WHITE PAPER

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Reference Architecture Guided Digital Initiative Assessment in Oil & Gas Sector

Identification and Prioritization of Digital Interventions in the Oil & Gas Industry by Leveraging the Digital Initiative Assessment Model Based on a Value-Chain Embedded Digital Reference Architecture

Abstract

The global oil & gas industry is witnessing extensive transformation like never before – a transition towards a less carbon portfolio, the ever-expanding core value-chain, and the proliferation of digitization in almost every business sector. As such, organizations in this industry are trying to adapt to the changing geopolitical and socio-economic impacts through echnological disruptions and new ways of managing a business.

Owing to the resource-intensive nature of the oil & gas industry, digital adoption has mostly been to address specific business challenges or aspirations and often been ad-hoc without a comprehensive business level planned approach. Hence, a pragmatic framework comprising digital reference architecture, digital levers, and maturity dimensions will provide actionable insights for strategic end-to-end digital transformation.

Background

The oil & gas industry is undergoing a transition, aiming to achieve a NetZero Carbon portfolio in the long run. The COVID-19 pandemic has accelerated this transition as many more oil companies, governments, and regulatory bodies are pledging to embrace this change. Besides, global oil companies are increasing their portfolio share towards LNG, renewable energy (wind, solar, sea-waves), and bio-energy (bio-methane, ethanol-blended fuel). Amid this, oil companies are also adopting a "glocal" (global-yet-local) strategy depending upon the country of operation, per-capita income, and the availability of such alternate low carbon resources. Due to this transition, the core business value-chain of oil & gas companies is expanding

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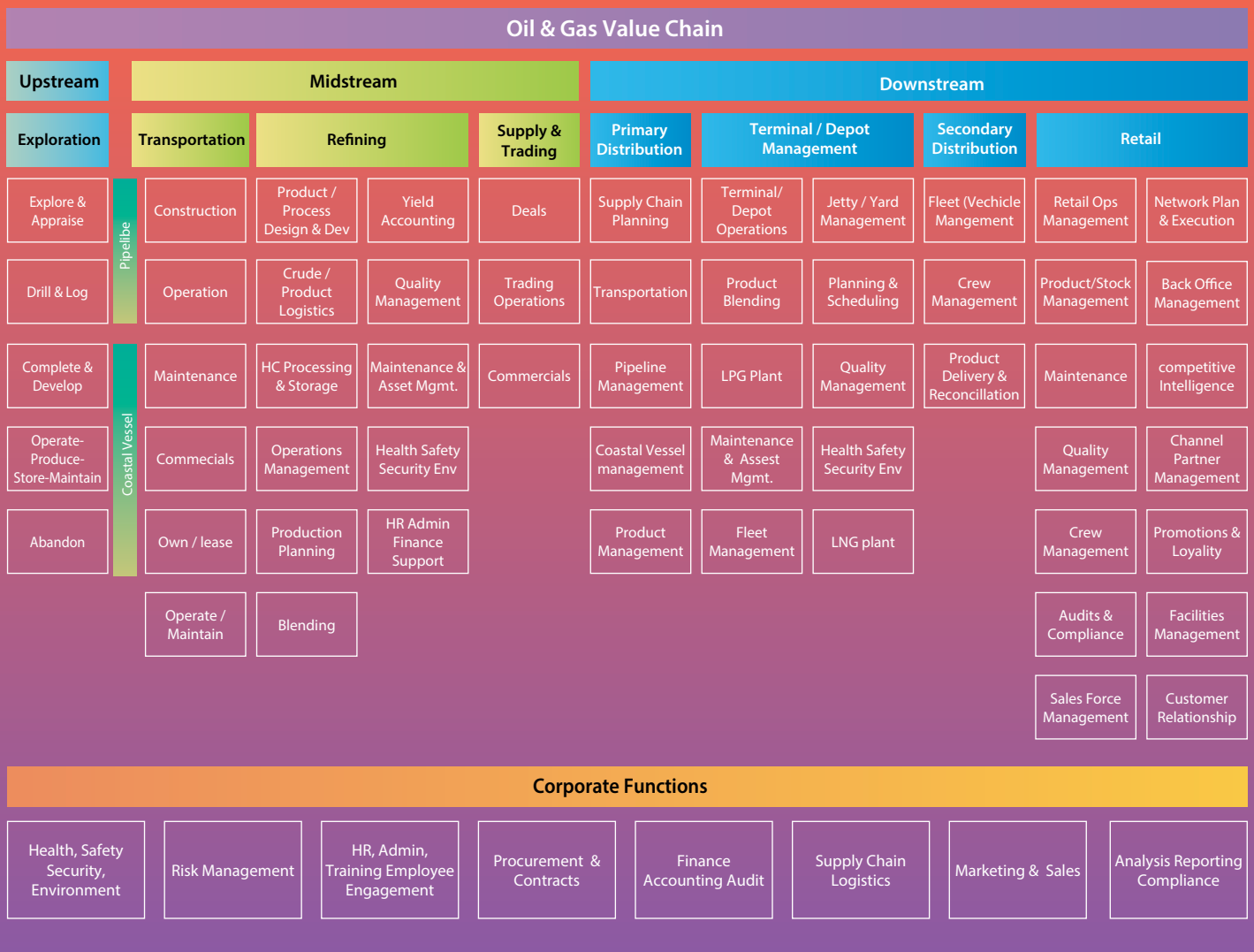
As the Fourth Industrial Revolution has brought about a digital transformation, organizations are moving towards becoming more adaptable, resilient, and purposeful through the innovative adoption of digital technologies.

