

Feasibility: Localisation of Collision Prevention System Components for Trackless Mobile Machinery

MOSH TMM CPS Symposium


23 October 2025

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- The background features a light gray grid pattern. On the left side, there are several interlocking gears of various sizes. On the right side, there are technical symbols including a circle with a dot inside, a circle with a horizontal line through it, a series of four right-pointing chevrons, and a series of five vertical bars of varying heights.



1. Introduction

Customer Requirements and Background

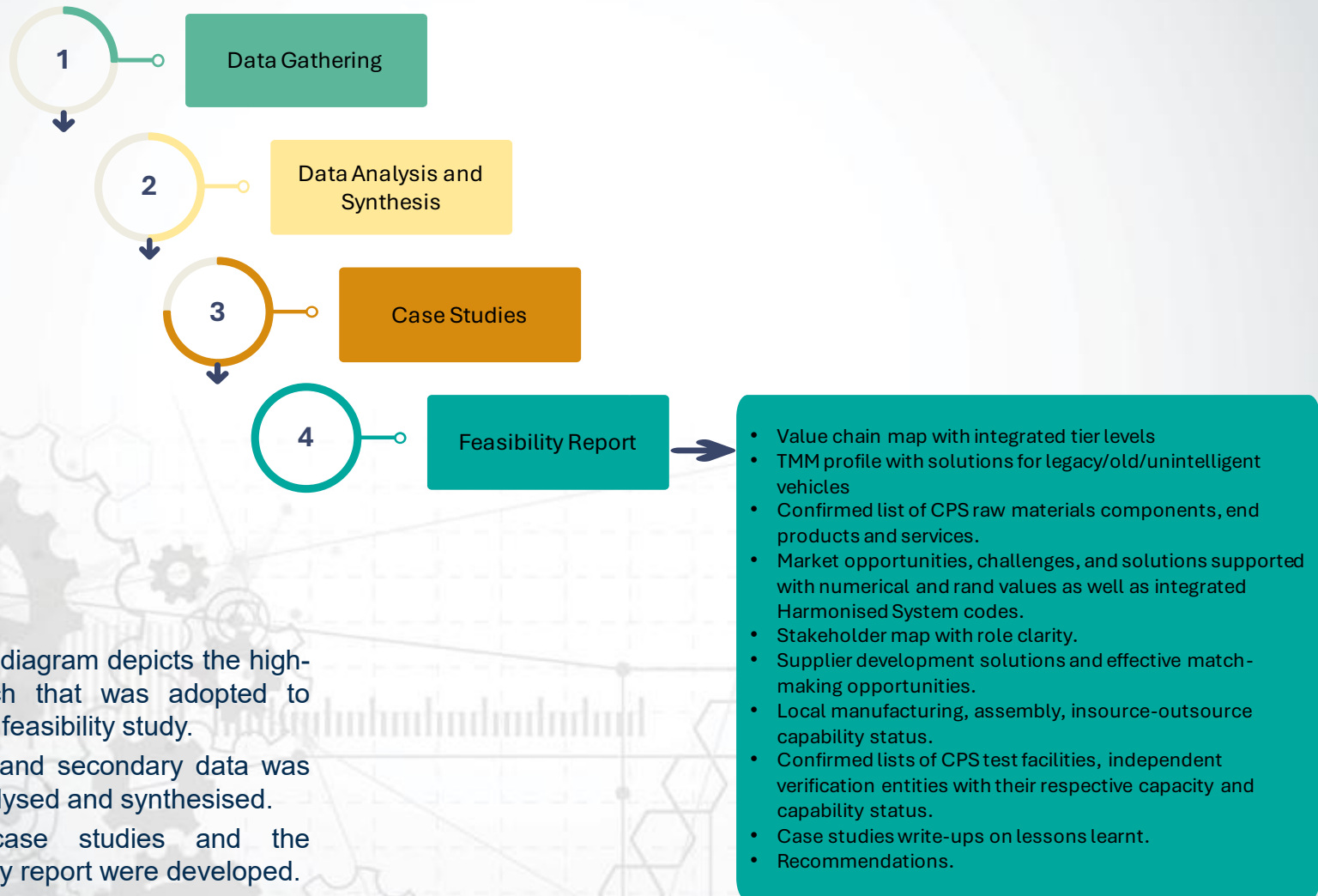
The Minerals Council South Africa wanted to investigate the feasibility of localising collision prevention system components that are used in the manufacture of trackless mobile machines and collision warning and avoidance devices. Such localisation could include component manufacture, assembly and/or insourcing-outsourcing.

To this end, the Minerals Council developed a comprehensive Request for Proposals and commissioned the Technology Localisation Implementation Unit to undertake this work.

The RFP stipulated the key elements of the project scope as follows:

- Desktop/literature review
 - Categorisation correctness
 - Stakeholder mapping
 - Supplier development
 - Market valuation
 - Local manufacture, assembly, insource-outsourcing capability
 - CPS testing capability
 - Case studies
 - Other opportunities
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- The background of the slide features a complex technical illustration. It includes several interlocking gears of various sizes, some with numbers like '100' and '10' on them. A grid pattern is overlaid on the scene. There are also technical symbols such as a target icon, a series of four right-pointing chevrons, and a barcode-like pattern. The overall aesthetic is that of a mechanical or engineering design.

High-Level Approach and Methodology



- The adjoining diagram depicts the high-level approach that was adopted to undertake the feasibility study.
- Both primary and secondary data was gathered, analysed and synthesised.
- Thereafter, case studies and the feasibility study report were developed.
- The areas that were covered by the report are shown.

The background is a complex, abstract composition of various shades of blue. It features several overlapping geometric shapes, including triangles and polygons, which create a sense of depth and movement. Interspersed among these shapes are faint, stylized icons of gears and mechanical parts, suggesting a theme of technology, industry, or engineering. The overall aesthetic is clean, modern, and professional.

2. Strategic Context

Strategic Context

- The global mining industry plays a crucial role by providing the minerals and raw materials used to develop infrastructure and produce a variety of industrial and consumer products.
- There are four key technologies that are disrupting the global mining industry namely drone technology, collision-avoidance systems, artificial intelligence, and digital twinning systems.
- Globally, more than 30% of mining industry deaths are caused by failures of vehicle interaction controls.
- To reduce mining fatalities due to vehicle interactions, the global mining industry is increasing the adoption of safety-related technologies.
- The key international industry bodies that focus on CAS are the Earth Moving Equipment Safety Round Table (EMESRT) and the International Council on Mining and Metals (ICMM).
- Key future technologies include LiDAR, AI Cameras, Radar and Ultrasonics.
- Africa is the fastest growing market for CAS, with South Africa being a leader from a regulatory, technology development and manufacture, and testing and certification perspective.

- Regulation 8.10 of the Mine Health and Safety Act, 1996, (Act No. 29 of 1996) deals with collisions between TMMs and pedestrians. Sub-regulations 8.10.1.2b and 8.10.2.1b were published on 21 December 2022 and compel the mining industry to provide collision prevention systems and devices that will automatically slow down and stop TMMs so that collisions are avoided.

- To support the SAMI's compliance with the new TMM regulations, the following initiatives from the Minerals Council provide critical enablers toward the achievement of Zero-Harm:
 - Development of the MOSH CPS Guideline
 - Special project on “Industry Alignment on TMM Regulations”
 - Establishment of a testing capability at the University of Pretoria's Vehicle Dynamics Group.

