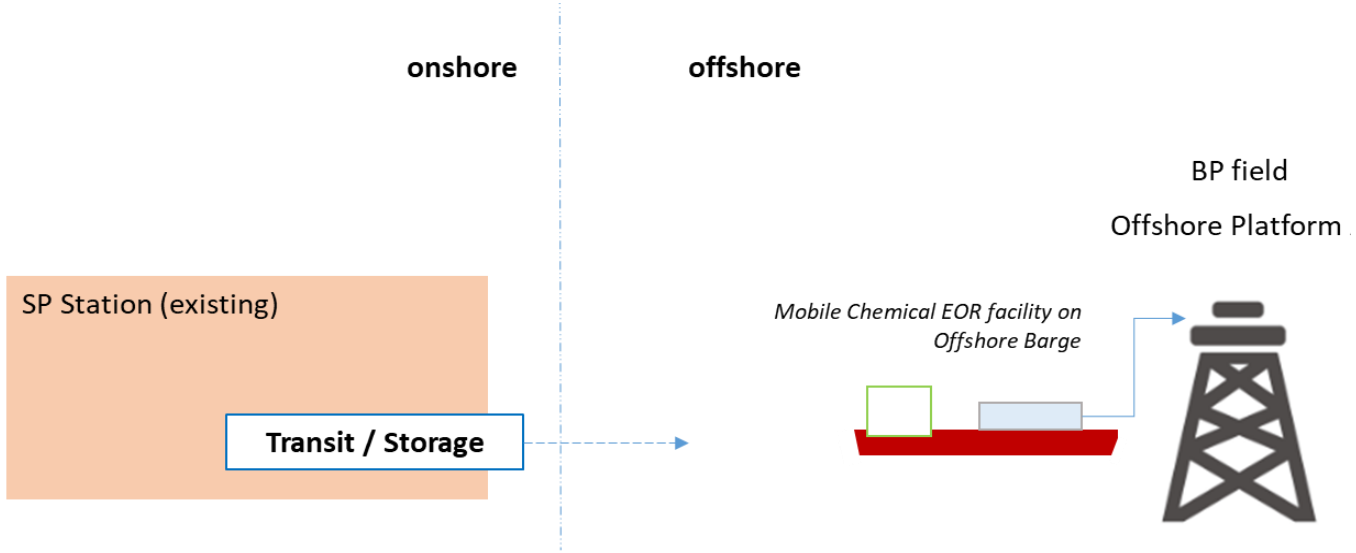
EOR methode	
Polymer / Surfactant Flooding	✓
Carbon Dioxide (CO_2)	✓
Nitrogen (N_2) / Flue Gas	✓
Hydrocarbon Gas (HC)	

- Subsurface and Non Subsurface aspects were developed for scenarios above, preliminary economic analysis
- Screening Study concludes to pursue chemical EOR (Polymer / Surfactant Flooding) option and to continue to lab. works and more detailed subsurface simulation

- Lithology : Sandstone
- Oil Gravity : 39.9 – 41.7° API
- GOR : 900 – 1000 scf/bbl
- CO_2 3-4%, no H_2S
- Oil Viscosity : 0.49 - 0.63 cP
- Oil Saturation : 14% - 27%
- Porosity : 13 – 31%
- Permeability : 380 – 1500 mD
- Depth : 1350 – 2300 mSS
- Temperature : 80 – 114 ^oC
- Salinity : 7500 – 20000 ppm

" Screening exercise done in a rather strategic approach, avoiding over-analysis, balancing hard and soft issue, and with time target "

BASE CASE SCENARIO | CHEMICAL EOR

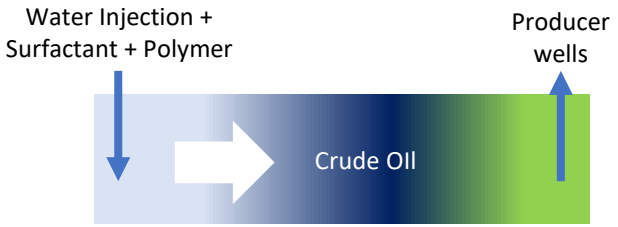


Chemical EOR scenario

Wells	Surface Facility	Operations
WI wells, existing OP wells revival	WI Platforms	Rental chemical injection equipment & barge, Rental sea water treatment equipment & barge, Logistic, supervision, Laboratory, Well OPEX

Polymer improves macroscopic efficiency (reservoir sweeping efficiency) by increasing viscosity of water injected

Surfactant improves microscopic efficiency by stripping out remaining oils that otherwise remains attached (immobile) to rock surfaces



