How Should South Africa Redesign Education, Industrial Policy, and Fiscal Incentives to Harness Artificial Intelligence (AI) for Productivity Growth While Limiting Labour Market Disruptions?

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I. Introduction

AI can reshape occupational tasks, although exposure does not establish actual employment effects (Gmyrek et al., 2025, p.1). Technological adoption is also not synonymous with economic transformation. Evidence from Spanish SMEs associates IT-enabled organisational change with digital skills, formal digital strategies and external collaboration (Romero, 2025, sections 4–5). The policy challenge is therefore not simply to increase AI use, but to convert it into sustained productivity and broadly shared gains.

For South Africa, persistent unemployment, inequality and unequal digital access make that distinction especially important (Ngqula and Khoza, 2026). Domestic firms may build useful AI services, supply infrastructure or improve existing production using imported technologies. None of these routes automatically creates inclusive employment, but neither does productive adoption require local ownership of every technology. AI may alleviate information and production constraints while leaving unreliable electricity, unequal education and weak institutions unresolved. Policy must distinguish these longstanding weaknesses from problems AI intensifies or newly creates.

This essay proposes a competitive, selective and coordinated strategy: strengthen foundational and applied skills, improve access to governed data and infrastructure, and finance additional learning and innovation where wider benefits justify support. Sections II–III establish the framework and assess South African opportunities; Sections IV–VI develop education, industrial and fiscal responses; Sections VII–VIII address workers and implementation. The test is whether intervention removes a demonstrated constraint more effectively than alternatives, at a defensible public cost.

II. A Framework for Value Capture in the AI Economy

AI depends on interconnected activities with different capital, skills and infrastructure requirements. This essay distinguishes raw materials, semiconductor equipment and fabrication, processor design, data centres/cloud, model engineering and applications. This six-component synthesis draws on supply-chain analysis rather than reproducing the BIS taxonomy (Gambacorta and Shreeti, 2025, pp.2–6). It maps dependencies, not profitability rankings.

Specialised suppliers can create bottlenecks and switching costs. NVIDIA designs processors and associated software; foundries such as TSMC manufacture chips. Hardware concentration and software ecosystems can constrain choice and access (Gambacorta and Shreeti, 2025, pp.2–6). Strategic autonomy therefore means managing dependencies and retaining capabilities, not manufacturing every component domestically.

2.1. Interlocking AI and Data Value Chains

Data intersect this supply chain but follow a broader lifecycle: generation and lawful collection, curation/annotation, management, governed access and reuse, analysis and application. They support non-AI activities as well as model training, evaluation and deployment; feedback makes the lifecycle iterative. Hosting data does not by itself confer unrestricted rights to use it or guarantee commercial returns (Jooste, 2022, section “Myth 1”).

AI may improve prediction or process control without resolving power shortages, exclusion or weak accountability. David's (1990, pp.357–359) electrification analysis highlights the role of complementary organisational and technical change. A South African public-sector review similarly recommends investing in skills, digital infrastructure and connectivity alongside ethical governance when adopting emerging digital technologies, including AI (Baloyi et al., 2026, section “Managerial implications and recommendations”).

2.2. Domestic Gains and the Case for Intervention

Domestic gains include supplier earnings, worker incomes, local knowledge and productivity improvements in adopting industries; domestic IP is one route, not the sole objective. Four tests assess an activity's commercial credibility and developmental contribution:

- **Capability:** Can the activity be performed or realistically developed?
- **Competitive cost:** Are production and operating costs viable?
- **Demand:** Are there sufficient paying customers or justified public-service needs?
- **Domestic linkages:** Will participation develop firms, workers, knowledge and suppliers?

Capability, cost and demand establish commercial credibility; domestic linkages assess the contribution to the wider economy. These tests do not establish a case for subsidy. A separate diagnosis asks which market or institutional failure prevents beneficial activity and why public action outperforms private provision or simpler reform. Innovation policy distinguishes market failures from wider systemic problems in interactions and institutions (Bleda and del Río, 2013, section 1). Candidate failures include knowledge spillovers, coordination problems, information asymmetry and exclusion; their presence must be demonstrated in the selected application.