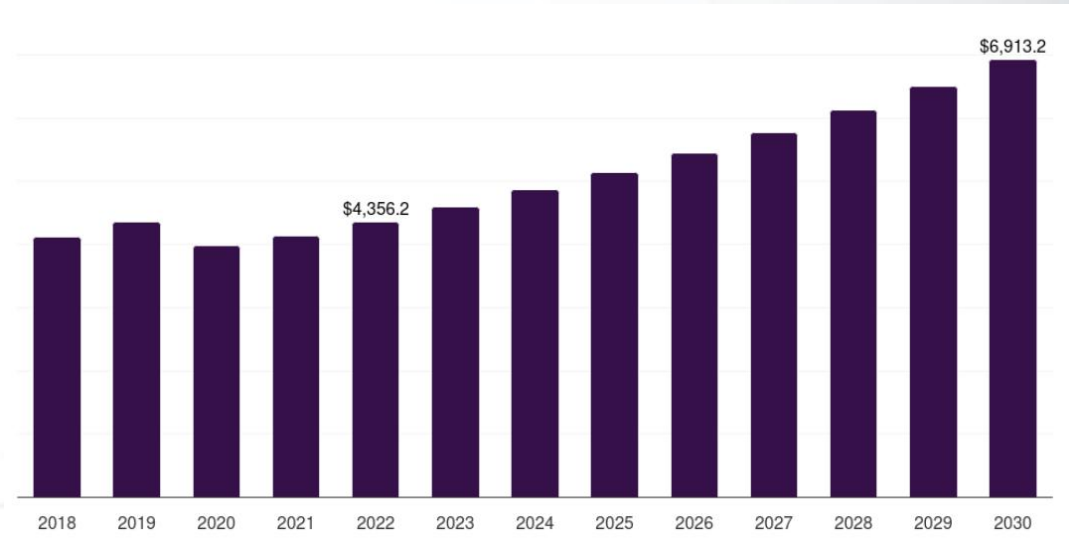


3. Industry Analysis

Mining and Mining Equipment in South Africa

- Mining contributes about 8% to GDP
- Mining has been in decline for more than two decades due to:
 - Policy certainty
 - Clarity on environmental issues such as the carbon tax
 - Regulatory framework
 - Infrastructure issues including electricity, ports, and railroads
 - Security issues.
- Production and sales has recently shown year-on-year growth because of strong demand from world commodity markets.
- DMRE intends to catalyse exploration by streamlining the licensing regime
- Investment in new mining projects has come to a virtual standstill.
- Challenges:
 - High input costs
 - Environmental, health and safety regulations
 - Relationship between management and organised labour
 - Fluctuating exchange rate
 - Logistic inefficiencies

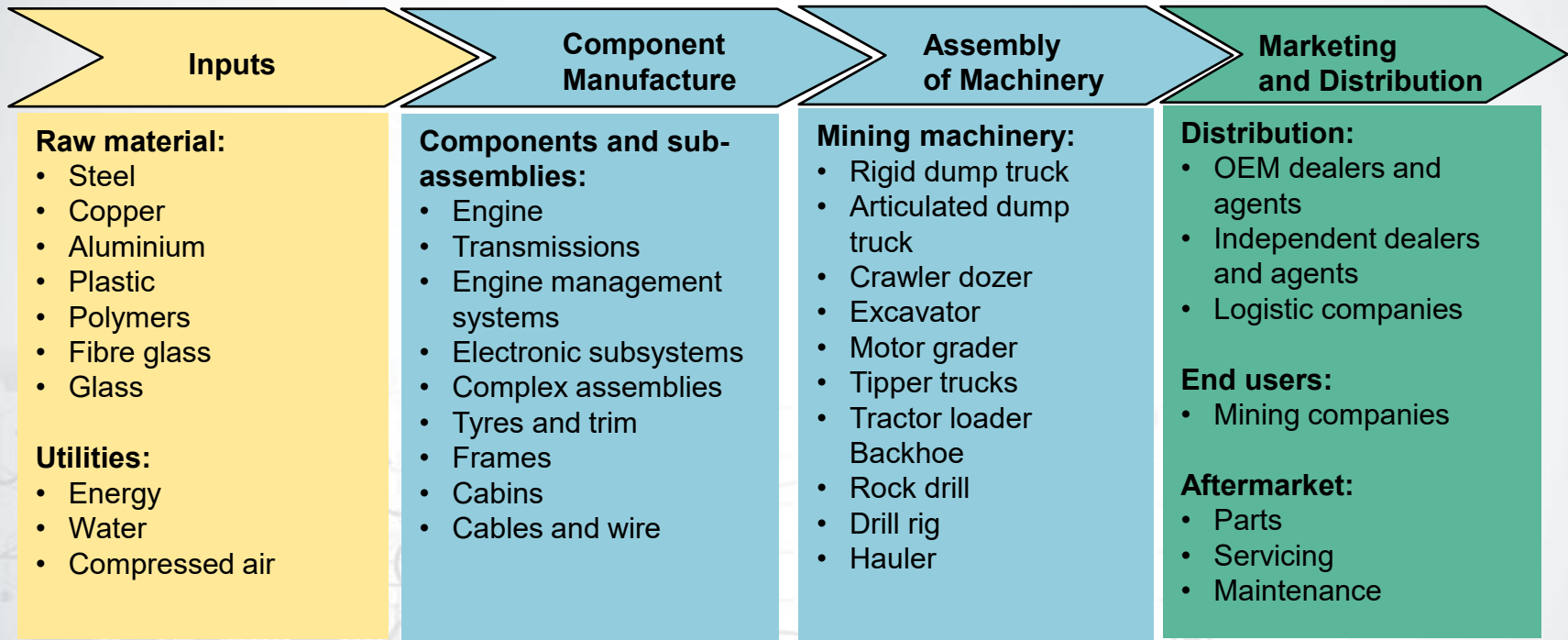
South Africa Mining Equipment Market, 2018 - 2030 (US\$M)



Source: <https://www.grandviewresearch.com/horizon/outlook/mining-equipment-market/south-africa>

- In 2022, the SA mining equipment market achieved revenue of USD 4 356.2 million
 - Surface mining equipment achieving a revenue share of 42.15%
 - Machinery for underground mining applications was the most lucrative and fastest growing market segment.
- The country's mining equipment market is expected to grow to USD 6 913.2 million by 2030, achieving a CAGR of 5.9% between 2023 to 2030.

Value Chain - TMM



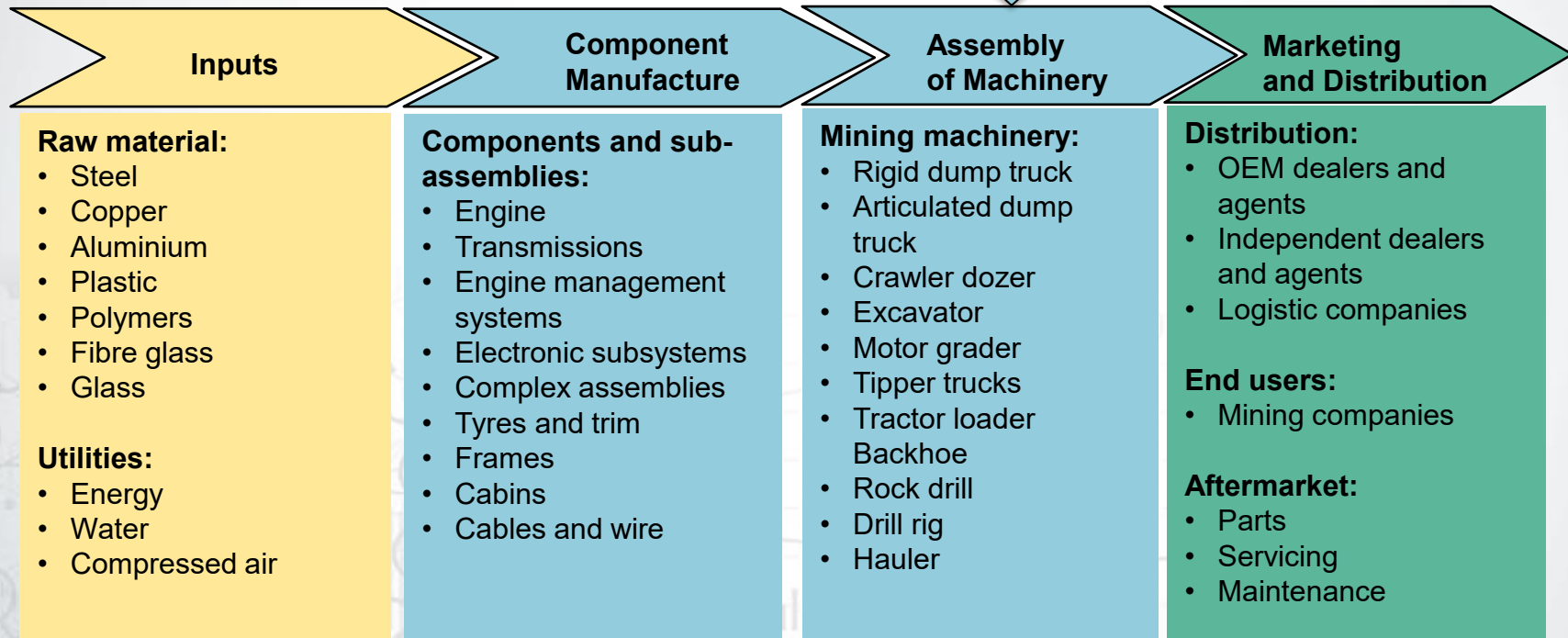
OEMs: R&D, Product Development, Manufacturing, Assembly and Financing

