A DEVELOPMENT ROADMAP FOR THE DIGITALISATION OF MINING, FOCUSING ON THE IMPACT OF SMART WEARABLES ON OHS

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BSc. in Physiology & Psychology (WITS); B. Health Sc (Honours) in Physiology (WTIS); PGDip. in Business Administration (GIBS); Executive MBA (Henley).

Vishaylin has over six years of management consulting experience, contributing to corporate strategy projects across sectors like mining, energy, and innovation. He specialises in integrating human processes with business structures, driven by his academic background.

Vishaylin holds a BSc in Physiology & Psychology and a Bachelor of Health Science (Honours) in Physiology from the University of Witwatersrand, a Post-Graduate Diploma in Business Administration from the Gordon Institute of Business Science, and an Executive MBA from Henley Business School. His expertise is enhanced by studies in strategic thinking and digital transformation from the Gordon Institute and Harvard Medical School.

He has developed transformative digital tools in the South African mining industry, including a leadership competency assessment tool, the ESG Impacts Lens Dashboard, and a digitalisation roadmap for smart wearables in occupational health and safety.

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THE FOCUS OF THE STUDY

OBJECTIVE

The proposed research aims to investigate the current state of smart wearable technology in South African gold and platinum mines, focusing on stakeholder perceptions and the potential for widespread adoption.

This study will serve as the foundation for designing a roadmap to guide the implementation of wearables in the mining industry, addressing key hazards and enhancing safety as the sector continues to modernise.

PURPOSE

Modernisation initiatives like the RTIMS program are set to revolutionise mining, improving not only safety but also operational efficiency and sustainability.

However, concerns over job losses and ethical considerations around data privacy remain significant challenges. By addressing these issues, smart wearables could play a crucial role in creating safer, more efficient mining operations.

OUTPUT

A DX (digital transformation) roadmap associated with the adoption of smart wearables on mine OHS practice and governance for the SAMI and tripartite stakeholders.

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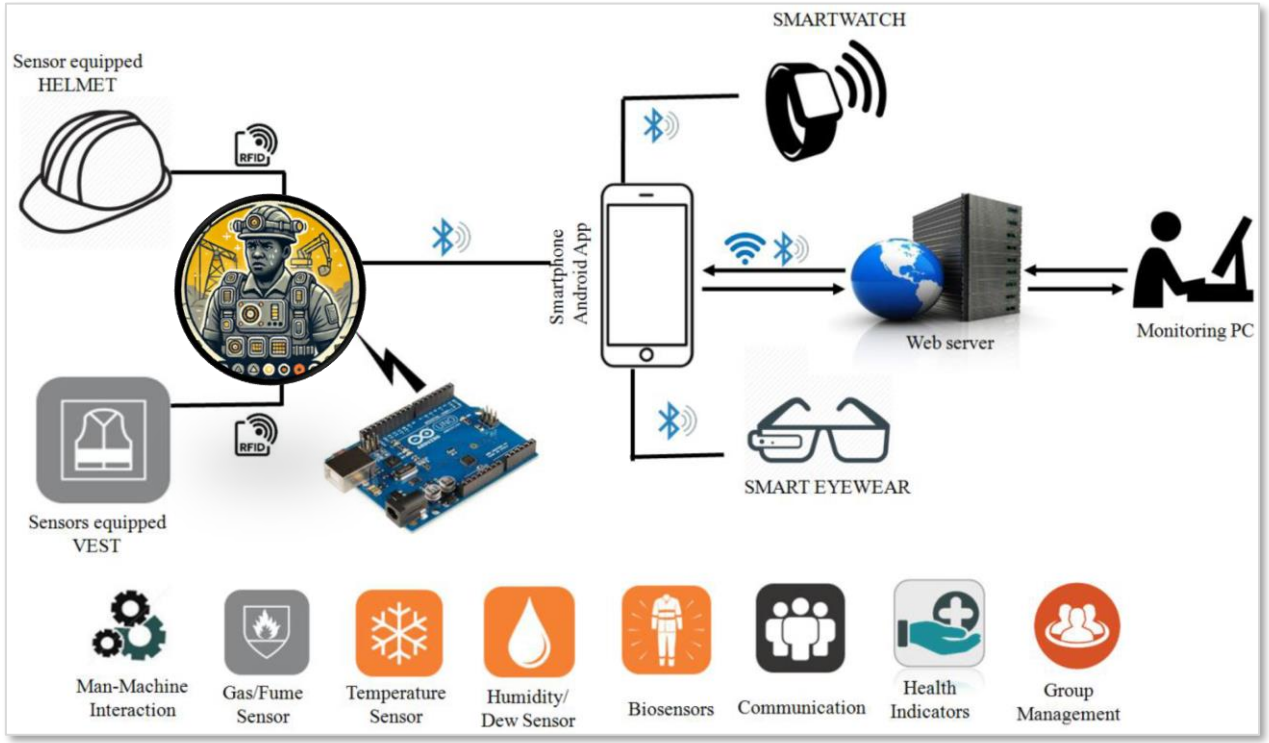
SMART WEARABLES IN MINING