Every proposal must specify beneficiaries and cost-bearers, mechanism, delivery, funding, safeguards and review criteria. Supplier earnings, productivity and employment remain distinct outcomes. The following assessment uses these distinctions to select priorities rather than pursue every technically possible activity.

III. South Africa's Strategic Position in the AI and Data Value Chains

South Africa’s plausible entry points include enabling infrastructure, sector-specific data/AI services and adjacent materials processing. Section II’s tests favour building on industry knowledge and applied capabilities. The cases below indicate potential, not established demand or grounds for subsidy.

3.1. Physical capabilities, compute and infrastructure coordination

Manganese Metal Company reports commissioning a 6,000-tonne annual-capacity manganese sulphate plant in Mbombela, with qualification production expected in the second half of 2026 (Manganese Metal Company, no date). This demonstrates upgrading from existing processing expertise. Its battery-materials market connects only indirectly to AI infrastructure: support requires evidence of competitive costs, customer demand and domestic supplier learning, not presumed AI demand.

Compute is a more direct opportunity. International Data Corporation (IDC, 2025) projects global AI infrastructure spending of US$758 billion by 2029, indicating the scale of anticipated demand—not guaranteed returns. Locally, Mawson (2026), reporting on DBSA's study, identifies forecast installed data-centre IT load capacity rising from 435 MW in 2024 to 829 MW by 2029. IT capacity is not total facility electricity consumption or guaranteed utilisation. Power planning and resilient supply therefore remain important conditions for expansion. A published market-report summary identifies grid instability as a driver of investment in backup generation and battery storage (Expert Market Research, 2026).

The policy question is how infrastructure expansion can give domestic users reliable, competitively priced services, rather than whether South Africa should match global spending. Domestic benefits should be assessed through local supplier participation, skills transfer and usable access—not ownership alone. Quinot and Swart (2026, pp.37, 82) identify procurement barriers to local participation and recommend partner channels and skills-transfer commitments. South Africa should assess advanced semiconductor fabrication against importing specialised hardware, comparing capital expenditure, electricity reliability, water and other input requirements, supplier dependencies and specialised skills. Domestic fabrication should not be prioritised without a credible cost, capability and demand case. Imported hardware may support productive domestic applications without replicating fabrication capacity; public support should remain conditional on additional learning or shared benefits, rather than subsidise routine purchases.

3.2. Sectoral data, applied AI and commercialisation constraints

DataProphet uses industrial data and machine learning for process optimisation and reports reduced scrap/defects and international platform deployment (DataProphet, no date). Khula! connects farmers with inputs, markets and finance and offers smart recommendations and AI-enabled partner tools (Khula!, no date). Together, they demonstrate an existing base of firms combining industry knowledge and data-driven services—not an ecosystem that must be invented from nothing.

These cases offer a closer connection between existing sector knowledge and useful products than an undifferentiated push into every AI layer. Their scalability still depends on data-engineering skills, lawful access, compute costs and paying customers. For industrial applications, developer income and manufacturers' productivity are different potential gains; for agricultural platforms, useful and affordable services to farmers matter alongside the platform's growth. Company examples do not establish sector-wide employment or productivity effects.

Policy should test sector-specific applications and their enabling constraints. In South Africa’s financial sector, 53% of surveyed AI users reported insufficient talent or access to skills, and 39% insufficient data access (Hlophe and Mabetha, 2025, p.35). The industrial pilot must establish whether comparable constraints affect its users. Sections IV–VI develop linked skills, shared-access and financing responses. Materials processing remains conditional on its own market case.