Financing Institutions, Logistic Services, and Government Agencies

Value Chain – TMM with CPS

TMM CPS:

- Machine to CxD Interface (MCI)
- Machine Control (MC)
- Machine Braking System (MBS)
- Machine Sensing (MS)



OEMs: R&D, Product Development, Manufacturing, Assembly and Financing

Financing Institutions, Logistic Services, and Government Agencies

Stakeholder Map

CxD Suppliers	TMM OEMs	Third-Party Integrators	Local Manufacturers
<ul style="list-style-type: none"> • More than 25 companies 	<ul style="list-style-type: none"> • More than 17 companies 	<ul style="list-style-type: none"> • More than 9 companies 	<p>Electronics Sector:</p> <ul style="list-style-type: none"> • More than 15 companies <p>Automotive Sector:</p> <ul style="list-style-type: none"> • 13 OEMs in KZN, EC and GP • 500 component suppliers • 180 Tier 1 suppliers • NAACAM has a list of members
<p>Mining Industry: Mining Houses, Junior Miners and Service Providers</p>			
<p>Government Departments and Agencies: DMPR, DSTI, DTIC, MHSC, CSIR, Mintek, MMP, TLIU, SABS, TIA, IFPTI</p>			
<p>Tertiary Educational Institutions: UP, Wits Mining Institute, UJ, VUT, CUT</p>			
<p>Industry Associations: Minerals Council, SECDI, MEMSA, SAMPEC, CONMESA, SACEEC, NAACAM, NAAMSA, EMESRT, ICMM, MIASA</p>			

CPS Testing Capability

TRL 4 – UP

- *Log keeping*
- *Machine sensing*
- Self-diagnostic
- Machine controller
- Interface test
- Effective warning
- Detection & tracking
- Scenario
- Robustness

TRL 6 – Gerotek

- CPS Integration
(surface and underground)

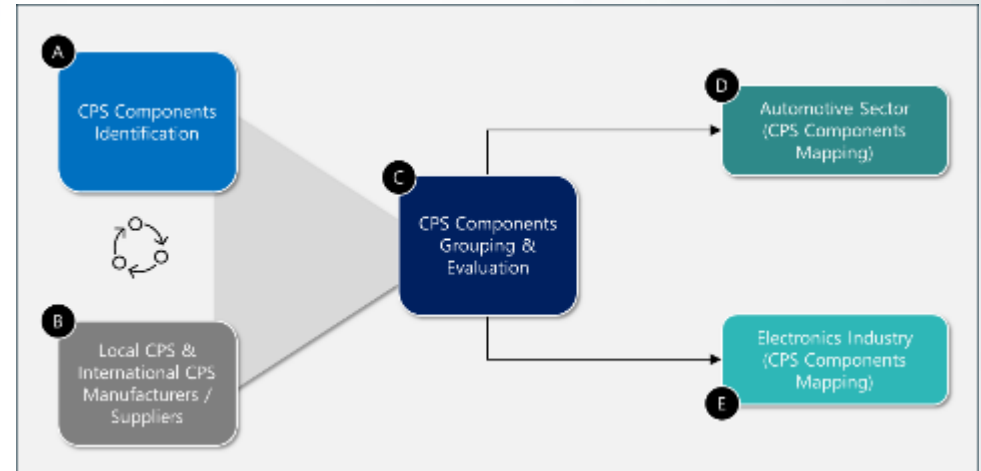
TRL 8 & 9 – Mine sites

- Surface CPS
- Underground CPS
- CPS Validation

There is a gap (opportunity) with regards to TRL 7 testing with the objective of creating a sub-set of interaction scenarios in representative environment to ensure robustness of CPS products.

Local Manufacturing and Assembly Capability Assessment Approach

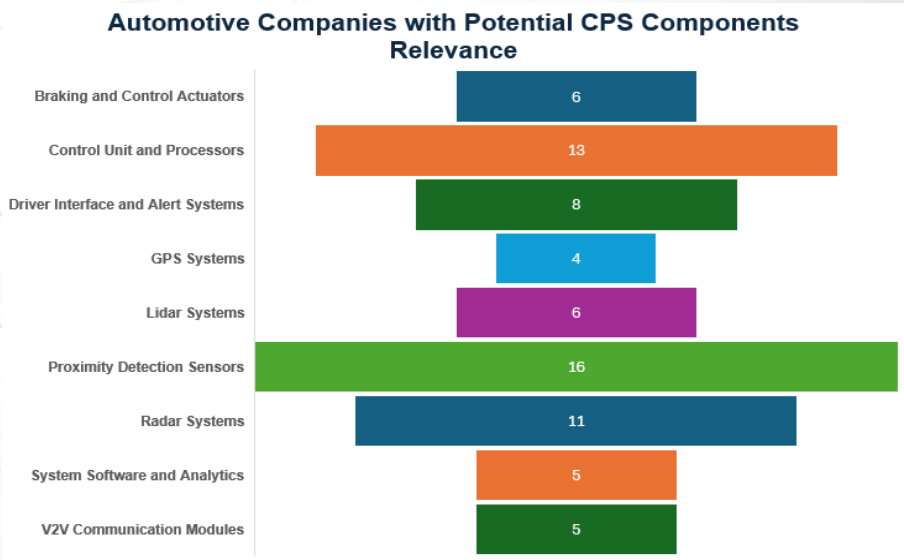
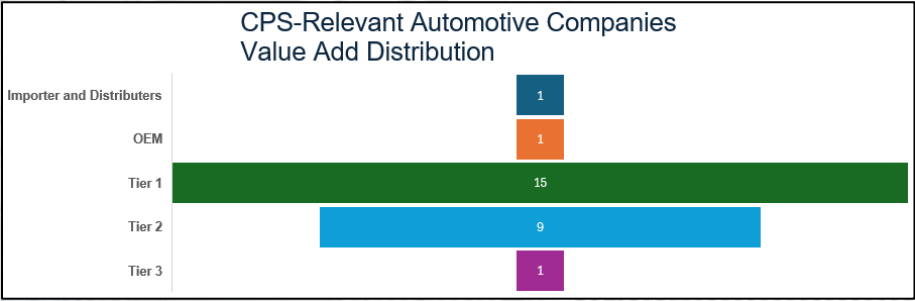
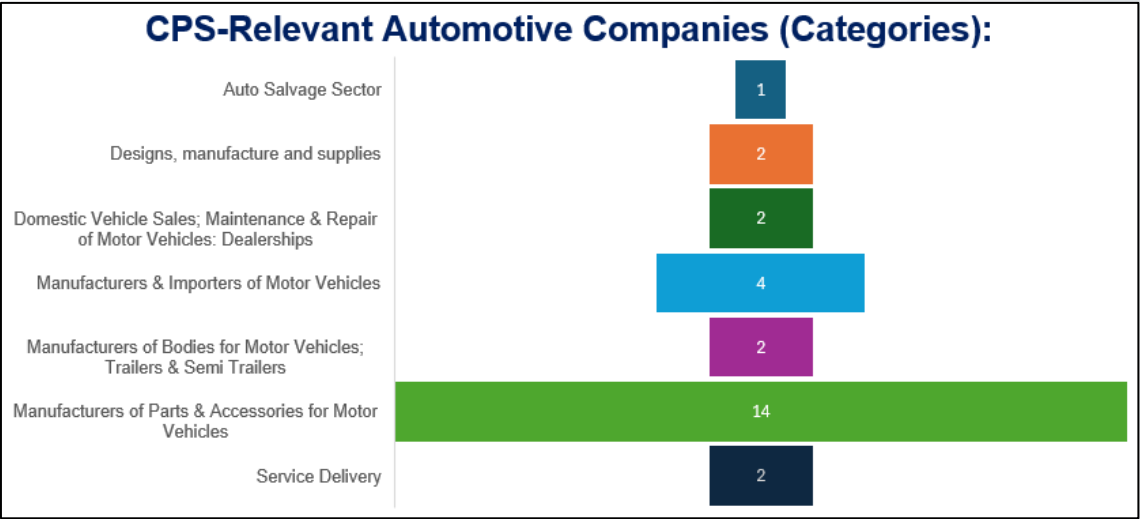
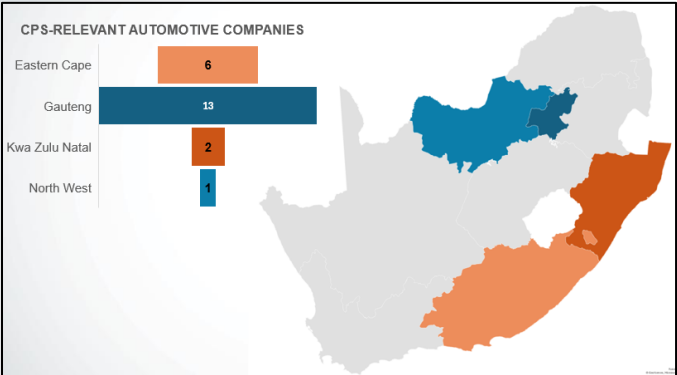
- Key components (and sub-components) associated with CPS technologies/ecosystems were identified based on the current CPS landscape.
- The identified components are then used as a guide for mapping the capabilities of the automotive and electronics industries.



