



# Digital Well Integrity Solution Helps Visualize and Communicate Risk Throughout the Well Lifecycle

AINIL IZZYAN NAFFI  
WELLS ENGINEER, PETRONAS CARIGALI SDN BHD

# CONTENT

 **BACKGROUND & PAIN POINTS**

 **OBJECTIVES**

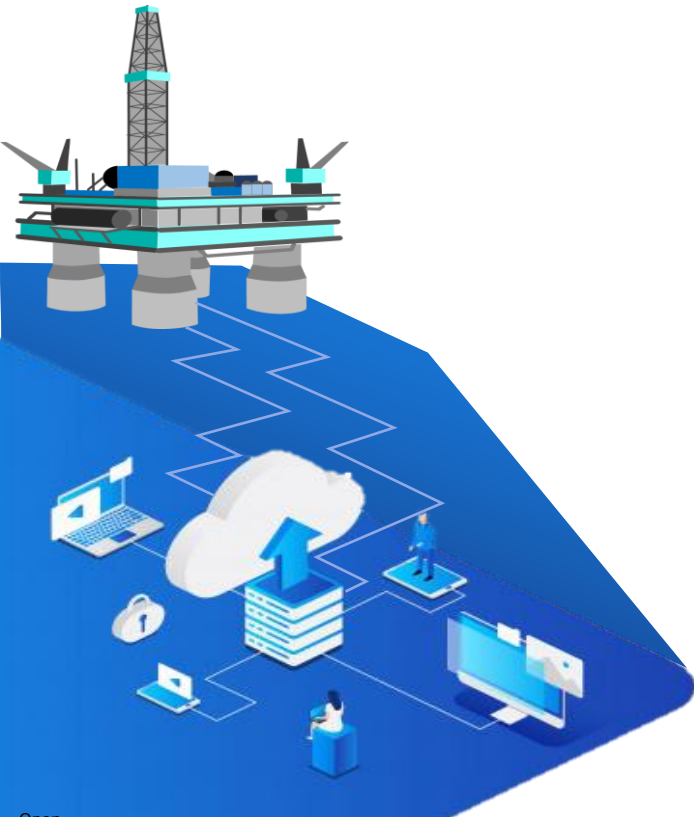
 **APPROACH**

 **WELLBARRIER WORKFLOW**

 **RESULT**

 **FUTURE POSITIONING**





# BACKGROUND

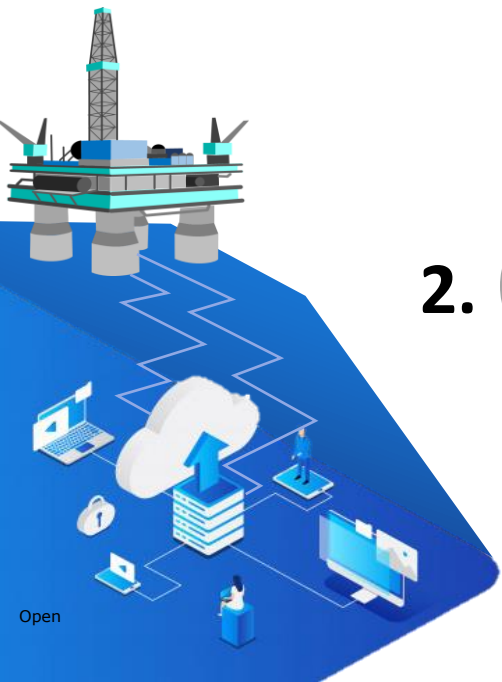


- Wells is taking a determined and proactive approach to embrace digital revolution through integrating our digital well integrity processes in providing stakeholders a collaborative platform to manage well integrity risk throughout well lifecycle.
- The Wellbarrier solution has been well adopted within the Wells operating culture since 2016. The solution was initially implemented to help understand vulnerabilities in drilling phase and quickly expanded to cover all phases of the well lifecycle.