Smart wearable devices (or interchangeably as wearables) are worn by miners to enhance safety and improve productivity. Largely, this is thanks to the Internet of Things (IoT) and smart technology a range of devices include smartwatches, smart glasses, smart helmets, smart clothing, bands, wearable cameras, and RFID tags.

Benefits of Smart Wearables in Mining:

- **Increased Safety:** Monitors worker health and environmental conditions, reducing accident risks.
- **Improved Productivity:** Provides real-time data for optimised resource allocation.
- **Reduced Downtime:** Enables proactive maintenance, minimising equipment downtime.
- **Enhanced Communication:** Facilitates better communication and quicker decision-making.
- **Cost Savings:** Reduces accidents and downtime, leading to significant cost reductions.



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SMART WEARABLES IN MINING

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6 FACTORS IMPACT THE ADOPTION OF MODERN TECHNOLOGY

The following 6 challenges were identified as critical factors when adopting modern technology in the South African mine industry.

SAFETY & RISK

High risk related to the adoption of unproven technology and performance systems focused on volumetric production.

Safety remains a priority through critical measures such as safety protocols, SoPs, training, and OEM guidance.

HUMAN READINESS & BEHAVIOURAL CHANGE

One of the main barriers to implementing new technology is the resistance to change among employees, who are the primary users (due to a lack of change management, adequate stakeholder engagement, and worker inclusion in equipment design, training, and HRLs).

Culture and technology strategy alignment is needed to alleviate resistance to behaviour change.

LACK OF DIGITAL SKILLS

South Africa's low qualification levels make acquiring the digital expertise needed for technology implementation difficult.

The right skills are essential for technology adoption, and the current skill deficit poses a significant challenge.

TECHNOLOGY READINESS LEVELS

The level of new technologies is a significant barrier to adoption in the mining industry due to high risks and low motivation to adopt unproven technologies.

Companies tend to avoid technologies that are not fully tested and integrated into operational processes.

TECHNOLOGICAL ADVANCEMENTS REQUIRE CHANGES IN STRATEGY & LEGISLATION

A technology strategy that aligns with the organisation's culture and values is needed. Strong leadership commitment is needed to drive the technology strategy.

Related legislative and regulatory changes are needed to enable technology adoption and the use of technology safely.

CAPITAL FUNDING

The mining industry faces a lack of capital funding as a crucial barrier to implementation, which often requires significant investment.

Non-competitive pricing and local OEMs' capability to meet mines' needs may deter investment into technology.