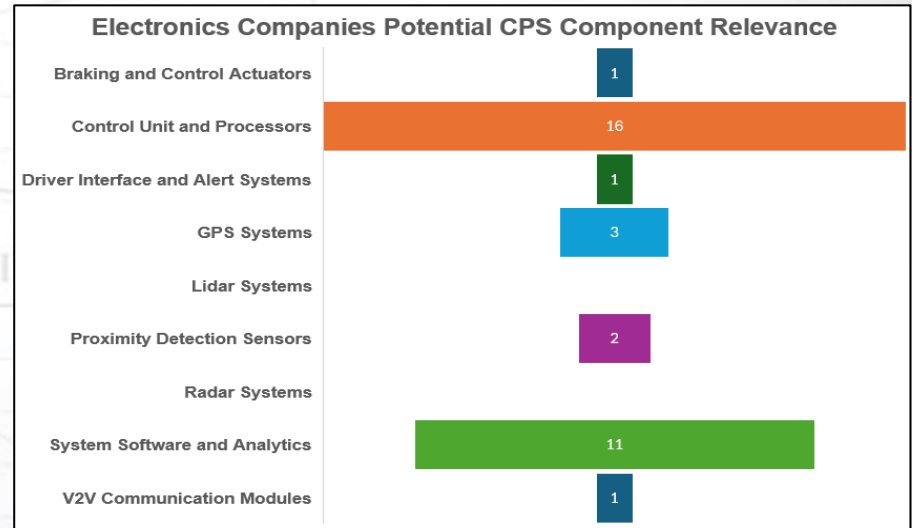
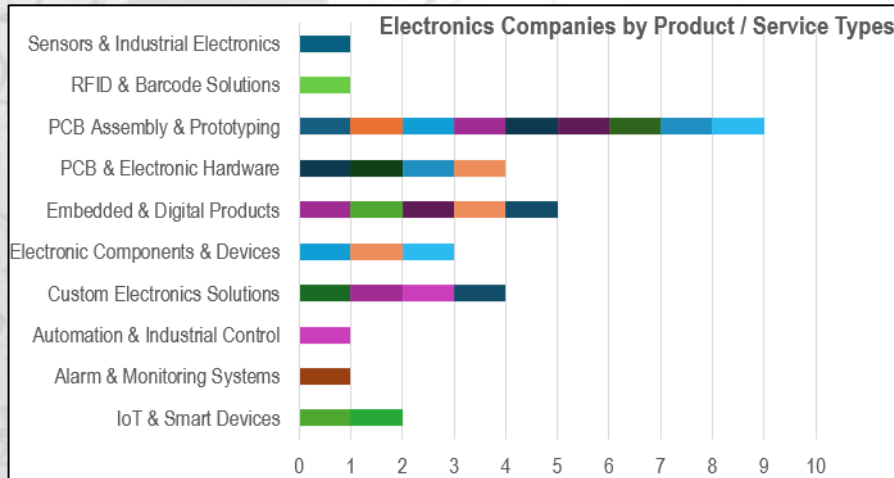
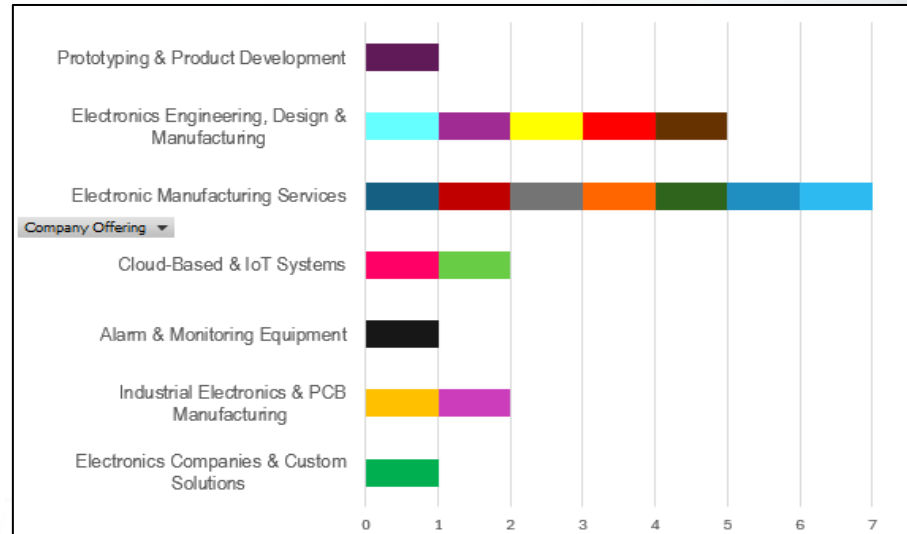
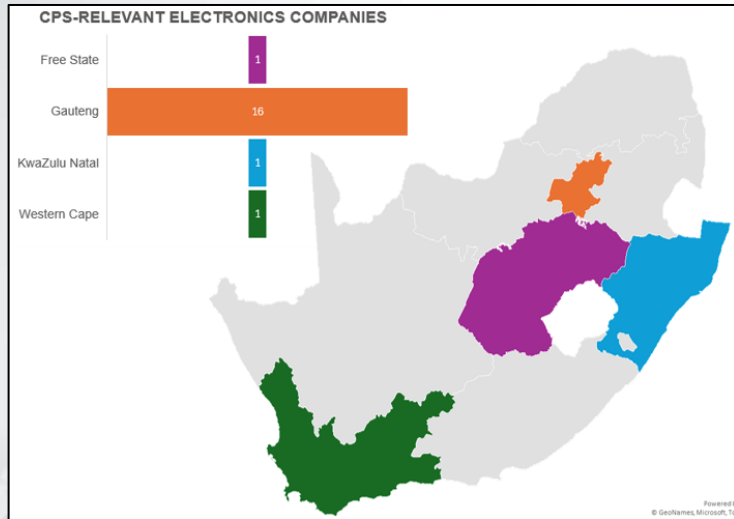
Mapping CPS key components for the automotive and electronic industries