IV. Pillar 1 — Education: Building AI and Data Capabilities

Education should build capabilities firms can productively employ, not qualifications without demand. PIRLS 2021 found that 81% of South African Grade 4 learners did not reach the Low International Benchmark in reading (Department of Basic Education, 2023, p.31). IITPSA survey respondents reported AI/machine-learning and data-science shortages (Africa Analysis, 2024, p.35). Most workers, however, need complementary rather than specialist AI skills (Green, 2024, p.3). The ILO's exposure analysis suggests transformation, not wholesale job replacement, as the more likely outcome (Gmyrek et al., 2025, p.1).

4.1. Diagnosing Foundational and Workforce Skills Gaps

Policy must distinguish three priorities: repairing foundational learning, upgrading existing workers' capabilities and developing specialist skills linked to credible domestic opportunities. Respondents to the IITPSA survey identified basic-level education and training weaknesses (26%), skilled migration (24%), insufficient graduates (24%) and technological change (21%) as shortage drivers (Africa Analysis, 2024, p.33). These perceptions—not causal estimates—caution against attributing longstanding problems to AI.

The response should differentiate foundational reform from near-term upgrading. Existing curricula and workplace learning could develop practical data literacy, verification of AI outputs and industry-specific judgement. Employer-led short modules should address real tasks rather than generic software certificates. Public support should target evidenced financing, information or coordination barriers that exclude disadvantaged learners and SMEs or underprovide transferable skills. Stronger ordinary schooling remains essential; specialist courses cannot substitute for it.

4.2. Employer-Linked Pathways Through Shared Learning Clusters

Ken Research's (2026) mining-market overview identifies limited availability of combined mining, automation and AI expertise, and a need to reskill operator, technician and control-room roles. A proposed pathway could combine data engineering and model evaluation with mining or manufacturing expertise, with employer assessments confirming task-level demand and access barriers before public co-financing.

Selected universities and technical and vocational education and training (TVET) colleges could open existing laboratories to students, workers and entrepreneurs through scheduled learning clusters. Assess supervision, laboratory capacity, connectivity, compute and accessible schedules before investment; extended access must not compromise teaching or displace existing learners.

Universities and TVET colleges should review qualifications, enrolment, graduate outcomes and employer demand to identify opportunities for curriculum redesign or resource redeployment. Consolidating provision should protect current students and meet accreditation and capacity requirements. New facilities should follow only where adaptation cannot meet verified demand cost-effectively.

The Department of Higher Education and Training (DHET) and relevant Sector Education and Training Authorities (SETAs), including merSETA and the Mining Qualifications Authority (MQA), could coordinate employer partnerships. SETAs' grant-allocation and workplace-learning functions include allocating grants and identifying workplaces for practical experience (Skills Development Act 97 of 1998, s.10(1)(b)–(c)). merSETA's grant policy provides routes for eligible higher-education and TVET institutions and strategic partnerships, subject to priorities, funding processes and approval (merSETA, 2026, sections 10–11). Before launch, partnerships must demonstrate host capacity, eligibility under the applicable funding window and approved resources. Industry partners would contribute production problems, governed datasets, supervision and placements linked to Section V's pilot. Training should develop lawful data handling, evaluation and organisational change—not software proficiency alone.

The pilot should require costed co-investment agreements: eligible grants could support curriculum delivery and educator development, while employers contribute supervised workplace access, authorised data and computing resources. Employers should finance proprietary benefits; public support should target additional transferable skills and inclusion. Section VI's costing must cover instructors, connectivity, compute and learner access. Compare cluster delivery with employer-led training, curriculum reform and suitable remote provision before expansion.

Evaluate independently assessed competence, workplace use, placements, retention and earnings against baselines and credible comparators. Assess cost per competent participant and equitable participation, not enrolment alone. Expand only where additional skills and productive applications justify costs relative to alternatives; otherwise redesign or stop. Section VII addresses workers whose adjustment needs extend beyond these specialist pathways.

