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# BENCHMARKING AUSTRALIA'S QUALITATIVE INTERNET OF THINGS (IOT) EXTENSIVENESS

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**ABSTRACT**

Australia as one of the most referred industrial countries in the world is currently going through national scale Industrial Revolution 4.0 (IR4.0) that is driven by Internet of Things (IoT). The technical deployment and business model have been devised in a roadmap, which mainly covers historically successful use cases (industrial solutions) in Australia – hence giving it the globally renown sophisticated reputation with international technology companies making up the IoT business along with local enterprises and start-ups. However, this roadmap has never been assessed and given the importance of Australia as a point of worldwide technological reference, it is crucial to qualitatively benchmark it against a tested standard. In this paper, the roadmap would be measured against the proven Key Performance Indicators (KPIs) specified in enhanced CREATE-IoT standard. The original CREATE-IoT successfully assessed smart cities in European countries, while its enhanced version has plausibly evaluated Malaysia's national IoT deployment roadmap. The assessment outcome finally discovers that 41 out of 50 (82%) of Australia's IoT KPIs are of advanced quality. This score reflects the maturity of current Australia's IoT ecosystem, which is deemed fit for purposes.

**Keywords:** *Australia IoT, Australia economy, Australia assessment, Australia KPI, Australia CREATE-IoT*

## 1. INTRODUCTION

Australia as one the top 15 most popular economies in the world is currently facing a technology transformation challenge as conjectured by economists [1-6]. The transformation even gets more push after the catastrophic Covid-19 pandemic, where it could have been avoided had countries coordinated each other via Internet of Things (IoT) driven pandemic monitoring system [7-15]. Furthermore, it is argued that the modern development in Australia was contributed more by external factors than the national productivity [1]. This is assumed to be risky for the long term as national productivity capacity has not been significantly improved. Many productivity-related industries can be upgraded by integrating IoT in order to better automate them and make them more efficient. Quantitatively, it is estimated that IoT may increase productivity level across these industries as much as 2% and generate profit up to AUD308 billions in the space of one (1) to two (2) decades.

It also has been found that the implementation of IoT in manufacturing sector in Australia has managed to decrease unexpected downtime and increase data integrity [16]. Another industrial sector in Australia that has benefitted from IoT is medical [17], where remote indigenous communities could receive medical services via IoT-enabled electrocardiogram sensors. The trend of integrating IoT in varieties of industry will only go up as the number of IoT sensors has rapidly increased to reach tens of millions of sensors.

The above mentioned widespread IoT implementation across various Australian industries has been supported by the government through the devising of National IoT Strategy. The existing IoT deployments in Australia and the overall strategy blueprint need to be qualitatively benchmarked to

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measure its level of extensiveness, thus the research conducted by this paper would fulfill this objective. In wider context, this paper would extend the previous works done by the authors; the enhancement of Key Performance Indicators (KPIs) of CREATE-IoT standard [18] – a standard to assess IoT platform [19] and another where the IoT readiness level of Malaysia was assessed [20]. After Malaysia, this paper's authors choose Australia as the next assessment subject due to its geographical closeness to Malaysia, where cross-border IoT collaboration is feasible and economic trade is practical as justified by [3], which claims Southeast Asian (SEA) countries to be the best provenance of Australia's economy livelihood. Such urgent assessment has not been done for Australia, hence the importance of this paper. The outcome of this paper may create domino effects, where other countries could follow suit to assess and improve their national-scale IoT infrastructure. This similarity in IoT assessment standard being used would increase compatibility chance when multiple countries decide to collaborate and establish an international IoT orchestration.

Moreover, this paper would be a part of future global coverage of national-level IoT platform assessments consisting of different countries. The more countries assessed, the more compatibilities among countries to connect to each other's IoT platform in order to orchestrate global collaborative IoT. All these national-level IoT platform assessments take precedence before the more specific and sovereign provider-level assessments, such as the ones accomplished by private consultants [21, 22].