Process ID	Description
Step A	<ul style="list-style-type: none"> • Identification of CPS ecosystem components (<i>Iterative process with step B</i>) • Identify CPS system components according to the Minerals Council MOSH CPS Guidelines.
Step B	<ul style="list-style-type: none"> • Identify the various suppliers and manufacturers of CPS components, both local and international
Step C	<ul style="list-style-type: none"> • In Step C, by grouping together the key components of the CPS ecosystem, a system-of-systems view of the TMM ecosystem was created
Step D	<ul style="list-style-type: none"> • Application of the core component grouping identified in steps A-C to the automotive industry sector • Map the automotive capabilities to the CPS component ecosystem
Step E	<ul style="list-style-type: none"> • Application of the core component grouping identified in steps A-C to the electronics industry sector • Map the electronics capabilities to the CPS component ecosystem

CPS Relevant Automotive Companies



CPS Relevant Electronic Companies





4. CPS Localisation Opportunities

CPS Localisation Opportunities

Local Manufacture:

- *Complete TMM Machine Controller.*
 - Already being produced by CxD companies
- *CPS-ready Cap Lamp Test Station*
- *CxD Test Station.*
 - Various options are possible:
 - A dedicated complete system test facility for the industry, possibly co-located with Gerotek, at UP or similar.
 - Manufacturer-specific test stations for use at the mines to test functionality and individual system components.
- *Semiconductors*
 - This is not a good localisation opportunity due to small volumes and high investment costs.
- *Display Screens*
 - This is not a good localisation opportunity due to small volumes and high investment costs
- *Sensor Integrated CCTV*
 - These are also semiconductors.

Local Assembly:

- *CxD Test Station:*
 - Assembly is an opportunity, based on the options listed under local manufacture.
- *Semiconductors:*
 - A semiconductor is a material, and assembly is not required.
- *Control system wiring:*
 - Assembly of automotive wiring harnesses already takes place in South Africa. It should be a relatively simple task to expand to include CPS wiring using the specified cabling and connectors.
- *Nuts and bolts:*
 - There are local suppliers of nuts and bolts. CxD companies to source locally or import
- *Back-up battery:*
 - There are various battery assemblers in South Africa that could be approached to undertake the assembly of batteries.
 - There are no cell manufacturing in South Africa. The local product of lithium-ion cells could be investigated.
- *Enclosures:*
 - The physical design of each component is customized to suit the selected enclosure.
 - The local CxD manufacturers have not standardized their enclosures. Standardisation would offer the opportunity of sharing tooling costs, but this would mean that all the local products would look similar.

Review of CPS Local Manufacturing Opportunities

Technology	Localisation Approaches	Outsource Supply Chain Issues	Local Assembly Options	Local Outsource-Insource Opportunities
CxD Test Station	Enable decentralised local build of test platforms with plug-and-play features	Imported diagnostics boards and comm modules still required for advanced tests	<ol style="list-style-type: none"> 1. Assemble test boards and UI panels at regional tech hubs 2. Integrate power units, switches, and test wiring locally 3. Pre-load diagnostic software and verify firmware in SA 4. Install plug-and-play components in local enclosures 5. Conduct local calibration, inspection, and certification 	<ol style="list-style-type: none"> 1. Outsource PCB fabrication and insource full unit assembly 2. Use third-party diagnostics sensors, integrate locally with power systems 3. Outsource interface touchscreen dev and insource housing integration 4. Work with contract manufacturers for wiring harnesses 5. Combine global protocol converters with local data loggers
Semiconductors	Promote SA-based system integration and component handling	Chips and analogue components imported with long lead times	<ol style="list-style-type: none"> 1. Assemble sensor and control boards using local surface mount technology (SMT) services 2. Conduct local testing and validation of completed boards 3. Mount heat sinks and apply protective coatings in SA 4. Build modules combining sensors and embedded controllers 5. Apply localised firmware and labelling pre-delivery 	<ol style="list-style-type: none"> 1. Outsource chipsets, insource module and board integration 2. Use local PCB populators to reduce import assembly 3. Partner with microelectronics labs for test and validation 4. Outsource high-speed layout design, insource final board testing 5. Outsource enclosure design, insource semiconductor board casing
Control system wiring	Create SA-based wire shops for bundling, routing, and termination	Specialty wires and insulation materials sourced internationally	<ol style="list-style-type: none"> 1. Cut, crimp, and label wires at local assembly shops 2. Bundle harnesses to standard lengths and formats 3. Mount terminal blocks and organise wiring looms 4. Conduct electrical integrity and insulation testing 5. Prepare installation kits with routing schematics 	<ol style="list-style-type: none"> 1. Outsource wire insulation and colour coding, insource final cut/crimp 2. Use third-party panel shops for base routing, insource PLC integration 3. Outsource wire design schematics, insource execution 4. Collaborate with OEMs for pre-cut stock, finish in SA 5. Joint ventures with vocational schools to build wire looms

Review of CPS Local Manufacturing Opportunities

Technology	Localisation Approaches	Outsource Supply Chain Issues	Local Assembly Options	Local Outsource-Insource Opportunities
Nuts and bolts	Local kitting and QA for fasteners, including customisation options	Corrosion-resistant alloys still imported	<ol style="list-style-type: none"> Sort and pack fasteners for machine-specific kits Apply anti-rust or protective coatings in SA Label and bag units per mining specifications Customise torque specs and QA tags on-site Integrate kits into broader mechanical assemblies 	<ol style="list-style-type: none"> Outsource material sourcing, insource kitting and QA Contract coating services while managing labelling locally Outsource kit design and insource final assembly for dispatch Partner with small hardware vendors for mixed-source kits Use imported blanks and finalise in SA with packaging
Back-up battery	Focus on local battery management system (BMS) integration, pack casing, and wiring	Cells and fire-retardant wraps imported, slow delivery	<ol style="list-style-type: none"> Assemble battery packs and wire BMS units in SA Mount and secure cells with vibration-proof support Connect terminals and test charge/discharge performance Encapsulate in locally made rugged enclosures Apply compliance labelling and firmware updates locally 	<ol style="list-style-type: none"> Outsource battery cells, insource assembly and BMS wiring Partner with local firms for thermal packaging Outsource firmware design, insource QA and load balancing Use third-party cycle testers, insource verification Import fireproof insulation, assemble packs in regional hubs
Enclosure	Enable local customisation and integration of electronics	Imported seals and locking mechanisms with quality variance	<ol style="list-style-type: none"> Drill and finish plastic or metal enclosures locally Integrate internal electronics and wiring Seal, label, and mark enclosure components Conduct ingress testing and enclosure integrity check Package and prepare units for mine-specific use 	<ol style="list-style-type: none"> Outsource gasket and seal manufacturing, insource final assembly Use third-party powder coaters, perform mounting in-house Outsource CAD design, insource CNC/machine finishing Work with enclosure shell suppliers, integrate tech locally Mix imported locks with SA-made chassis and covers