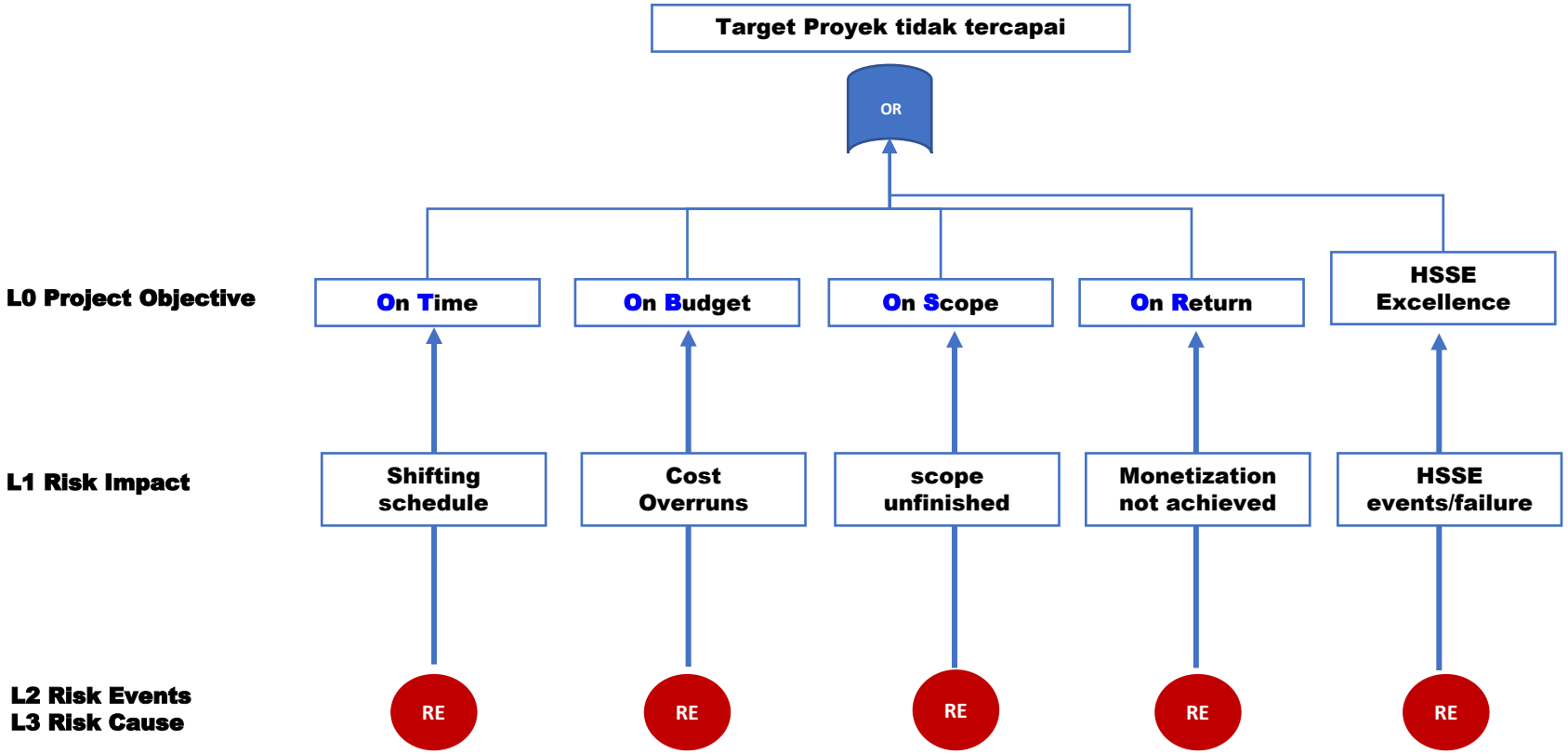
Objective then can be written : " within timeline xx, to execute EOR project with scope xx, to produce xx mmbbls, and creating value of xx MM$ "

Elaborate :

- Production profile (preliminary EOR performance prediction)
- Cost estimate : wells, surface facilities, chemical EOR operation, decommissioning
- Costs and revenue planning
- Business model / PSC terms, tax
- Full cycle project economic
- Sensitivities, identification of factors impacting project economic

RISK MANAGEMENT PROCESS

Risk = effect of uncertainty on objectives - *ISO 31000:2018*



Scope, Context, Criteria

- Base case scenario, with production and cost profile
- Cost structure, economic model and sensitivities
- Organization, Stakeholder Map
- Governance, Risk Criteria

Risk Assessment

(identify, analyze, evaluate)

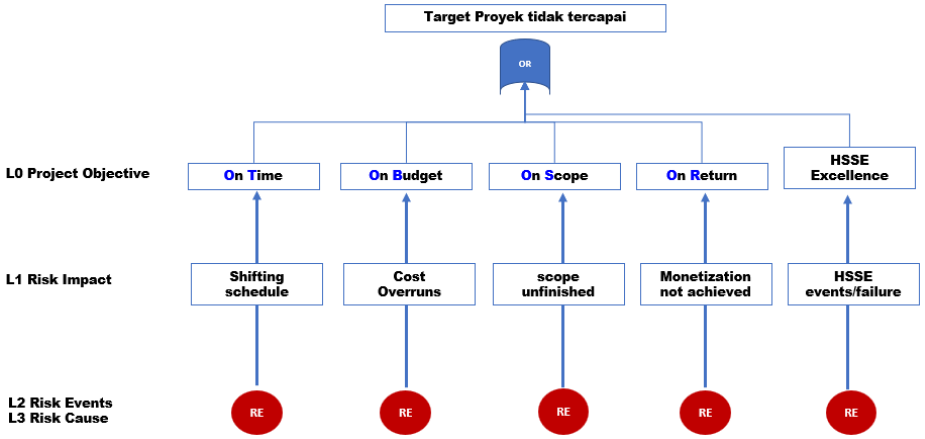
- Team's brainstorming to list Risk Events, list causes and how they will affect objective
- Group/classify events around themes OTOBOSOR and HSSE
- Estimate Probability and Consequences (Qualitative/Quantitative)
- Risk Map