With expanding business value chains, digital interventions are becoming prime enablers that can immensely benefit oil & gas companies in terms of cost, scale, and reach, providing meaningful insights and key decision-making capabilities.

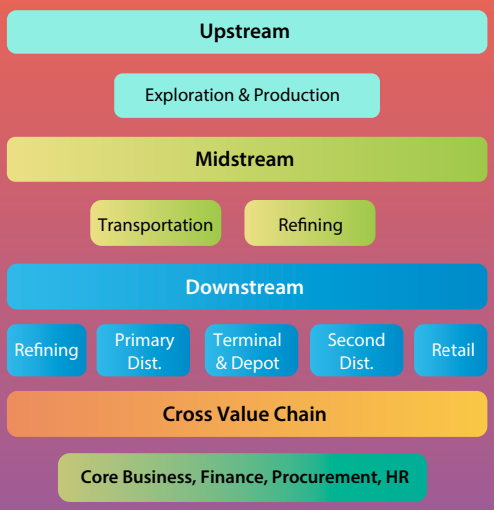
To appreciate the various digital trends in the oil & gas sector, a closer look at the value chain is paramount. The value chain is decomposed into granular processes and sub-processes until the final (lowest level) process list is compiled to explore specific digital possibilities.



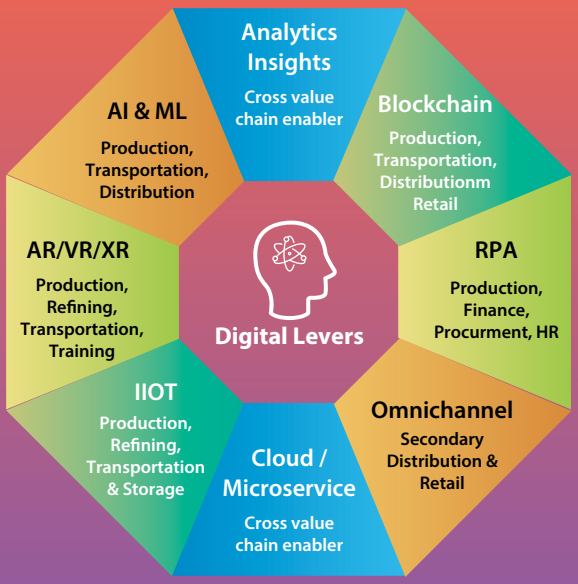
Bussiness Process decomposition across the value-chain

With the evolution of digital technologies, some new tech can be applied across the value chain to build foundational capabilities, while some can be applied to specific segments or more granular areas of the value chain to enhance their capabilities.

The figure below gives a comprehensive view of the most popular digital forces and their footprint across the value chain.



Oil & Gas Value Chain



Proliferation of Digital Levers cross the value-chain

… we realized the need for a value-chain embedded Digital Reference Architecture coupled with Digital Initiative Assessment Model.