V. Pillar 2 — Industrial Policy: Linking Infrastructure, Data and Domestic Firms

Skills alone cannot commercialise the opportunities identified in Section III. Firms also need reliable inputs, governed data and customers willing to test and purchase useful applications.

Industrial policy should connect these complementary investments, building on Section IV's pathways. Hausmann and Rodrik (2003, p.603) explain why discovering viable activities can generate benefits that pioneering firms cannot fully capture; this provides a rationale to investigate, not automatic justification for support.

5.1. Testing Infrastructure Coordination and Shared Access

Existing provision should be assessed before creating new facilities. The CSIR already offers industry access to specialised facilities, expertise and prototyping support (Council for Scientific and Industrial Research, no date). The proposed pilot should establish whether these services, commercial cloud providers or bilateral research partnerships can meet participating firms' needs. Public support should proceed only where documented demand, access barriers and comparative costs demonstrate an unmet coordination or shared-capability need. High costs or dominant suppliers alone do not establish market failure.

IDC's global forecast establishes investment scale, not a South African market failure or a case for public ownership (IDC, 2025). Grid coordination, negotiated cloud contracts, aggregated procurement or existing research facilities may outperform a new public GPU facility. Compare lifecycle costs, utilisation, security, service quality and obsolescence. Reliable electricity and connectivity may warrant priority; managed access to international technology can complement domestic capability.

For the sectoral pilot below, aggregate participating firms' requirements and purchase existing compute/testing services first. A dedicated shared facility should follow only if demand and lifecycle comparisons justify it. Industrial customers should contribute technical expertise and finance for proprietary benefits; public co-financing should support additional shared capabilities. The Department of Trade, Industry and Competition (the dtic), Council for Scientific and Industrial Research (CSIR) and universities could coordinate through existing structures. Any such coordination should be subject to confirmed mandates, delivery capacity, budget approval and applicable procurement rules. Published eligibility, tariffs and allocation procedures should protect smaller entrants. Success means useful access and domestic learning—not installed capacity alone.

5.2. Testing Data-Sharing and Sectoral Partnerships

An industrial process-optimisation pilot would connect Section III's applied-AI capabilities with Section IV's shared learning clusters. Through competitive selection, industrial customers, developers and researchers could work on a defined production problem, with cluster participants contributing supervised projects and accessing workplace placements. Customers

would supply appropriately governed datasets and developers would test applications against agreed baselines. Independent validation could support commercial contracts. DataProphet illustrates existing capability, not a preferred recipient; agricultural applications remain a possible later pathway, not a second pilot assumed necessary.

The partnership is justified only if ordinary bilateral contracts or existing services cannot deliver comparable shared learning and access. Common standards and voluntary licensing may suffice. May (2024, p.3) identifies potential AI competition risks, but does not establish exclusion in South African compute or data markets. Assess that risk locally rather than infer it from global concentration.

Any partnership should specify lawful access and reuse, confidentiality, data/IP rights, portability and competition safeguards. POPIA's processing roles do not themselves determine commercial ownership or licensing; agreements should therefore clarify permitted uses and rights in project outputs, subject to applicable law (Protection of Personal Information Act 4 of 2013, s.1). Data-sharing arrangements should also be assessed under section 4(1) of the Competition Act 89 of 1998. Access controls, independent handling and appropriately aggregated historical information should limit disclosure of competitively sensitive firm-level data, following the Competition Commission's guidance (Competition Commission South Africa, 2023, sections 5–7). Published selection and access rules should limit incumbent capture, with targeted assistance only where smaller firms' barriers justify it. Where small farmers are intended beneficiaries, evaluation should test affordability and useful adoption rather than assume developer support reaches them.

Consistent with a discovery-oriented approach (Rodrik, 2004), assess useful uptake, comparative costs, supplier learning, paying customers and verified production improvements. Scale, redesign or withdraw accordingly. Sections VI and VIII address financing and implementation: these measures form one package, not separate programmes to fund automatically.