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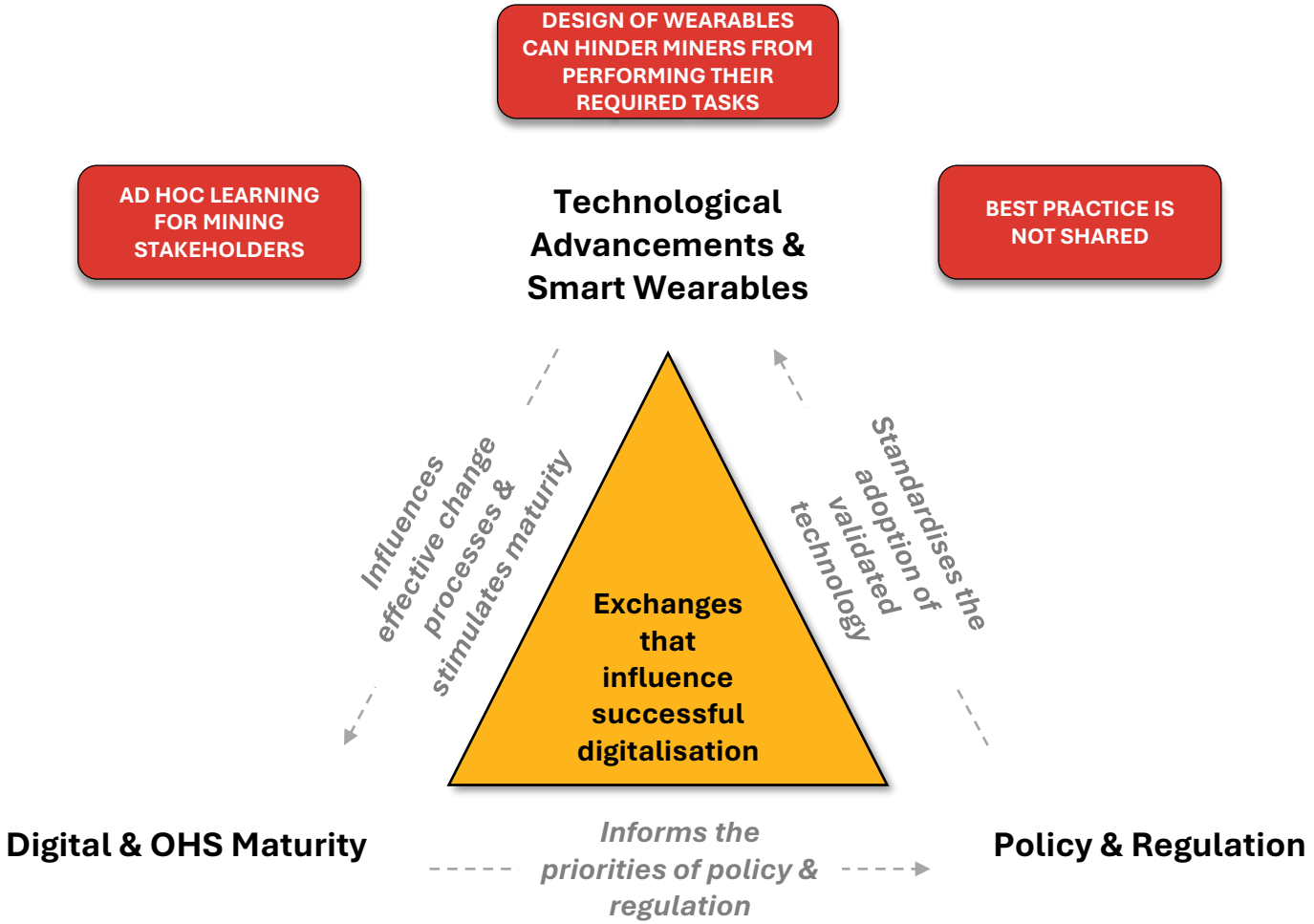
CHALLENGES IMPACTING THE ADOPTION OF SMART WEARABLES IN MINING

The adoption of advanced wearables will facilitate a data-driven digital ecosystem, enhancing productivity and occupational health and safety while reducing human exposure to hazardous conditions.

Furthermore, this refers to improvements to the reliability, accuracy, ergonomics, and user-inclusivity of smart wearable technologies.