A few noteworthy examples of digital use cases include:

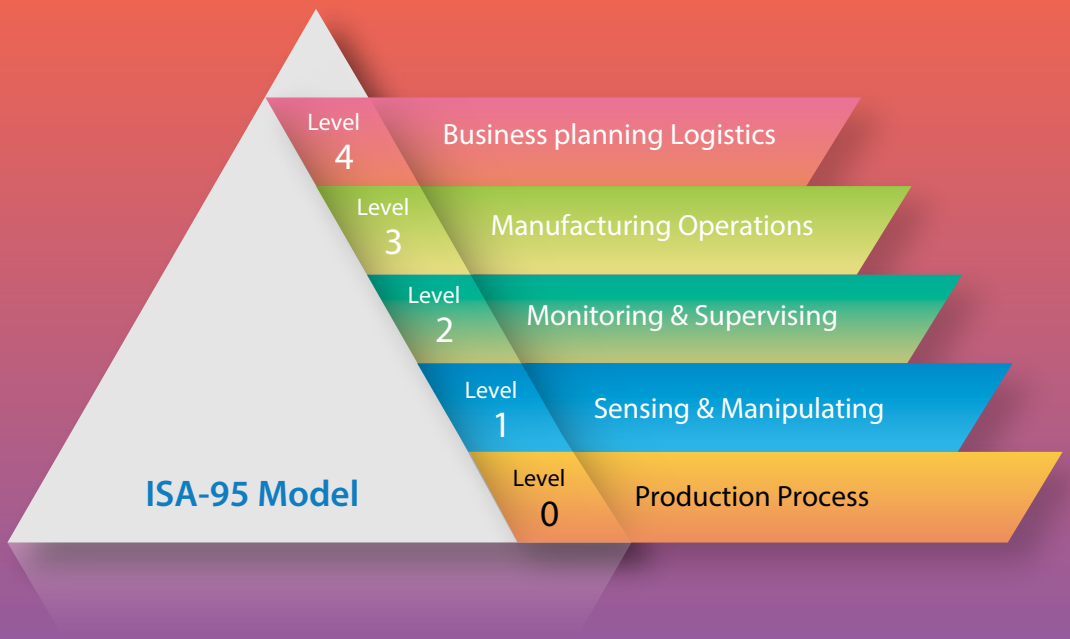
- An "LPG Demand Forecasting and Inventory Prediction System" will use a set of digital interventions in downstream LPG terminals.
- The "asset health prediction" system will use a different set of digital interventions for critical refinery equipment.
- With digital interventions such as AR/VR, the training about "Golden Safety Rules" can be reimagined before sending any new joiner to the work-field.
- A dedicated digital tool can help in Supplier Invoice Reconciliation, the last process undertaken by Finance.

As value-chain processes and digital enablement go together, we realized the need for a value-chain embedded Digital Reference Architecture coupled with Digital Initiative Assessment Model.

This paper charts a Digital Reference Architecture for the oil & gas industry (TCS – DigRefOG) and a Digital Initiative Assessment Model (TCS – DigIniOG) that oil & gas companies can use to determine their current digital state and build a future roadmap encompassing an enterprise-wide digital blueprint.