The subsequent section would present the result of Australia's qualitative IoT extensiveness benchmarking using the enhanced CREATE-IoT standard followed by the conclusion.

## 2. QUALITATIVE BENCHMARK OF AUSTRALIA'S IOT PLATFORM BY CREATE-IOT STANDARD

This section presents the result of the proposed benchmark study mentioned in the previous section. The Australia's qualitative IoT platform extensiveness was benchmarked against the KPIs mentioned in the enhanced CREATE-IoT standard [18]. This is the novelty of this paper, where its outcome could be the reference for possible future similar assessments aimed for other countries. The documents involved in this benchmark are official reports published by Australian government offices and legitimate private enterprises. Table 1 below summarizes the quality level of every benchmarked KPI, where it was deemed as either non-existent, basic, unsustainable, or advanced.

*Table 1. The KPIs Qualities of Australia's IoT Platform*

| 1. **Dimension**: | Technology Development |
|---|---|
| **KPI:**<br>1. *IoT Devices and Modules: Options for Addition of IoT Devices*<br>Current plan: The IoT platform market in Australia offers diverse operators from both local and International companies, which support popular and preferred wireless connectivity options [1]. A local Australian company Morse Micro even managed to create an improved version of Wi-Fi with smaller figure. This diverse market would guarantee protocol compatibility and encourage ease of IoT device on-boarding.<br>Assessment conclusion: Advanced.<br>Plausible benchmark: PTC Kepware [24]. | |
| 2. *IoT Devices and Modules: Availability and Readiness of Device Facing Application Programming Interfaces (APIs)*<br>Current plan: Use of open APIs have been proposed to ensure compatibility with external global IoT platforms and to sustain long-term IoT capability [1].<br>Assessment conclusion: Advanced.<br>Plausible benchmark: Software AG Cumulocity IoT [25]. | |
| 3. *IoT Devices and Modules: Supported Varieties of Device Types*<br>Current plan: The device types would revolve around use cases or solutions where Australia has historically thrived at, such as construction, manufacturing, healthcare, mining, agriculture, fishing, and forestry. Hence, the supported device types would be as follows:<br>- Construction: Vibration sensor to detect construction flaw, biometrics sensors to detect workers' fatigue, proximity sensor to prevent workers from getting too close to hazardous machines, crack sensor to estimate and detect cracked concrete, drones to detect security breach, temperature and humidity sensors to monitor safe climate for concrete curing.<br>- Manufacturing: Vibration sensor to detect frail machines, temperature & humidity sensor to ensure machines are in safe level of temperature, proximity sensor to detect if one machine/robot is too near to another machine/robot, gas sensor to detect gas leaking, pressure sensor to make sure equipment is within safe pressure level, infrared sensor to detect infrared radiation, vision sensor to determine positioning and accuracy of machinery parts, acceleration sensor to detect out of order machines, sound sensor to detect the out of order pitching of machines.<br>- Healthcare: Biometrics sensors (heartrate, blood pressure, oxygen level, temperature, insulin level, glucose level, inhaler, ingestible sensor, contact lens, electroencephalogram, motion, electrocardiogram, | |

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electromyography), location sensor to tract medical devices' locations, temperature & humidity sensors to monitor clinic/hospital environment.
- Mining: Drone with vision sensor to monitor mining site, proximity sensor, strain gauge sensor, seismic sensor, tilt sensor, inclinometer sensor, extensometer sensor, piezometer sensor, load cell sensor, pressure cell sensor, pressure sensor, vibration sensor, flow rate sensor, temperature & humidity sensors, gas sensor, level sensor, radiation sensor, noise sensor .
- Agriculture: Water level sensor, lighting sensor, pH level sensor, temperature & humidity sensors, electroconductivity sensor, soil moisture sensor, vision sensor to detect soil texture, mineral contents, and clay content, nitrate level sensor, nutrient level sensor, light intensity sensor, CO2 level sensor, noise level sensor, soil type sensor, transpiration rate sensor, gas sensor.
- Fishing: Temperature sensor, pH level sensor, vision sensor, oxygen level sensor, pH level sensor, turbidity sensor.
- Forestry: Temperature & humidity sensors, soil moisture sensor, air quality sensor, CO2 sensor, gas sensor, oxygen level sensor, smoke/fire sensor.
Assessment conclusion: Advanced.
Plausible benchmarks: PTC [24] and Software AG Cumulocity IoT [25].