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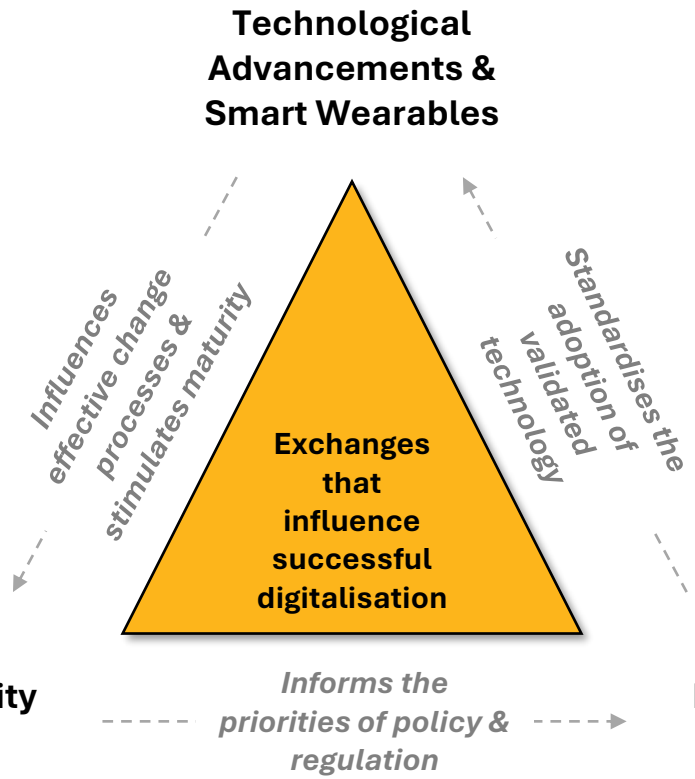
CHALLENGES IMPACTING THE ADOPTION OF SMART WEARABLES IN MINING



- A TRUST DEFICIT BETWEEN MANAGEMENT & OPS
- DIGITAL INFRASTRUCTURE & INTEROPERABILITY
- COMPREHENSIVE DIGITAL TRANSFORMATION STRATEGY WITH DEFINED OBJECTIVES
- INCLUSIVITY IN MINING
- DATA SECURITY RISKS

The integration of smart wearables depends on the digital readiness of mining operations, including connectivity infrastructure, workforce digital skills, ethical and privacy maturity, and automation adoption.

Increasing real-time monitoring, predictive analytics, and AI-driven safety interventions will enhance OHS and operational efficiency as mines transition from traditional to modern.

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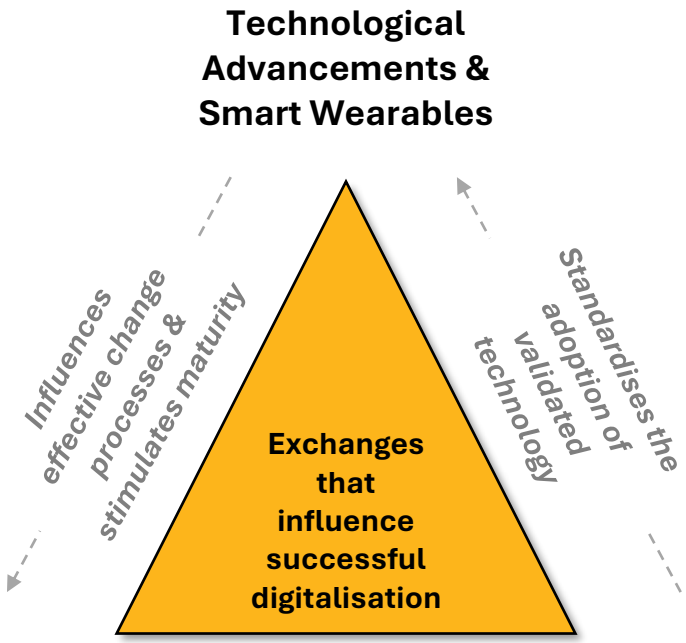
CHALLENGES IMPACTING THE ADOPTION OF SMART WEARABLES IN MINING

Establishing clear regulatory frameworks and compliance standards is essential to guide the responsible adoption of smart wearables, ensuring data privacy, ethical surveillance, and workforce protection while aligning with OHS regulations and digital transformation policies in the mining sector.