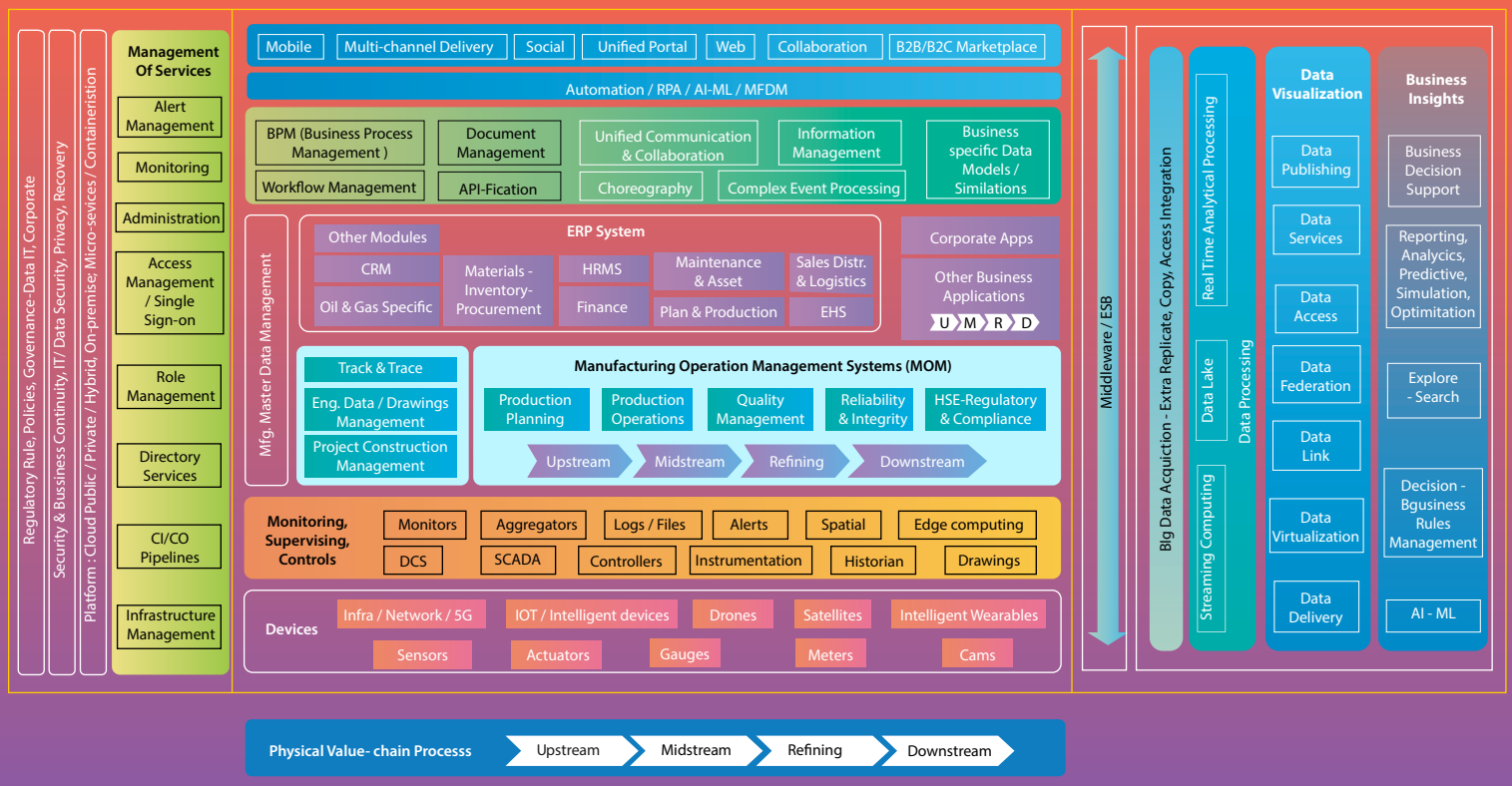
Digital Reference Architecture for Oil & Gas (DigRefOG)

A reference architecture captures and represents various systems and data appropriately. The ISA-95[1] is one such model that is globally accepted since digital interventions can be leveraged at every layer of the ISA-95 model.



[1] *For details on ISA-95 Model, refer to: https://www.isa.org/standards-and-publications/isa-standards/isa-standards-committees/isa95*

We have extended the ISA-95 model to arrive at a value–chain embedded Digital Reference Architecture, as shown below:



Digital Reference Architecture - oil & gas (DigRefOG)

Using such a reference architecture, companies can develop enterprise-wide digital systems.

Key Features of DigRefOG

… This layer can accommodate the extending value-chain of the rapidly transforming oil & gas industry.

Value-chain physical process: The architecture starts with value-chain physical processes and their decomposition. The processes may be decomposed up to six levels of hierarchy. This layer can accommodate the extending value-chain of the rapidly transforming oil & gas industry.

Digital interventions: There are multiple digital interventions – at device, processing & automation, and even the business interaction levels. For example, IOT/Intelligent devices, 5G, smart wearables such as smartwatches, HoloLens, AR/VR/MR/XR gadgets, drones, cams, satellites,

Digital interventions also come into play in the automation layer where AI/ML, Edge Computing, RPA, and other Conversational Experience mechanisms can be leveraged …

MOM systems can be classified as Production Planning, Production Operation, Quality Management, Reliability & Integrity, and HSSE Regulatory & Compliance

and others can be considered at the device level. Relevant monitoring, supervising, and control level instrumentation can be added at the next supervisory control layer.

Digital interventions also come into play in the automation layer where AI/ML, Edge Computing, RPA, and other Conversational Experience mechanisms can be leveraged and value delivered using the TCS Machine-First-Delivery-Model™ (MFDM™)[2] approach.

Value-chain embedded: At the next higher level (Level 3) is the "Manufacturing Operations Management (MOM)" system layer, and according to the value-chain, respective MOM systems can be positioned here. MOM systems can be classified as Production Planning, Production Operation, Quality Management, Reliability & Integrity, and HSSE Regulatory & Compliance. For example, LIMS is a MOM system used in Refinery Product Quality Management.