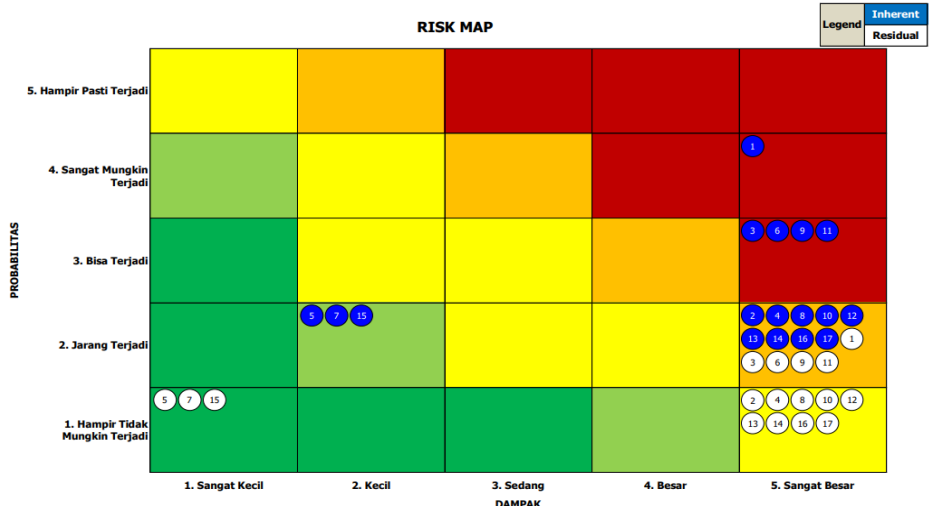
Risk Treatment

- Avoid, Eliminate, Sharing, Accept
- Risk Reduction Measures

RISK REGISTER, TOP RISKS

Risk Assessment : Identify, Analyze, Evaluate





Risk Register

Quantitative	1	Shifting schedule (approval, stakeholders alignment) ★
	2	Shifting schedule (permits)
	3	Shifting schedule (procurement)
	4	Shifting schedule (drilling, well interventions)
	5	Cost overrun (drilling, well interventions)
	6	Shifting schedule (surface facility investment)
	7	Cost overrun (surface facility investment)
	8	Existing production facilities not optimal
	9	subsurface performance not achieved (underperformed) ★
	10	Gas and/or Oil price
	11	Overrun incremental Opex ★
Qualitative	12	Well blow out
	13	Environmental impact / pollution
	14	Health incidents
	15	Security incidents
	16	Accident (LTI), injuries or assets damage
	17	Breach to compliance system / bribery

Top Risks

3 Top Risks	Risk Reduction Plan
Shift in project approvals/ realization schedule	• Add personnel as needed for EOR realization, across discipline/functions • Establish integrated planning and effective control • Obtain stakeholder consent as scheduled
Production target / incremental EOR gain **not achieved** (underperformed)	• Conduct chemical EOR Lab analysis (include core floods, injectivity tests, various chemical tests ..) • Acquire new cores as needed • Reservoir simulations using lab data • Conduct Pilot Phase to prove EOR method • Design QA/QC aspect to be implemented at EOR operation on site
Cost overrun / incremental Opex related to chemical EOR material, operations and various logistic	• Pursue option internal fuel gas supply (i/o purchase) • Market survey • Contract Strategy • Integrated planning • Attention when scaling up from lab to field scale

KEY TAKEAWAYS

Case Study of EOR at **Screening and Initiation Stage**

Screening stage includes both subsurface aspect and **non-subsurface** aspect

Multidiscipline group : geology-geophysics, petrophysics, reservoir engineering, production/ fluid chemistry, drilling/well, surface facility design and operation, engineering/project, investment planning, economic and risk

Risk management process

1. adapted to the progress of the study
2. using available information, awareness of uncertainties and information to be acquired at the next stage of the study

Benefit of risk process at early stage of EOR,

1. helping to structure different puzzles
2. portrait the project at its stage
3. statement of objective
4. aligning with business objective: economics and factors with significant impacts
5. establish list of top risks / challenges,
6. establish risk reduction measures,
7. seek management support and stakeholders'

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"If you write the problem down clearly, then the matter is half solved."

Kidlin's Law

TERIMA KASIH

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