- REGULATORY LAG
- ETHICAL CONSIDERATIONS
- STANDARDS FOR HEALTH RISKS FROM EMFS
- STRUCTURED COLLABORATION ACROSS KEY STAKEHOLDERS

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THIS IS WHAT WE DISCOVERED THROUGH STAKEHOLDER ENGAGEMENT AND RESEARCH

These discoveries were considered when developing the digitalisation roadmap.

01

ONE-WAY DEPENDENCY

Micro-level innovations at the operational level drive macro-level policy and regulatory change, not the other way around.

02

SMART WEARABLE ADOPTION BEGINS AT THE MINE LEVEL

Technology adoption in operations spurs policy re-alignment. These bottom-up innovations have the potential to catalyse broader industry transformation.

03

OHS POLICY AND REGULATION CAN EITHER ACCELERATE OR HINDER TECHNOLOGY ADOPTION

Digital and OHS maturity directly influence the development of policy, which in turn must evolve to standardise and validate technologies across the sector.

04

THERE IS A LACK OF COORDINATED SECTOR-WIDE ACTION.

Technology adoption and innovation is occurring throughout. But best practice and holistic learnings are not shared.

05

BRIDGING THE GAP REQUIRES PROACTION

Proactive regulatory and industry processes that support, not restrict, the uptake of validated smart technologies.

06

MORE ALIGNMENT IS NEEDED

There is a need for alignment to between operational practices and policy frameworks to scale the adoption of smart wearables across South Africa's mining industry.

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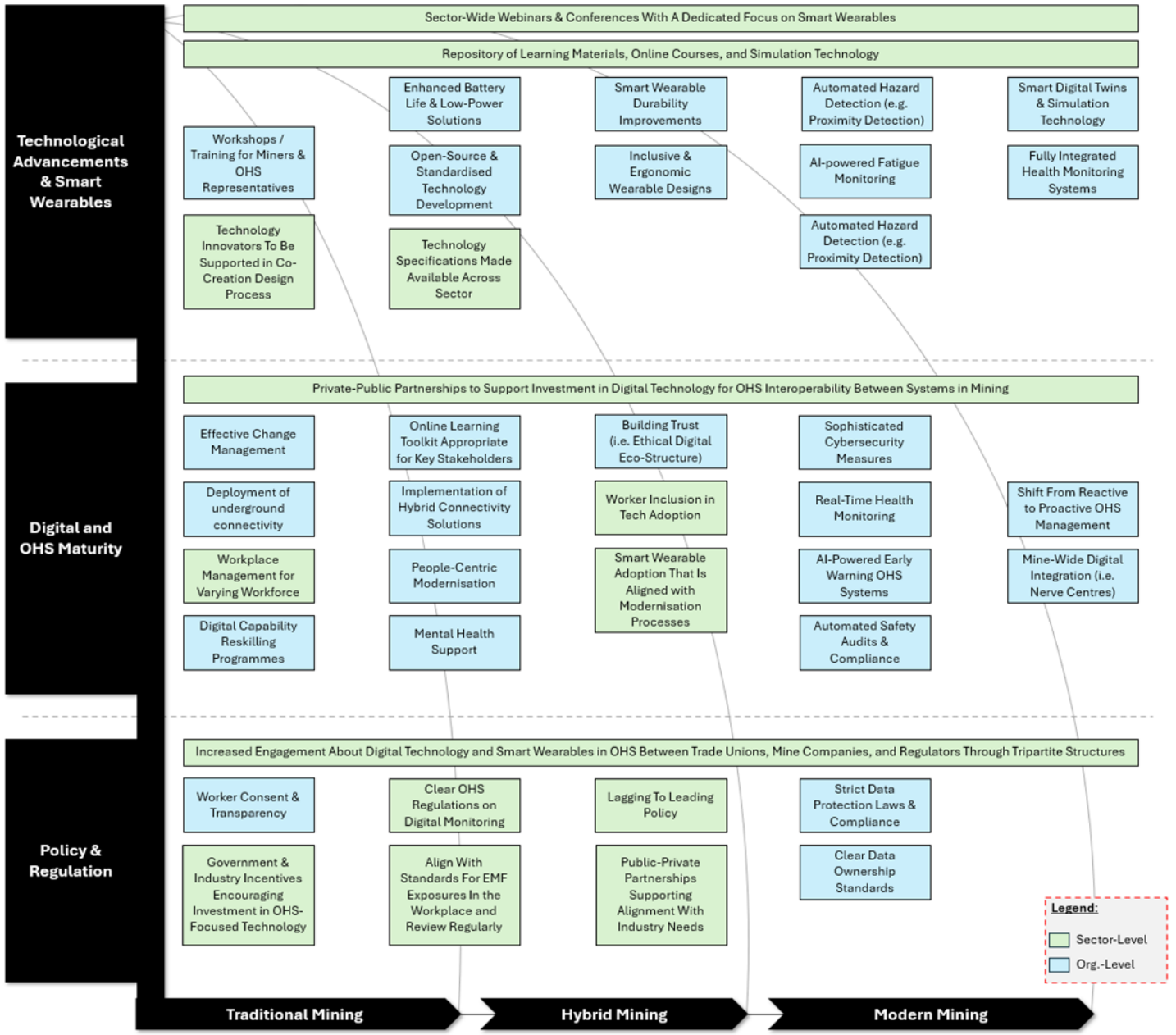
DX ROADMAP