4. *IoT Devices and Modules: Long Term Cost Efficiency of IoT Platform's Compatible Devices*

Current plan: Most sensors are imported from United States (US), European countries, and China [1], especially due to high cost to set up local Research and Development centre and factories.
Assessment conclusion: Unsustainable. Gradually in phases, local manufacturers may start producing IoT sensors and devices for one use case first, and then sequentially expanding to other use cases. With this bespoke strategy, sensors will not be wasted for uncertain use cases or solutions.

5. *IoT Devices and Modules: Device Security*

Current plan: Device security controls and mitigations have been formulated as follows [1]:
- Physical security measures to prevent illegal access to IoT devices
- Human-related security risks are taken into account, such as social engineering
- Loosely coupled IoT architecture is proposed to prevent the whole IoT platform from collapsing in case any individual IoT component is compromised
- Device registration (list of allowed and disallowed devices) has been proposed to be established
- Change of default device password has been part of security control
- Ensuring device password complexity and validity period enforcement are parts of proposed security practices
- Regular security testing for IoT devices has been recommended
- IoT devices security monitoring has been devised for both manual and automated tests, and also for both preventive strategy and mitigations
- Device firmware update/patching is included in the security plan
Assessment conclusion: Advanced. However, the roadmap does not mention about device encryption. This should be explicitly clarified.

6. *IoT Platform: Platform Security at the Device Border*

Current plan: Security blueprint has been designed at the device border, which covers the following [1]:
- Centralized authentication and access levels management have been proposed to contain security risks comprising human and devices
- End-to-end security monitoring and mitigation centre for Australia's IoT platform has also been included in the roadmap
- Segmentation-oriented security method is included in the plan, for example, firewall-based Access Control List (ACL)
- Software patching is in place that includes servers and sensors

Assessment conclusion: Advanced. However, extra protection methods can be included, such as device anti-spoofing and device-to-user mapping.

7. *IoT System Monitoring: IoT Platform Monitoring Capability*

Current plan: Australia's construction use case includes IoT based monitoring applications called SmartSite and AutoDesk Fusion Connect [1]. Other use cases are also equipped with monitoring application, such as healthcare/hospital, manufacturing, mining, agriculture, forestry, and fishing.
Assessment conclusion: Advanced.
Plausible benchmark: Microsoft Azure IoT [26], GE Predix [28], Philips Healthcare [33], Queen Elizabeth Hospital [34], Propeller Health [35], Tetra Pak [36], Rio Tinto [37], Hitachi [38], Monsanto [39].

8. *IoT Architecture: Size of Data Storage*

Current plan: The planned data storage is a hybrid approach, which includes both cloud-based and on-premise storages in order to accommodate the estimated data size accumulating in zettabytes of unit [1].
Assessment conclusion: Advanced.

9. *IoT System Functional Design: Service Redundancy or High Availability (HA)*

Current plan: General scalability plan has been in place by utilizing data centres with the ability to hyperscaling IoT services and applications [1].