Review of CPS Local Assembly Opportunities

Technology	Localisation Approaches	Outsource Supply Chain Issues	Local Manufacturing Opportunities	Local Outsource-Insource Opportunities
Complete TMM Machine Controller	Design and manufacture controller units within SA to meet mining safety requirements	Dependence on imported microprocessors, sensors, and embedded modules	<ol style="list-style-type: none"> 1. Fabricate controller chassis using local CNC and metal forming 2. Design and print PCBs using SA-based PCB facilities 3. Manufacture cable harnesses and panel mounts in SA 4. Produce ruggedised casing components and brackets locally 5. Localise firmware and safety interlocks for mine compliance 	<ol style="list-style-type: none"> 1. Outsource chipset procurement and insource PCB and housing manufacture 2. Partner with OEMs for high-level design, localise final builds 3. Outsource compliance testing to labs, insource firmware development 4. Import edge computing modules (microprocessors & other chipsets) locally integrate with CPS software 5. Use local harness makers while importing specialty connectors
CPS-ready Cap Lamp Test Station	Develop SA-specific testing platforms with modular architecture	IoT modules and high-accuracy sensors may be imported	<ol style="list-style-type: none"> 1. Manufacture station frames and support locally 2. Develop switchboards and wiring panels in SA 3. Produce mounts and LED indicators via local suppliers 4. Print casings and control panels using 3D printing in SA 5. Build power regulation and status indicator boards locally 	<ol style="list-style-type: none"> 1. Import sensors and insource control panel production 2. Use global IoT platforms while assembling casings and displays locally 3. Outsource software logging design, insource hardware production 4. Partner with test labs to co-design but manufacture in SA 5. Outsource PCB layout, manufacture and populate locally
CxD Test Station	Focus on modular test infrastructure with locally built components	Import dependency for diagnostic integrated circuits (ICs), ports, and connectivity boards	<ol style="list-style-type: none"> 1. Fabricate enclosures with modular access in SA workshops 2. Manufacture panel controls and overlays locally 3. Build switchgear and power distribution components 4. Print and populate interface PCBs for diagnostics 5. Develop protective packaging for mobile deployment 	<ol style="list-style-type: none"> 1. Outsource diagnostic chips, insource board production 2. Use imported rugged components but assemble enclosures in SA 3. Partner with test service providers for modular plug-in interface design 4. Insource all metalwork and outsource firmware for test diagnostics 5. Localise software dev and outsource advanced sensor sourcing

Review of CPS Local Assembly Opportunities

Technology	Localisation Approaches	Outsource Supply Chain Issues	Local Manufacturing Opportunities	Local Outsource-Insource Opportunities
Semiconductors	Enable basic semiconductor testing, and system-level integration		<ol style="list-style-type: none"> 1. Test ICs in SA 2. Assemble embedded boards with logic controllers and filters 3. Manufacture auxiliary circuitry such as buffers and relays 4. Build test jigs and automated quality inspection tools 	<ol style="list-style-type: none"> 1. Outsource die fab, insource board-level integration 2. Partner with CSIR/MINTEK for design and outsource validation 3. Insource mixed-signal circuit design, outsource test automation
Display Screens	Integrate rugged displays with local support systems and protective interfaces	Lack of domestic thin film transistor (TFT) and organic light-emitting diode (OLED) production and controller ICs	<ol style="list-style-type: none"> 1. Build display housings and sunshields in local workshops 2. Print and assemble interface PCBs for touch inputs and backlight control 3. Manufacture anti-glare protective coatings and screen filters locally 4. Localise display software interfaces and firmware logic 5. Fabricate brackets and adjustable mounts in SA 	<ol style="list-style-type: none"> 1. Import screen units, insource protective enclosure manufacture 2. Outsource UI theme design, embed and test locally 3. Use offshore screen drivers, integrate with SA control systems 4. License visual HMI tools and localise interface boards 5. Combine imported control ICs with locally fabricated PCBs
Sensor Integrated Closed Circuit Television (CCTV)	SA-assembled systems integrating commercial sensors into CPS	LiDAR, mm Wave, and IR sensors mostly imported with firmware locked	<ol style="list-style-type: none"> 1. Manufacture rugged enclosures and sensor housings in SA 2. Design and print signal processing PCBs using local suppliers 3. Build local power management and filtering modules 4. Produce modular sensor mounts and interface brackets 5. Develop custom embedded software to unify sensor data 	<ol style="list-style-type: none"> 1. Outsource sensor chipsets, insource PCB and logic integration 2. Combine foreign sensing stacks with local algorithm development 3. Outsource calibration tools, insource all housing and power logic 4. Build regional test rigs and outsource global benchmarking 5. License AI models for signal processing, embed locally

New Localisation Opportunities

- *Pedestrian Tag*
 - A large multi-national OEM and OTM has designed a new pedestrian tag that will replace the current device
 - The new tag will be able to be used for underground and surface mining operations
 - The market will be both local and export
 - The new tag will replace more than 15 000 devices locally and internationally
 - The following localisation opportunities are being discussed with the TLIU:
 - Local production of the new pedestrian tag
 - Local production of the cap lamp
 - Local repair and maintenance support for CPS products and systems.
- *Batteries and Cells*
 - In general, the batteries (typically, rechargeable Li-ion) used in CPS products are not produced in South Africa.
 - There are several battery manufacturing and assembly companies in the country.
 - The cells used are imported and there is no local manufacturing taking place.
 - The opportunity to localise the production of the Li-ion batteries used in CPS products should be investigated further.
 - The opportunity to localise the production of the Li-ion cells should be investigated further.
- *PC Board Material*
 - The South African PCB production capacity is a very small percentage of the global market.
 - PCB material is imported into the country as the demand is not sufficient to justify local manufacturing.
 - As the industry grows, the opportunity to localise the production of PCB material could be investigated.

New Localisation Opportunities

- *Enclosures*

- The cost of tooling and low production numbers for enclosures make local supply challenging.
- Imported products are superior in terms of quality
- International suppliers are more affordable.
- The international suppliers are agile with quick turnaround times for design and design changes, as well as delivery.
- Local converters are unable to produce intricate parts and enclosures and, therefore, these parts need to be produced in other countries such as China.
- Notwithstanding this, the opportunity to capacitate local manufacturers to produce enclosures locally should be investigated. This could have knock-on effects for other sectors in the country.

- *Cabling*

- There are several local cabling companies. However, as some of the required cabling is not widely used in South Africa, local companies cannot produce these cables cost-effectively to the required specifications.
- Notwithstanding this, cabling could be a localisation opportunity that could be investigated further.

Supplier Development

- South Africa's ground-breaking TMM regulations have led to the establishment of several companies and stimulated the development of new technology and products to meet the need for TMM regulations compliance by mining companies.
- The CPS industry is in a volatile growth phase, and there are many companies active in the market.
- It is likely that not all companies will survive, and local consolidation will take place through mergers and acquisitions.

- The process from product development to the final deployment of CPS systems is long and requires significant investment.
- While the local companies have invested heavily in new products and testing, very few CPS systems have received the required certification.
- It is also clear that the local CPS industry is still in its early stages of development, and that many companies need assistance to grow and become sustainable.

- Based on the study that was conducted, the following supplier development initiatives should be considered:
 - Support for product design, development and prototyping.
 - Support for local manufacture.
 - Support for testing, which is a long, iterative, and costly process.
 - Skills development support, especially regarding auto electrician training.
 - Market access support, especially regarding export markets.