The digital transformation roadmap outlines a structured progression for integrating smart wearables for OHS impacts in South Africa's gold and platinum mining sector.

Core Properties:

- **Represents a transition from traditional mining to hybrid mining and ultimately to modern mining.**
- **Focuses on three key pillars:** Technological Advancements and Smart Wearables, Digital and OHS Maturity, and Policy and Regulation.
- **The roadmap also differentiates between sector-wide initiatives that drive industry collaboration and organisation-level actions that individual mines could adopt.**



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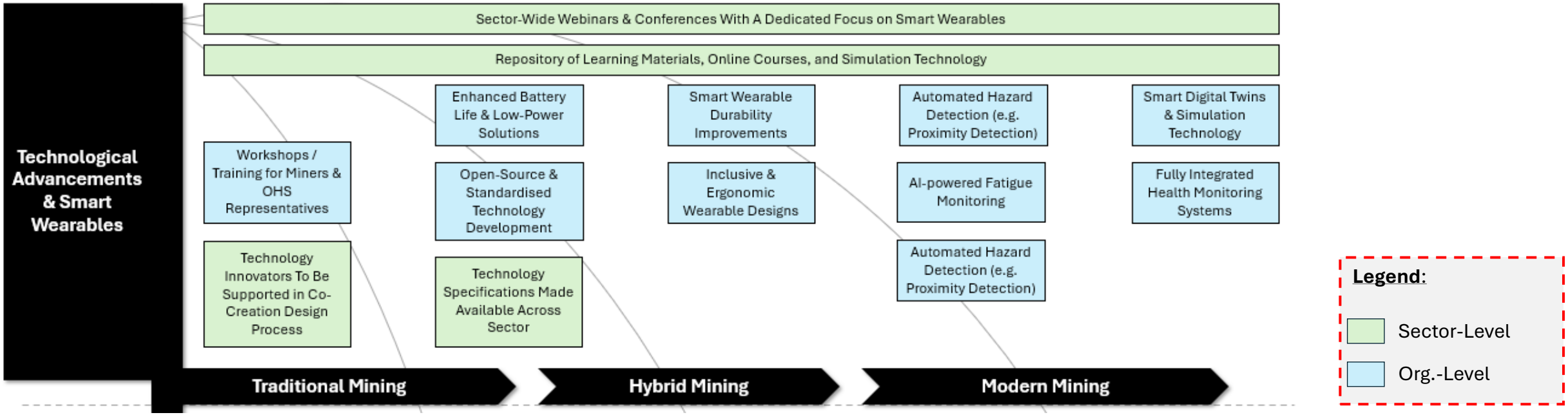
DX ROADMAP: TECHNOLOGY ADVANCEMENTS AND SMART WEARABLES



Traditional Mining

- Expand the use of smart wearables and real-time safety monitoring.
- Focus on training OHS reps and miners, and collaboration with tech developers.
- Develop open-source standards for wearable safety tech in mining.