# PAIN POINTS

The pain points faced by Wells team prior embarking this digital well integrity journey through Wellbarrier were:

-  **1. No centralized database**  
Well integrity data was residing in respective Asset's database, and was not easily accessible by stakeholders
-  **2. Non-standardized template**  
was used across Assets in capturing well integrity information
-  **3. No continuity of database throughout well life cycle**  
When well is handed over from one phase to the other, often crucial well integrity info are either missing or not updated
-  **4. Physical sitting & review session**  
was required to conduct Well Integrity Risk Assessment (WIRA) using manual Excel template

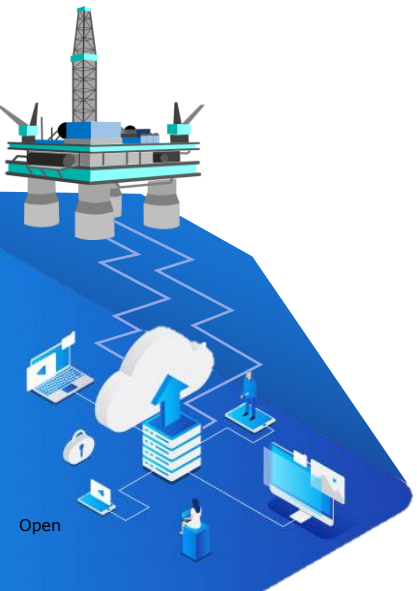


# OBJECTIVES

To communicate to the involved parties in drilling, well operations up until plug & abandonment on how to safeguard our well activity in a clear and concise manner throughout the lifecycle of the well.



Implementation in the well integrity value chain includes barrier definition, qualification & monitoring, risk assessment, and anomaly management.

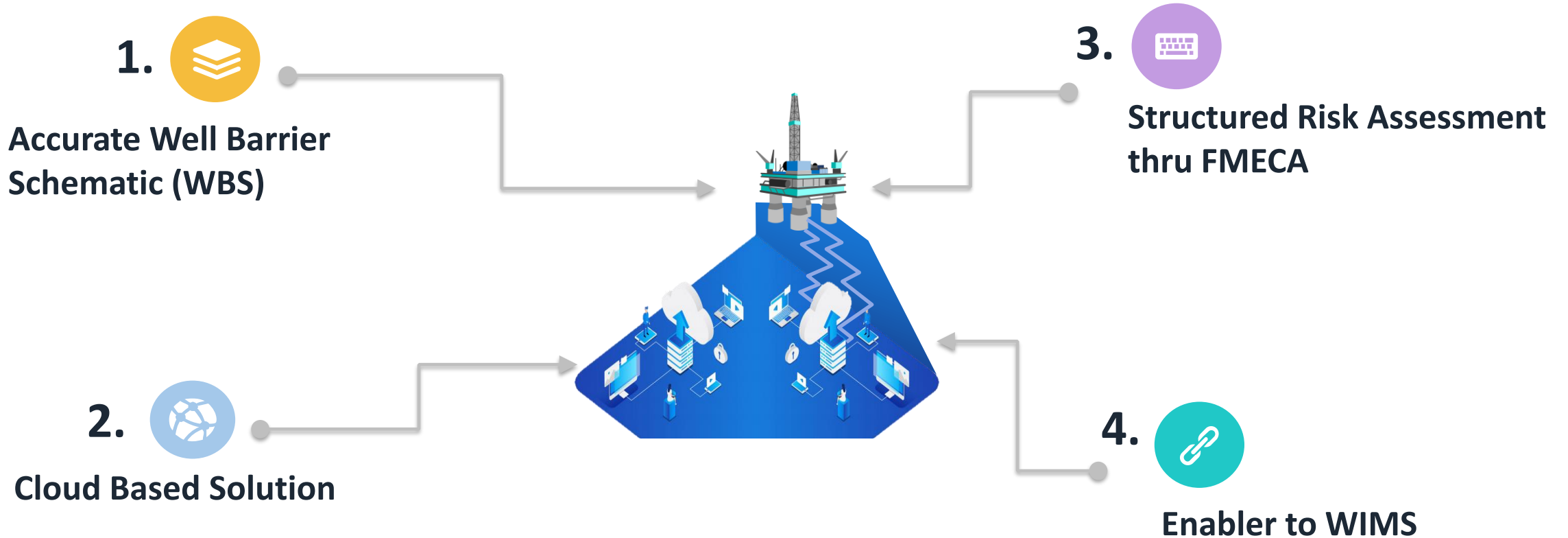


# APPROACH

The approach is a step-change away from “traditional” processes, to a more digitally integrated and cohesive solution to well integrity.