VI. Pillar 3 — Fiscal Incentives: Paying for Additional Domestic Value and Work Adjustments

Fiscal incentives should finance productive activities that private markets would otherwise underprovide, not reward investment simply because it involves AI. Knowledge spillovers may discourage research whose benefits extend beyond the investing firm (Arrow, 1962, pp.615–618), while labour-market imperfections can influence employers' incentives to finance transferable skills (Acemoglu and Pischke, 1999, pp.F112–F113). However, financing

difficulties may equally reflect weak demand or uncompetitive products. Public support must therefore demonstrate genuine underinvestment and additional domestic benefits.

6.1. Targeting Additional Investment and Spillovers

South Africa should prioritise the skills, shared-access and commercialisation measures proposed in Sections IV and V. Competitive grants could support additional industrial AI experimentation, while matching finance could enable developers and industrial customers to test commercially promising applications. Co-financing for Section IV's learning clusters should cover supervision, connectivity, compute and learner access where additional transferable skills justify support—not merely replace routine company expenditure.

Existing instruments should be examined first. Section 11D of South Africa's Income Tax Act 58 of 1962 provides a 150% tax deduction for approved qualifying operational scientific and technological R&D expenditure (South African Revenue Service, 2025). Eligibility is not automatic: routine data collection and testing do not necessarily qualify. Deductions may offer limited immediate benefit to pre-profit firms without taxable income. Milestone-based grants or innovation vouchers may therefore provide more accessible alternatives for qualifying smaller developers.

Commercially viable adoption should ordinarily rely on private finance. A mining company purchasing established AI software for its own productivity gains should generally bear that cost. Nevertheless, imported technologies can generate domestic benefits through improved production, skills and supplier learning. The relevant distinction is additional social value, not whether the technology or recipient is locally owned.

6.2. Measuring Domestic Benefits and Protecting the Fiscus

Every incentive should establish what investment, training or research would occur without support. Applicants should disclose existing commitments, demonstrate credible demand and identify additional activities and spillovers. Public contributions should be capped, competitively awarded and proportionately matched where feasible, without automatically excluding smaller or pre-profit firms.

Funding should be considered through prioritisation within existing research, industrial and skills programmes, subject to transparent budget approval, rather than an open-ended AI entitlement. Expenditure must be weighed against competing priorities, particularly foundational education, electricity infrastructure and worker-adjustment measures.

Independent evaluation should compare supported projects with credible baselines or similar unsupported firms, assessing additional investment, transferable skills, supplier learning, commercial customers and verified productivity improvements. Full fiscal costs, including administration and revenue forgone, must be considered alongside displacement and supplier capture.

Support should have defined review dates, milestone-based disbursements and withdrawal provisions. Clawbacks should address fraud, misrepresentation or misuse, while genuine commercial failure should trigger reassessment rather than automatic repayment.

Ultimately, South Africa should measure fiscal success by the additional domestic economic value generated per rand of public support, not the volume of AI expenditure subsidised.

VII. Labour-Market Adjustment: Connecting Productivity to Inclusive Gains

AI could expand South Africa's productive capacity, but its benefits will not be distributed automatically. Govender et al. (2025) report growing AI-skills demand and stronger job-advertisement trends in augmentation-exposed occupations; these associations do not establish causal employment gains. Policy must help workers adapt without assuming productivity growth guarantees accessible new jobs.

7.1. Uneven Exposure and Access to New Opportunities

Generative AI changes tasks rather than necessarily eliminating occupations. Clerical work is particularly exposed, while transformation is more likely than complete replacement (Gmyrek et al., 2025, p.1). These estimates do not cover every industrial AI application or establish South African job losses.

Local assessments should examine how education, gender, geography, connectivity and bargaining power shape adjustment, including barriers facing graduates and workers with limited digital skills. Global gender differences in exposure should not be treated as South African impact estimates.