The next level (Level 4) of applications comprises corporate applications, ERP, and value-chain based business applications. As the business expands, value-chain based applications play a key role in gaining success. However, certain digital intervention levers are more specific to a business value-chain component. For example, while blockchain will be more pertinent in supply & trading, AR/VR will be more useful in providing operational and safety training. Thus, value-chain embedment in a reference architecture couples the right digital interventions in a specific business sub-segment.

Analytics and Insights: Data generated from physical processes, devices, control monitoring systems, and applications are of varied nature (simple text, unstructured [millisecond frequency to once a quarter frequency], and varied modes [real-time, batch process, or complex event-driven]).

Horizontal and vertical integration: There will be horizontal and vertical integration of systems and processes at the same time. Analytics and Insights capture, process, and provide actionable insights on the data generated. The AI-ML powered, business-rule driven insights can provide hitherto unexplored, value-added business use-cases for effective decision making across a business.

Management of Services: It plays a critical role in the administration, monitoring, and role-based authorization to systems, along with infrastructure management.

[2] *For details of TCS- MFDMTM, refer to: https://www.tcs.com/content/dam/tcs-bts/pdf/mfdm/Building-the-Future-ready-Enterprise-with-MFDM_Flyer_111019.pdf*

Platform/Systems/Applications can be cloud-compatible or hosted on the cloud. Today, applications can also be built using micro-services/ containerization and deployed accordingly. Irrespective of deployment, all applications must have the right security, privacy, and governance in-place, complying with country-specific regulations and policies.

Key Benefits of DigRefOG

- **Scalable:** DigRefOG is a value-chain embedded digital reference architecture. It can also be referenced when business scales due to transition towards other energy sources as value-chain is a core component in this architecture.
- **Modular:** With this architecture, systems, services, digital interventions can be expanded as per the growing business size.
- **Founded for Enterprise-Wide Digital Systems Development:** This architecture can act as a reference for developing an enterprise-wide digital landscape.

The Digital Initiative Assessment Model (DigIniOG) can help oil & gas companies baseline their current digital landscape and define their enterprise-wide or business unit-level roadmap. To achieve this, TCS conceptualized the **E⁵ Assessment Framework** to identify and prioritize digital initiatives through the assessment of current readiness, prevalent digital proliferation across industry value-chain, and industry trends.

Digital Initiative Assessment Model (DigIniOG)

The Framework will help assess the digital tools for adoption across a time horizon through prioritization for the organization/business unit.

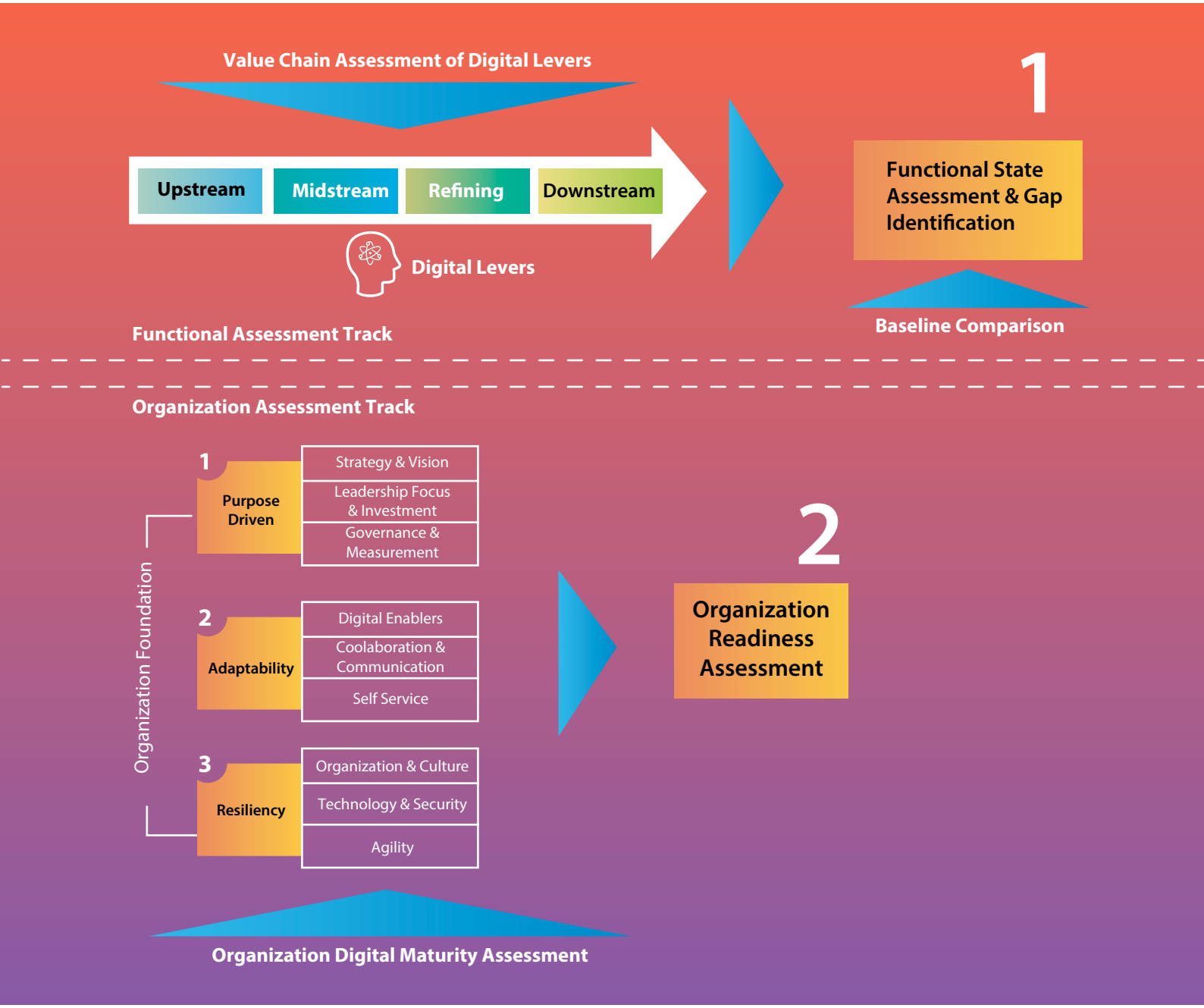
The **E⁵ Assessment Framework** will help assess the digital tools for adoption across a time horizon through prioritization for the organization/business unit. The outcome of the framework will be a list of prioritized initiatives covering five categories, namely **E⁵ – Enrich, Embark, Evaluate, Enlist, and Endure.**