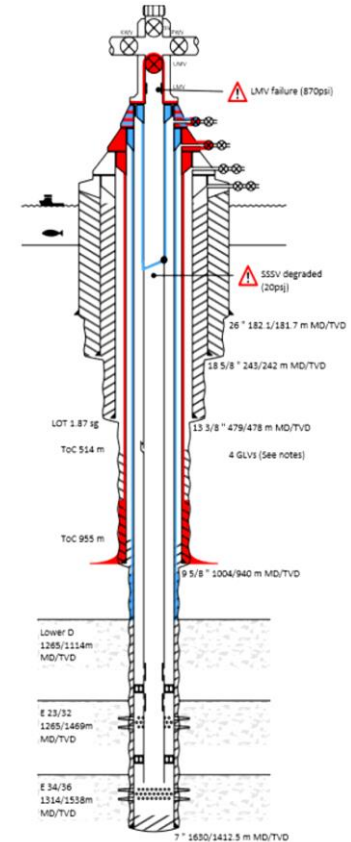
This removes subjectivity in the decision-making process, enables consistency and collaboration, and most importantly supports towards the environmental sustainability of our industry.





## 1. Accurate Well Barrier Schematic (WBS)

- Existing data is leveraged to prepare Well Barrier Schematics, that are used as the foundation to understand well integrity risk throughout the well lifecycle.
- The WBS provides standardized presentation of graphics and language to all stakeholders.
- Wellbarrier allows users to prepare high quality WBS in a quick and efficient manner.

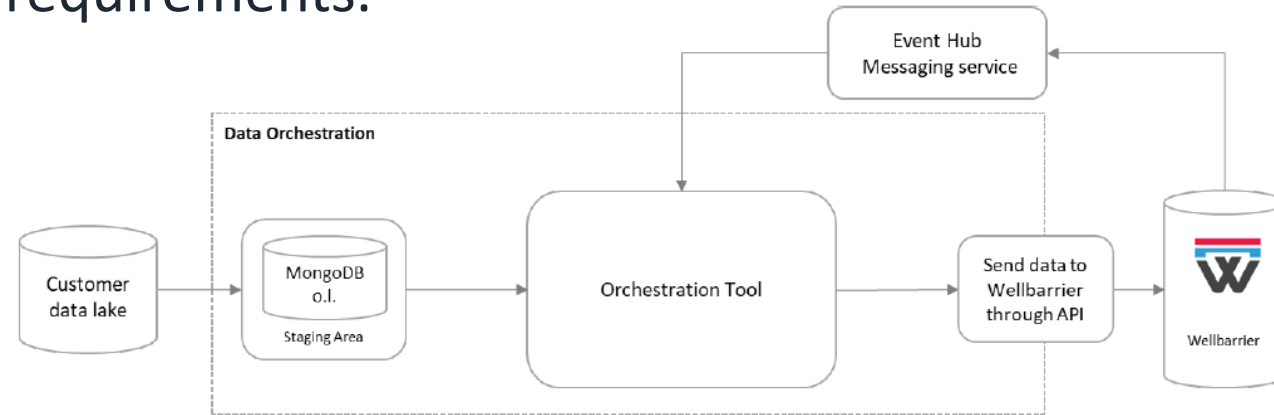


The software incorporates the barrier definitions that embrace the "two-barrier principle" as a core component of establishing well barriers.



## 2. Cloud Based Solution

- Wellbarrier is a cloud-based solution that helps to visualize our wells and the well barrier elements from well integrity perspective, with related to qualifying and monitoring requirements.



- Results are made available through an Application Programming Interface (API), to augment other digital decision analysis solutions within the organization.
- Having a cloud solution also provides easy access across organization.





## 3. Structured Risk Assessment thru FMECA

- Risk assessments are performed using Failure Mode Effect and Criticality Analysis (FMECA) techniques to objectively determine the risk of the well.
- The probability and consequence of each barrier failing is assessed, and risk mitigations are recorded in a structured way.