Hybrid Mining

- Introduction of automated hazard detection (e.g., proximity sensors) and AI-based fatigue monitoring.
- Improved wearable durability, battery life, and ergonomic, gender-inclusive design.
- Emphasis on practical usability in harsh mining environments.

Modern Mining

- Deployment of smart digital twins and fully integrated health monitoring systems.
- Real-time hazard detection and predictive analytics drive proactive safety interventions.
- Wearables and AI become core to OHS strategy and operations.

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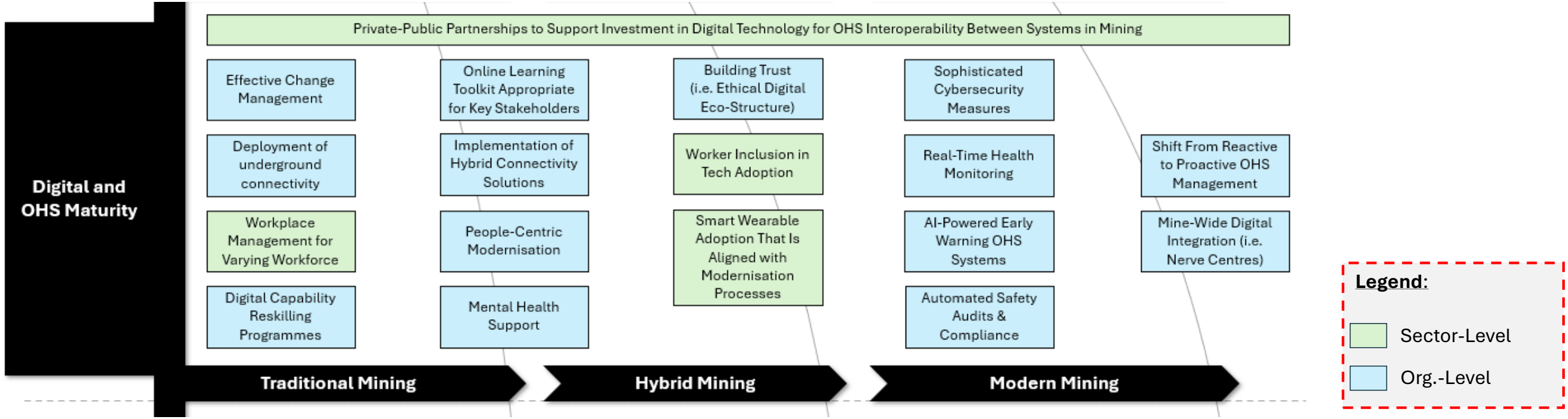
DX ROADMAP: DIGITAL AND OHS MATURITY



Traditional Mining

- *Challenges:* Poor underground connectivity, low digital skills, and resistance to tech adoption.
- *Focus areas:* Deploying underground connectivity; Reskilling and workforce management for diverse employment models.

Hybrid Mining

- Emphasis on worker inclusion in tech adoption and well-being.
- Introduction of hybrid connectivity tools (RFID, LiDAR) for real-time data flow.
- Mental health support systems introduced to address monitoring-related stress.

Modern Mining

- Deployment of AI-driven early warning systems, automated audits, and cybersecurity protocols.
- Shift to proactive safety management using predictive analytics.
- Establishment of Nerve Centres for mine-wide coordination of safety systems.