We have to appreciate the fact that as digital initiatives are adopted by the industry's leading organizations and only tangible benefits are observed, not all companies will be in a position to adopt them. Hence, assessing the maturity of the organization is extremely critical to realistically propose the need and sequence of adoption. A core component of the **E⁵ Framework** is the organization's digital adoption maturity that can be inferred from the following three key indicators:

A core component of the E⁵ Framework is the organization's digital adoption maturity …

- **Purpose-Driven:** Is the organization purpose-driven towards its digital journey?
- **Adaptability:** Can the organization adopt digital levers in its ecosystem?
- **Resiliency:** Does the organization have the resiliency to withstand the changes?

The assessment will be carried out in two distinct tracks, which will finally be merged to take the final decision on prioritization.

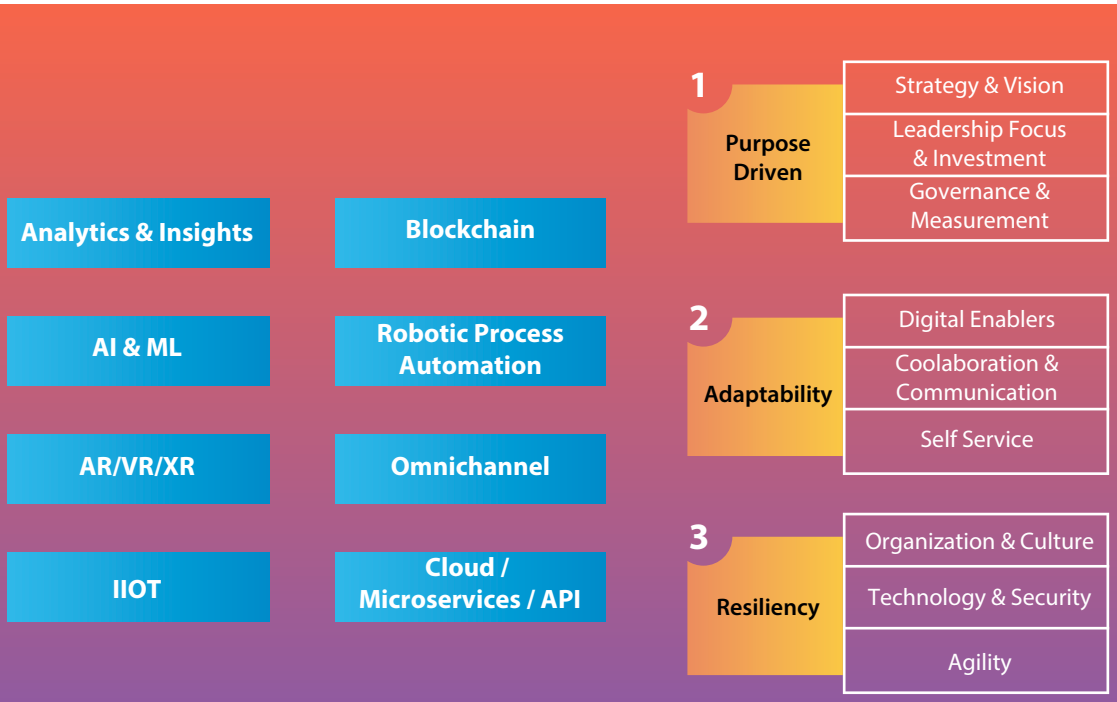


Digital Initiative Assessment Framework

The digital levers are carefully selected, keeping in mind the Industry 4.0 and TCS Business 4.0™ philosophy …

The novelty of the framework is the granularity with which it evaluates the digital footprint across the organization and the traceability of the prioritization decision at the enterprise level. The journey towards this decision is guided by the reference architecture with global trends projected by similar organizations along with technology leaders. The digital levers are carefully selected, keeping in mind the Industry 4.0 and TCS Business 4.0™[3] philosophy as depicted below.

The dimensions to assess the organization's maturity are Purpose Driven, Adaptability, and Resiliency, with sub-dimensions for each as depicted below. The maturity scale in order of lower to higher maturity is termed as – Basic, Siloed, Integrated, and Disruptive..



Digital Levers and Maturity Dimensions

The adoption decision will be categorized as one of the E[5] outcomes according to the analysis of industry trends and possibilities, current footprint, and finally, organization intent and readiness.

After assigning relative importance to each root business function – value-chain L1 & L2 level, each of the relevant business functions at the L3 level will be assessed and scored. This will be carried out for each digital lever, and thus the outcome for each lever across the value-chain will be obtained. The adoption decision will be categorized as one of the **E[5]** outcomes according to the analysis of industry trends and possibilities, current footprint, and finally, organization intent and readiness.

[3] *For details of TCS Business 4.0™, refer to: https://www.business4.tcs.com/foresight*

A view of the decomposed business function and discovery of digital footprint will indicate the strength and rigor of the framework to bridge the digitally driven business possibilities proliferating the industry. The figure below indicates a digital adoption heatmap across the midstream refining area. Heat maps for other processes will be generated to arrive at the desired outcome.

L2 Process Areas | Digital Levers	Analytics & Insights	AI & ML	AR/VR/AR	OT/IOT	Blockchain	RPA	Omnichannel	Cloud / Microservices / API
Refinery Product / Process Design & Development	LOW	LOW	NI	MODERATE	NI	LOW	MODERATE	MODERATE
Crude / Product Logistics	HIGH	HIGH	MODERATE	HIGH	NA	LOW	HIGH	LOW
Hydrocarbon Processing & Storage	HIGH	HIGH	NI	HIGH	NA	LOW	HIGH	LOW
Operations management Control room & Field activities	HIGH	HIGH	NI	HIGH	NA	LOW	MODERATE	LOW
Prodution planning & scheduling	HIGH	HIGH	NA	MODERATE	NA	LOW	HIGH	MODERATE
Blending	MODERATE	MODERATE	NA	MODERATE	NA	LOW	HIGH	MODERATE
Quality management	MODERATE	MODERATE	NA	MODERATE	NA	LOW	HIGH	MODERATE
Yield accounting	HIGH	HIGH	NI	HIGH	NI	LOW	HIGH	HIGH
Maintenance & assest management	HIGH	HIGH	NI	HIGH	NA	LOW	MODERATE	MODERATE