**RISK ASSESSMENT**

Illustration name: WB.D 4.1-01 rev. 104 - test  
Prepared by: Simon Copping  
Verified by:  
Modified date: 17-Aug-2022  
Status: Current - As Built

Well type: Gas formation storage  
Area of validity: Simon Copping  
Data quality:  
Participants:  
Stake holders:  
Duration of validity:  
Preconditions:

BARRIER ELEMENT	FAILURE MODE	P <sub>i</sub>	CONSEQUENCE	C <sub>i</sub>	R <sub>i</sub>	MITIGATION	E <sub>u</sub>	R <sub>u</sub>	I <sub>u</sub>	R <sub>c</sub>
	Collapse	2	Containment by other technical barrier	1	5	None	0	5	5	5
	Corrosion	2	Containment by other technical barrier	1	5	None	0	5	5	5
	Erosion	1	Containment by other technical barrier	1	5	None	0	5	5	5
Production casing secondary	Burst	1	Weak formation exposed	4	5	Downrate MAASP	2	5	5	5
	Collapse	2	Weak formation exposed	4	5	Downrate MAASP	2	5	5	5
	Corrosion	2	Weak formation exposed	4	5	Downrate MAASP	2	5	5	5
	Leaking thread - non gastight connections	3	None	0	0	None	0	0	0	0
Production casing cement	Gas migration	3	Weak formation exposed	4	12	None	0	12	12	12
	Channeling/microannulus	3	Weak formation exposed	4	12	None	0	12	12	12
	Cracking	2	Weak formation exposed	4	8	None	0	8	8	8
	Thermal degradation	1	Weak formation exposed	4	4	None	0	4	4	4
<b>Normalized risk index</b>							<b>40</b>	<b>56</b>	<b>40</b>	
Well/Probability	Age of tubing	71.9 years	5	None	0	5	0	5	5	5
	Age of well/casing	71.9 years	5	None	0	5	0	5	5	5
	Age of a mas tree	71.9 years	5	None	0	5	0	5	5	5
	Cement integrity confidence	Low	4	None	0	4	0	4	4	4
	Pressure	3000 psi	3	None	0	3	0	3	3	3
	Temperature cycling	50 °C	2	None	0	2	0	2	2	2
<b>Probability effects</b>							<b>24</b>	<b>24</b>	<b>24</b>	
Location/consequence effects	Location	Urban	5	None	0	5	0	5	5	5
	Medium	Gas	5	None	0	5	0	5	5	5
	Open flow potential	High	3	None	0	3	0	3	3	3
<b>Consequence effects</b>							<b>13</b>	<b>13</b>	<b>13</b>	
Annulus/operations effects	A annulus Gas type	Storage Gas	5	None	0	5	0	5	5	5
	B annulus Gas type	No Measurement	1	None	0	1	0	1	1	1
	C annulus Gas type	No Measurement	1	None	0	1	0	1	1	1
<b>Annulus effects</b>							<b>7</b>	<b>7</b>	<b>7</b>	
<b>Normalized with Local Impact Factors (LIF)</b>							<b>54.4</b>	<b>59.4</b>	<b>54.4</b>	

This is notes for the entire risk assessment

Need help? >

# 12 Elements of WIMS

Wellbarrier workflow is closely aligned with the 12-Elements of PETRONAS WIMS



## 4. Enabler to PETRONAS WIMS



2. Well Integrity Management



4. Organisational Structure



6. Well Barrier Elements (WBEs)

8. WBEs Verification

10. Continuous Improvement

12. Reporting & Documentation



1. Well Integrity

3. Well Integrity Policy

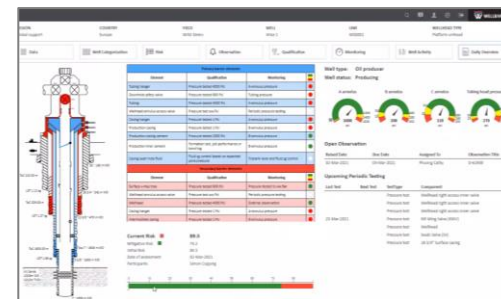
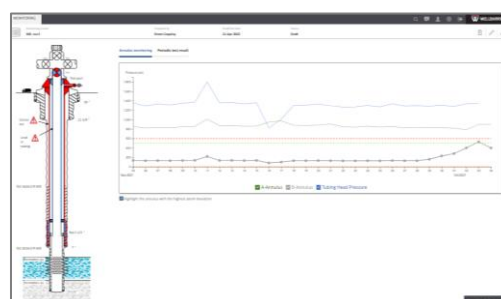
5. Risk Assessment

7. Performance Standard

9. Management of Change

11. Self Assessment, Technical Assurance & Independent Verification

System related supported by Wellbarrier



# RESULT

The solution provides a robust framework to manage well integrity and is closely aligned with the requirements of industry standards.