5. Market Analysis

South African CAS Market Size Estimation

- The global CAS market size was valued at U\$66.80bn in 2022 and is expected to expand at a compound annual growth rate of 11.4% from 2023 to 2030.
- The global mining sector CAS market was U\$5.3bn in 2022 and was projected to grow 10.2% from 2023 to 2030.
- North and South America account for the biggest market demand, whilst Africa is the fastest growing market.
- It is estimated that there are 8 810 intelligent TMMs suitable for retrofitting with CPS in 1 705 South African mines.
- Based on information from the mining industry, TMMs are on average replaced every 5 years.
- The current South African market size, for selected products, is estimated at R 828 million per annum

South African Market Size Estimation – Assumptions

Item	Assumption
Number of mining sites	1 705
Number of Intelligent TMMs	8 810
Number of mine workers	477 000
% of workers with cap lamps and tags	40
Number of visitor tags per mine	30
Number of reporting systems per mine	1
% vehicles fitted with fatigue monitors	30
% vehicles fitted with machine monitors	10
Controller replacement cycle	5 years
Pedestrian tag replacement cycle	2 years
Cap lamp replacement cycle	2 years

South African Market Size Estimation 2025

Products	Average Unit Price	Annual Volume	Estimated Market Size
Pedestrian tags	R 3 000	95 400	R 286 200 000
CPS-ready cap lamps	R 1 500	95 400	R 143 100 000
Mobile tags	R 4 000	51 150	R 204 600 000
CPS vehicle units	R 80 000	1 762	R 140 960 000
Tracking and reporting systems	R 120 000	341	R 40 920 000
Fatigue monitors	R 20 000	528	R 10 560 000
Machine monitors	R 10 000	176	R 1 760 000
Market Size Estimation			R 828 100 000

South African CAS Market Size Estimation

- Assuming a market growth rate of 10% per annum, the estimated local market (per volume) for the individual CPS components, for a five-year period, is shown in the adjoining table.

Estimated South African Market Size 2025-2029 (Volume)

Item	2025	2026	2027	2028	2029
	Number of Units				
Pedestrian tags	95 400	104 940	115 434	126 977	139 675
CPS ready cap lamps	95 400	104 940	115 434	126 977	139 675
Mobile tags	51 150	56 265	61 892	68 081	74 889
CPS vehicle units	1 762	1 938	2 132	2 345	2 580
Tracking and reporting systems	341	375	413	454	499
Fatigue monitors	528	581	639	703	773
Machine monitors	176	194	213	234	258

- Assuming a market growth rate of 10% per annum, and a 4% year-on-year price increase, the estimated local market (in Rands) for the individual CPS components, for a five-year period, is shown in the adjoining table.

Estimated South African Market Size 2025-2029 (Rands)

Item	Estimated Market (million)				
	2025	2026	2027	2028	2029
Pedestrian tags	R 286.20	R 297.65	R 309.55	R 321.94	R 334.81
CPS ready cap lamps	R 143.10	R 148.82	R 154.78	R 160.97	R 167.41
Mobile tags	R 204.60	R 212.78	R 221.30	R 230.15	R 239.35
CPS vehicle units	R 140.96	R 146.60	R 152.46	R 158.56	R 164.90
Tracking and reporting system	R 40.92	R 42.56	R 44.26	R 46.03	R 47.87
Fatigue monitors	R 10.56	R 10.98	R 11.42	R 11.88	R 12.35
Machine monitors	R 1.76	R 1.83	R 1.90	R 1.98	R 2.06
Total	R 828.10	861.22	R 895.67	R 931.50	R 968.76

The background is a dark blue gradient with various geometric shapes and gear patterns. There are several gears of different sizes and colors (light blue, dark blue) scattered across the page. There are also various polygons, triangles, and lines in shades of blue, creating a complex, technical-looking design.

6. CPS Localisation Case Studies

Case Study Development

- Engagements with 16 companies that operate within the South African TMM and CPS ecosystem were conducted to identify potential localisation projects for case study development.
 - Eight CxD OTMs
 - Seven TMM OEMs
 - One third party integrator firm.
- Seven case studies were prepared

	Company	Category
1	A	CxD OTM
2	B	CxD OTM
3	C	CxD OTM
4	D	CxD OTM
5	E	TMM OEM
6	F	Third Party Integrator
7	G	TMM OEM, Third Party Integrator and CxD OTM

The typical areas covered in each case study are:

- A description of the project
- The process followed to identify, develop and implement the localisation opportunity
- The key stakeholders involved throughout the process
- The type of support that was provided by the different role players
- The status of the project
- Key socio-economic indicators (job creation, Gross Value Added, financial performance)
- Critical success factors
- Challenges experienced and pitfalls to avoid
- Lessons learnt
- General advice on localisation.

Case Study – Key Findings and Insights

- South Africa is considered a global leader in the CPS domain. There is an opportunity to capitalise on this sentiment to capture a greater share of the global market. This can be achieved by showcasing South African CPS products and systems at international exhibitions and punting these proven technologies as the global benchmark.
- Some stakeholders perceive the incorporation of the MOSH CPS Guidelines as a hurdle in terms of the cost of implementation and possible misalignment with international standards, while others have praised the initiative. Notwithstanding this, the objective of achieving Zero-Harm in the SAMI received overwhelming support.
- All engagements have highlighted the need for a consolidated South Africa approach to leverage the pioneering work that has been conducted in the country as well as the proactive approach from a legislative and Minerals Council perspective.
- There are several good local suppliers that have focused on the full value chain. These companies have partnered with a range of stakeholders to design, manufacture, trial, test, certify and deploy their CPS technologies.
- A significant portion of production is local, with a mix of in-house assembly and third-party component production. However, specialised electronic components such as chips, screens, batteries and cabling are imported and have long lead times. Enclosures are also mainly imported due to better quality, more cost-effective prices, and shorter lead times.
- The components that can realistically be localised are already being done, and there seems to be little opportunity for further localisation.
- Almost all companies have self-funded research and development, design, manufacture, trial, testing, and certification.
- Most companies have not leveraged any form of assistance from government or other institutions and have developed their technologies on their own.
- Due to the high number of CPS suppliers operating in the country, the local market share for individual companies is small and investment in further development of local manufacturing becomes prohibitive.

Case Study – Critical Success Factors

- Strong collaboration with a variety of stakeholders is crucial to developing new CPS technologies and eventually deploying these into the market.
- Collaborating with mining companies is important for determining and specifying user requirements, as well as allowing on-site testing and providing development assistance.
- Collaborating with the University of Pretoria for assistance with verification testing, certification and product development. Comprehensive testing (i.e., testing that is performed under well-controlled conditions; that uses appropriate test equipment; that uses experienced human resources to conduct the tests and considers well-defined test procedures to ensure repeatability) guarantees robustness under the harshest conditions.
- A passion for innovation and continuous improvement results in the development of groundbreaking, fit-for-purpose solutions.
- The development of tailored solutions and having a flexible approach to meeting client needs.
- Extensive and customised internal training of engineers and technicians is crucial for the development and deployment of appropriate CPS solutions.



Case Study – Challenges Experienced and Pitfalls to Avoid

- Specialised electronic components such as chips, screens, batteries and cabling are imported and have long lead times.
- Access to markets can be challenging and obtaining client buy-in is difficult.
- Industry growth is likely to come from exports, but international marketing is costly. Attending international expos and trade shows is viewed as prohibitively expensive. Targeted government assistance in this regard would enable the industry to grow internationally by increasing exports.
- Overcoming barriers to compete with international companies requires persistence and proof of reliability.
- The need for rigorous testing and validation, requires continuous resources and financial investment.
- Ensuring a skilled workforce through ongoing and extensive training investment is sometimes exacerbated by the 'brain drain'.
- There is an ongoing need to educate end users on technical and regulatory requirements for effective solutions.
- There is a need for ongoing alignment between CPS companies and testing institutions on the testing methodology and criteria.
- Lack of a clear understanding by some customers of the solutions needed to solve specific problems. This leads to the development of an unclear scope of work.
- Some customers are unable to understand and interpret the data received from the system.
- Some customers attempt to integrate new technology with the old on legacy equipment.
- Some OEMs do not see value in being part of partnerships that address CPS compliance.
- Access to funding, both for technology and product development as well as for establishing and developing the business, is a challenge and own funding is generally used.
- It can be very difficult to secure a contract with a mining company, especially if they already have installations from other suppliers.
- Whilst enclosures can be made locally, the cost of tooling is prohibitively expensive for small product volumes.