Industrial applications, data services and technical occupations offer possible opportunities, but temporary data-centre construction differs from ongoing operations. Neither these activities nor potentially automatable data annotation can be assumed to absorb displaced workers at scale.

7.2. Employer-Linked Transitions and Temporary Protection

South Africa should augment existing workers where viable and support occupational transitions where tasks become redundant. In mining and manufacturing, supervised use of AI could

complement experienced workers' practical knowledge; this proposition requires workplace testing, not assumed productivity gains.

Training costs, uncertain returns, lost earnings and geographic immobility should inform support design. Employers should finance firm-specific training; Section VI's conditional public co-financing should address demonstrated transferable-skills and access barriers, not routine company expenditure.

Section IV's learning clusters could connect employers, SETAs, TVET colleges and universities through recognised short courses, supervised workplace learning and placements. Employment services should help graduates and informal, contract and platform workers access suitable opportunities. Existing skills funding should be assessed before new tax concessions.

Retrenchment already requires consultation on avoiding or minimising dismissals and mitigating their effects (Labour Relations Act 66 of 1995, s.189(1)–(2)). Worker participation should therefore inform AI-related job redesign and transitions.

Temporary protection should accompany retraining where justified. UIF-supported training and relief arrangements offer possible routes, subject to eligibility and agreements—not automatic AI-related entitlements (Department of Employment and Labour, no date, pp.5–7). Additional assistance requires explicit financing, coverage and time limits.

Independent evaluation should assess competence, placement, retention, earnings recovery, job quality, productivity and equitable access against credible baselines and comparators. Redesign or withdraw support where additional benefits fail to justify full costs. Success means improved worker opportunities and economic security, not AI-related job counts alone.

VIII. Implementation: Demand-Backed Pilots and Accountable Scale-Up

South Africa should begin with a competitive call for expressions of interest from university- and TVET-led partnerships with employers and domestic technology developers. Proposals should identify an industrial problem, such as mining equipment downtime, a committed customer and capacity for supervised learning and testing through existing facilities. The dtic could coordinate selection, DHET/SETAs facilitate training partnerships, and CSIR support technical appraisal, subject to verified mandates. Shortlisted partnerships should demonstrate authorised data access, employer contributions, inclusive participation, worker consultation and advantages over existing provision. Selection would not guarantee funding: the responsible budget authority must approve a costed proposal before launch.

The selected pilot should proceed through milestones, with disbursements conditional on verified progress. An independent evaluator should establish baselines and comparators before delivery, assessing additional competence, productive applications, supplier learning, placement, retention, earnings and productivity against full costs. Staged reviews should combine rapid interim assessments with longer-term outcome evaluation (Frontier Economics, 2024, pp.20–23). Published responsibilities and reporting should address procurement delays, institutional overload and incumbent capture. Scale where additional benefits justify costs; redesign or withdraw otherwise. New facilities should follow only where verified demand exceeds shared capacity and private provision or simpler reforms cannot deliver comparable benefits cost-effectively.

IX. Conclusion: From AI Adoption to Inclusive Economic Transformation

South Africa should pursue selective participation in the AI economy, building on industrial strengths rather than attempting technological self-sufficiency. Foundational education, applied skills and competitive access to governed data and computing infrastructure should be coordinated with industrial demand and conditional fiscal support.

David's (1990, pp.357–359) analysis of electrification highlights the importance of complementary investment and organisational change in realising productivity gains. Similarly, South Africa should connect learning to industrial applications, helping domestic firms develop capabilities and businesses improve production. Supplier success and higher profits, however, do not automatically improve employment or earnings. Worker augmentation, employer-linked retraining and targeted temporary support should therefore broaden participation and ease adjustment.

Success depends on commercial demand, competitive costs and accountable implementation. South Africa should test proposals through demand-backed pilots and scale only interventions demonstrating additional domestic productivity, capabilities and worker opportunities relative to full costs. Inclusive transformation—not adoption or infrastructure ownership alone—should guide the strategy.

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