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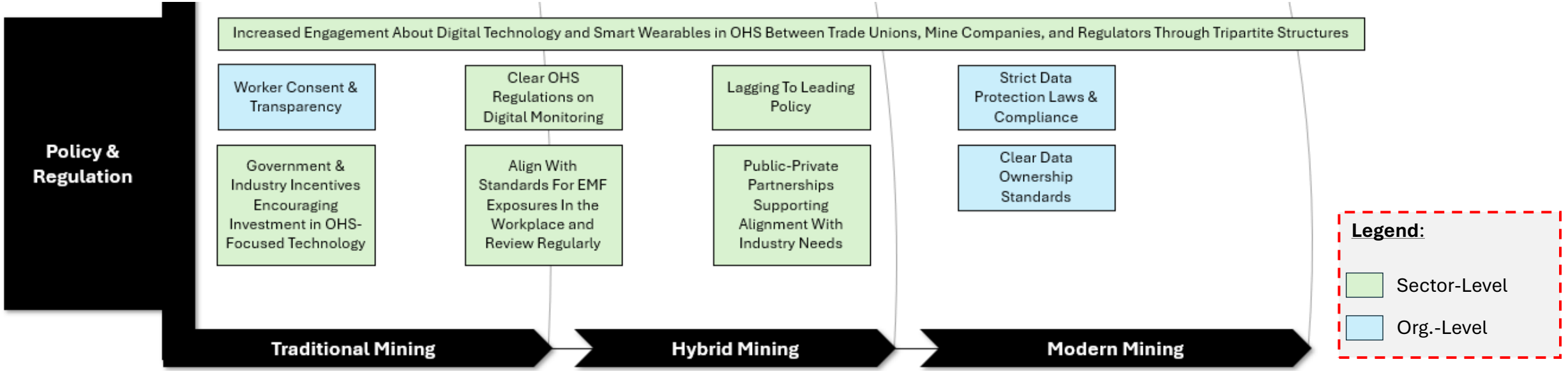
DX ROADMAP: POLICY AND REGULATION



Traditional Mining

- Need for greater worker consent and transparency in digital monitoring.
- Government and industry incentives crucial to drive investment in smart OHS technology.
- Absence of defined EMF safety standards for wearable tech presents risks to worker health.

Hybrid Mining

- Public-Private Partnerships drive regulatory evolution.
- Shift from reactive to proactive, supportive policy frameworks for digital OHS.
- Introduction of clear regulations for digital monitoring and worker data usage.

Modern Mining

- Strong regulation ensures compliance with data protection laws (e.g. POPIA).
- Establishes ethical AI use, standardised data ownership, and safeguards for biometric data.
- Regulatory alignment enables safe, ethical, and inclusive digital transformation.

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RECOMMENDATIONS

01

ESTABLISH AN INTEREST GROUP/HUB FOR DIGITAL INNOVATION IN OHS BETWEEN THE MMP, THE MINE HEALTH AND SAFETY COUNCIL AND THE MINING QUALIFICATIONS AUTHORITY.

The interest group/hub will disseminate best practices through dedicated sessions, identify and scope a research agenda, fast-track policy development, and align OHS digital policy with the modernisation agenda across the mine sector.

02

PREPARATION OF AN ONLINE TOOLKIT/LEARNING PACKAGE AVAILABLE TO ALL MINING STAKEHOLDERS.

Comprehensive and inclusive communication about the advances, potential, risks, and ethical concerns about using real-time data in smart wearables.

03

SUPPORT CO-CREATION AND COLLABORATION.

MMP/industry to support co-creation pilots for the design and adoption of smart wearables, focusing on collaboration with end-users (miners) in each stage of the design and adoption process.

04

CONTINUOUSLY REVIEW RELEVANCE OF POLICY AND REGULATIONS.

The Mine Health and Safety Council in collaboration with the Mine Health and Safety Inspectorate to regularly review, update and disseminate standards for EMF exposure in the mine workplace.

05

ENHANCE INTEROPERABILITY THROUGH STRATEGIC PARTNERSHIPS.

The industry should explore public-private partnerships and tax concessions with government partners to support the adoption of smart technology in OHS and digital interoperability between systems across the gold and platinum sectors.

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