Case Study – Lessons Learnt

- Significant investment is required for upskilling and training electricians and auto electricians, as these skills are key to operations and are in short supply.
- Ensuring safety is a fundamental driver of success.
- Investing in the development of local expertise drives and enhances innovation.
- Training must be accessible, inclusive, and practical. Tailoring training to diverse workforces improves understanding.
- Recruitment strategies must focus on talent that is fit-for-purpose. Selecting the right people improves implementation efficiency.
- Effective stakeholder engagement is fundamental. Transparency and collaboration minimise bottlenecks and enhance cooperation.
- Successful localisation requires a good understanding of local market needs. It is important to quantify the demand for the products and systems, and solutions must be tailored to customer requirements. It is also important to ensure that the necessary skills and knowledge are available.
- Off the shelf modules are useful for concept validation, but custom designs are required for the final product to meet all requirements such as power usage, reliability and environmental compliance, amongst others.
- Continued relevance in the industry is achieved by keeping abreast with industry developments, including legislation, and consistently meeting the customer's brief.

Case Study – General Advice on Localisation

- Localisation is key to a prosperous South Africa. However, it does require high levels of perseverance, and a focus on self-reliance rather than importing when convenient. The pursuit of safety and Zero-Harm on the mines is a big unifying factor (and rallying call) that can help in this domain.
- It is important to leverage industry associations for policy support and market access.
- Localisation should be consistently and continuously promoted as a key driver of economic growth.
- Companies should partner with local suppliers to drive South Africa's GDP growth and build a resilient economy, ensuring fair opportunities for South African companies by fostering a supportive market environment.
- Companies should engage with universities and research institutions to access research and development support, and to ensure that solutions are scientifically validated.
- Local manufacturing capabilities should be strengthened to reduce dependence on imports and enhance supply chain resilience.
- South African innovations should be showcased, and locally developed technologies should be promoted through dedicated platforms. Government needs to develop mechanisms to showcase South African products.
- Government should help to promote local South African CPS companies by driving minimum thresholds for local content.
- Due to the high costs of participating in promotional events, it will be important for the relevant government departments to provide support to companies to attend these events and take advantage of any opportunities to export their products and systems.
- To effectively support localisation, government departments such as the Department of Science, Technology and Innovation (DSTI) and the Department of Trade, Industry and Competition (the DTIC) should be more accessible and should proactively assist in the localisation drive. It would be useful to entrepreneurs if these departments invested in small scale electronics and other production facilities so that local start-ups do not need to seek assistance in China.
- Localisation embodies many aspects and can have many meanings. There is no common understanding, and localisation needs to be defined within the context of CPS.
- Localisation needs to be driven by the buyers of equipment, and the regulators need to provide an enabling environment that will support local developments and encourage local purchases.



7. Conclusions

Conclusions

- South Africa's TMM regulations have stimulated the related technology and product developments as well as the establishment and growth of several companies competing in the market.
- The CPS industry is in a volatile growth phase, and there are many companies active in the market. It is likely that:
 - Not all companies will survive
 - Local consolidation will take place through mergers and acquisitions, and this has already happened in recent years
 - The more successful companies will merge or partner with TMM OEMs or large international companies active in this market segment.
- Most of the CPS products and components are already being localised and this has warranted significant investment of own resources by the companies, with very little non-financial and financial support provided by government.
- There is a need to assist the CPS ecosystem to develop, manufacture, test, certify and deploy their products and systems. Such support could be provided by both local and international, public and private sector players.
- As with all technology-based products, development is not a once-off event, but rather an ongoing activity to stay ahead of the competition. There will be a continuous need to invest in research and development to develop the next-generation CPS.
- The CPS ecosystem has made significant investments to train employees in product development, and the integration and installation of CPS systems. There is a shortage of installation and maintenance skills in the form of auto electricians.

Conclusions

- Some form of local collaborative approach and centralised support would assist South Africa to maintain and even expand its current lead.
- The local automotive and electronics sectors have strong technological and manufacturing expertise that could be harnessed to assist CxD OTMs. Potential areas for collaboration include:
 - Core technologies such as LiDAR, radar, V2X communication, and sensor fusion are already prevalent in the auto sector and directly applicable to TMM CPS systems.
 - Both domains leverage vehicle interface controllers, HMIs, and intervention logic, enabling reuse of platforms and components.
 - The CPS development in mining presents an added market for the automotive and electronics sectors.
 - Automotive suppliers offer established, scalable manufacturing and integration capabilities for sensors, embedded systems, and HMIs.
- South Africa's lead in this field does provide international market opportunities as other countries adopt similar regulations. Exploiting this opportunity will entail significant marketing efforts and associated costs.
- TMM population data requires further validation and verification as some data is missing from the submission. The data analysis result, percentage, is however representative as it reflects similar numbers to 2017 DMRE data.
- South Africa has the capacity and capability to conduct testing according to MOSH requirements.

Conclusions

- Assessments were conducted on the 12 CPS opportunities identified for local manufacture and assembly. Eight of these opportunities are unlikely to be feasible for localisation due to factors such as too small market demand and too expensive to produce. The following opportunities warranted more detailed investigation for localisation: CPS-ready cap lamp test station, control system wiring, back-up battery assembly, and enclosures.
- Five new potential localisation opportunities were identified through consultations with CPS companies, namely pedestrian tags, batteries and cells, PCB material, enclosures and cabling. These opportunities were investigated.





8. Recommendations

Recommendations

- To support the local CPS ecosystem, and the South African Mining Industry to achieve regulatory compliance, it is recommended that the TLIU and the Minerals Council lead the establishment of two Sector-Wide Technology Assistance Packages (SWTAPs). These initiatives will need to be investigated and unpacked further, leading to the development of sound business cases.
 - *CPS Product Design and Manufacture SWTAP*. The aim of this SWTAP is to provide CPS companies access to product design and manufacturing capabilities and facilities that are available at science councils, government-funded entities, universities, and local and international private sector companies.
 - *CPS Testing and Certification SWTAP*. The aim of this SWTAP is to provide CPS companies with access to testing and certification capabilities and facilities that are available at the University of Pretoria and other local and international facilities. A secondary objective could be the capacitation of UP to offer the full range of testing and certification services at reasonable lead times.
- Whilst recognising this is a competitive environment, the formation of a CPS industry body or forum (possibly under the Mandela Mining Precinct) should be considered with a view to strengthening the sector by addressing common problems and issues such as:
 - Standards
 - Testing
 - Installation and maintenance skills base
 - Commonisation of non-proprietary components
 - International marketing

Recommendations

- It is recommended that an initiative to provide international market development assistance to the CPS ecosystem be investigated and developed with the dtic. This could include:
 - International market development
 - Development of a brand South Africa product identity
 - Promotion of South Africa as a leader in the field
 - Support for international market development including trade missions and exhibitions
- It is recommended that CPS orientated auto electrician training be provided to ease the pressures regarding installation and maintenance.
- The opportunities to localise CPS-ready cap lamp test station, batteries and cells, PCB material, enclosures and cabling should be investigated further through joint engagements with the CPS ecosystem.
- The opportunity to use a digital tool such as digital twins to support the demonstration of CPS system performance in a representative environment should be investigated. The digital twin can be used to verify the robustness of CPS products and can be extended to testing beyond TRL 6 to mitigate against safety risks while operating in a representative environment.
- The potential to access an independent mock or test mine facility should be investigated. This will enable the testing of TMMs in a representative environment without impacting negatively on operations and safety.
- It is recommended that the TMM population data be further validated and verified, especially regarding the classification of “legacy, intelligent” and “legacy, unintelligent”, and a determination of which machines can be retrofitted with CPS systems.



End