1.

Single  
Repository  
Platform

3.

Interactive  
Dashboards

5.

Reduce  
manhour in  
well integrity  
processes

2.

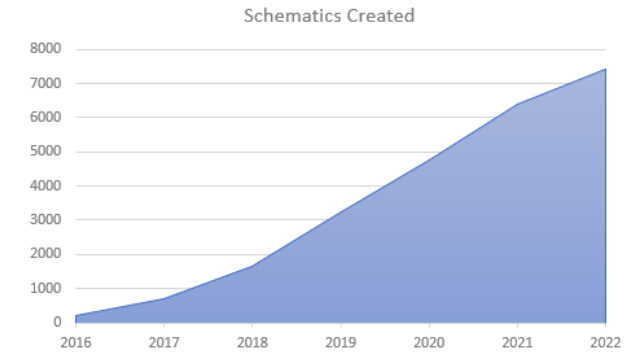
Single Source  
of Truth

4.

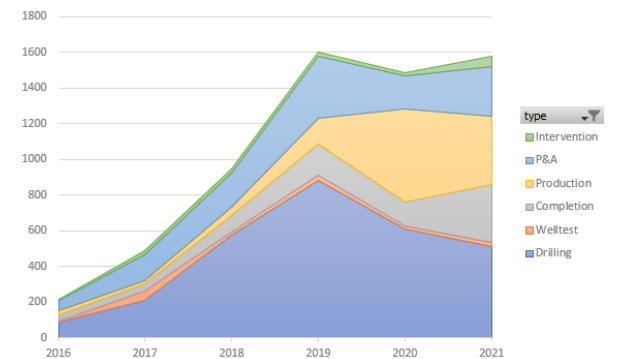
Risk  
Prioritization

6.

Common  
"language" of  
well integrity



7400 schematics = 30,000 hours effort using traditional methods, compared to 2,000 hours using Wellbarrier



Moving from Drilling to entire Lifecycle perspective

# FUTURE POSITIONING



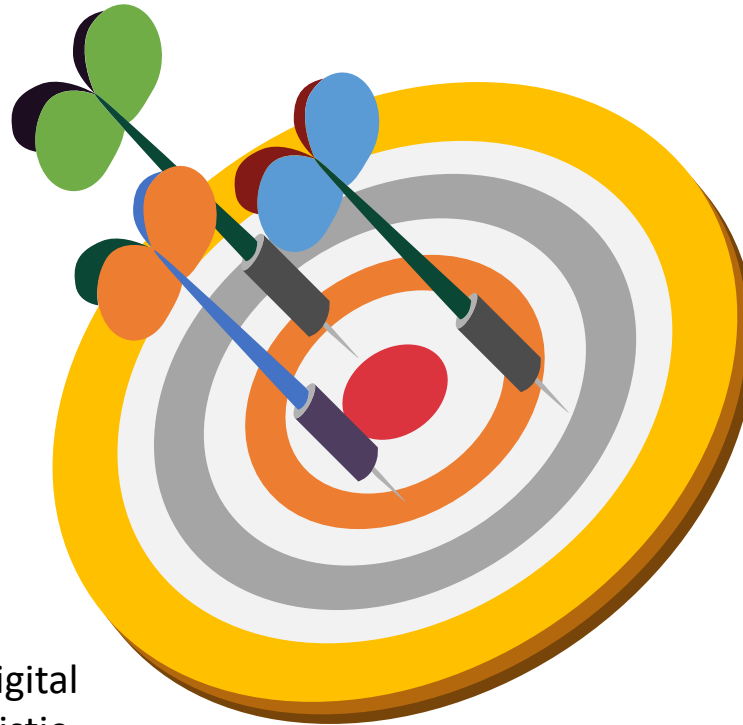
## Culture Change

To collaborate with stakeholders to be on board with digital well integrity journey through Wellbarrier through system integration, constant improvements and trainings.



## Integration

Integration with other digital initiatives to provide holistic solution and address pain point of engineers having to do manual data entry.



## Streamline

Integration with field data coming from Critical Device Function Test (CDFT) results will further streamline the data workflow, and support with condition-based monitoring, production optimization opportunities, data analytics and possible machines learning opportunities.



THANK YOU  
FOR YOUR ATTENTION

---