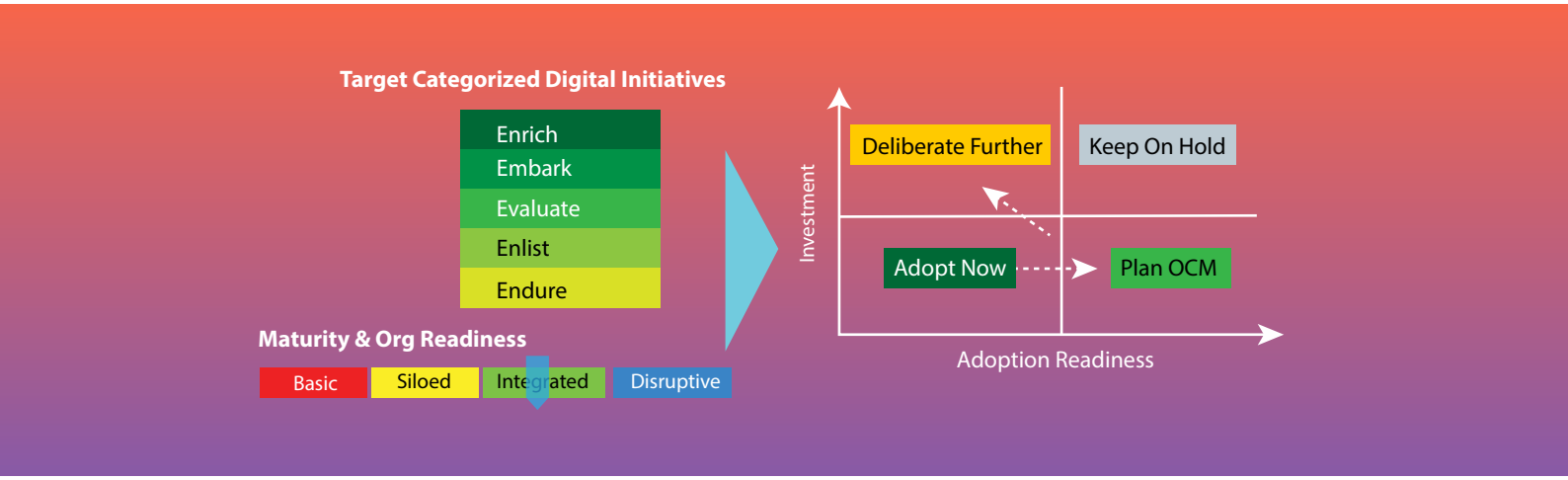
Low = < 2.5, Moderate = 2.5 - 4, High => = 4, NI - Not Initiated, NA - Not Applicable

Digital Adoption Heatmap

> While many of the digital levers may appear to be ready for immediate adoption, the organization's maturity compounded with an appetite for investment will also come into the picture.

Once the comprehensive value-chain based digital adoption is uncovered, the final step is prioritization. While many of the digital levers may appear to be ready for immediate adoption, the organization's maturity compounded with an appetite for investment will also come into the picture.

These factors will guide the analysis to prioritize the initiatives and take a decision on – *Adopt Now, Plan Organization-Wide Socialization and Change Management for near future adoption, Deliberate Further* on investment vis-a-vis benefit, and Keep on Hold in case the benefit is not considerable. The potential applicability of the digital lever shall also be taken into consideration while finalizing the priority.



Digital Lever Adoption Prioritization

Enrich	Leading digital presence and may choose to enrich further
Embark	Adequate presence and time to embark new initiatives
Evaluate	Fair adoption so far and time to evaluate new capability
Enlist	Time to enlist realizable digital initiatives for tangible benefits
Endure	Needs serious thinking on digital journey, endure for now

E*^{5} *Criteria

Basic	Organization is yet to appreciate digital
Siloed	Digital is still a novelty through standalone application
Integrated	Organization wide conscious decisions on digital are visible
Disruptive	Organization is an example in digital adoption to the industry

Organization Digital Maturity

This assessment framework will enable organizations to determine the digital initiative adoption path with a 360-degree view of functional, technical, and organizational maturity.

While CXOs and CIOs are constantly influenced by digitization through industry reports, technology partners, and product vendors, this reference architecture and framework will help them look inwards within their organization and take an external view of the market. Finally, the outcome will be an informed, objective, and conscious decision focused on the digital journey and at the same time cognizant of the appetite and potential for the same.

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Conclusion

… judicious adoption of digital levers will help address critical business challenges - right from operational efficiency to resilience and employee safety.

The oil & gas sector, with its massive investments in upstream projects, pipelines, refineries, plants, logistics, distribution, and retail facilities, needs all the means to withstand the impact of disruptions while operations remain safe and hazard-free. The judicious adoption of digital levers will help address critical business challenges - right from operational efficiency to resilience and employee safety.

However, as businesses get disrupted to reap maximum benefits from digital investments, the most important question is: How fast and effectively can organizations adopt digital levers across the value-chain, embedding digitalization as a core on the new extended/transformed section of the value chain?

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Acknowledgements

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