Assessment conclusion: Advanced. However, data privacy issue may rise since most of the proposed data centres are located overseas (US).
Plausible benchmark: Software AG Cumulocity IoT [25] and Microsoft Azure IoT [26]

10. *IoT Verification, Validation, Testing and Certification: IoT Platform Audit*

Current plan: Security-wise, the Australia's IoT platform roadmap posits regular cybersecurity testing for both public and private sectors, which covers software and hardware (IoT devices) [1]. A secure IoT platform would indirectly create new jobs, higher profit, more collaborations, and more use cases to tackle more

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problems. General aspects of testing would also be conducted via 'Try, Test and Learn' framework.
Assessment conclusion: Advanced

| **2. Dimension**: | Technology Deployment and Infrastructure |
|---|---|

**KPI:**

11. *Usages of Open Technology Devices and Platforms : Devices utilizing Public Protocols and IoT Platform based on Open Source*

Current plan: Australia's IoT ecosystem is served by mostly International vendors, which provide open systems to allow bespoke modification by local IoT developers [1].
Assessment conclusion: Advanced.

12. *Use of Supported Standards : Diversity of Supported IoT Standards*

Current plan: There is a plan to support wide IoT standards regarding open APIs, communication spectrums, data protection, data storage, cybersecurity, and use case related standards. Besides technological standards, organizational and professional standards have also been included [1].
Assessment conclusion: Advanced.
Plausible benchmarks: Software AG Cumulocity IoT [25] and GE Predix Platform's [28]

13. *Capacity to Solve Interoperability and Connectivity Issues : Convergence of Diverse Protocols*

Current plan: National and international IoT connections would support common connection options, such as Wi-Fi, Bluetooth, Sigfox, LoRa, cellular (4G/5G/4GX), satellite, etc [1].
Assessment conclusion: Advanced.
Plausible benchmarks: Software AG Cumulocity IoT [25] and Microsoft Azure IoT [26]

14. *Scalability : Reporting Capability and Expandability*

Current plan: The Australia's Smart Construction solution comes with automated reporting capability.

Assessment conclusion: Basic. The proposal is missing information about report retention duration and whether other IoT solutions have been built with reporting feature too.

15. *Scalability : Tenants' Share of Events*

Current plan: Finding balance between data sharing and access level has been included in Australia's IoT recommendation. The types of data have also been proposed to be identified in order to classify their levels of sensitivity.
Assessment conclusion: Advanced.

16. *Efficiency in The Maintenance, Deployment and Life-cycle of Services and Software Running : Affordability of Service Performance*

Current plan: The proposed roadmap does not currently discuss about the estimated duration to complete a service transaction.
Assessment conclusion: Non-existent.
Plausible benchmark: GE Predix Platform's wind forecasting application [28]. For its deployment of four wind farms, the application ingests data from edge/devices, runs analytics on the data, and then sends the analytics results to the edge. All this flow is accomplished in 18 seconds.

17. *Efficiency in The Maintenance, Deployment and Life-cycle of Services and Software Running : Affordability of Data Storage*

Current plan: The Australia's IoT roadmap will implement hybrid data storage approach – utilizing both highly affordable cloud storage and highly secure on-premise storage [1]. Thus, the best of both worlds are indulged by Australia's IoT ecosystem.
Assessment conclusion: Advanced

18. *Integration with the existing and new infrastructure*

Current plan: Telecommunication sector has been taking part in Smart Fleet use case [1]. And more use cases are able to be assisted by telecommunication companies.
Assessment conclusion: Advanced.

| **3. Dimension**: | Ecosystem Strategy and Engagement |
|---|---|

**KPI:**

19. *Ecosystem Awareness*

Current plan: Quite number of corporations in Australia are still confused by IoT interference that is spreading to varieties of use cases [1]. The future full benefits of IoT also have not been fully understood and/or embraced by top-level managers and shareholders. It is caused by the current focus that is mainly on technical aspect, while the business aspect is still being partly leveraged.
Assessment conclusion: Basic. Although the benefits of IoT have been understood by technical Information Technology (IT) engineers and start-ups, the full support of big industrial leaders is still lacking simply due to minimum understanding of profit generation strategies.

20. *Stakeholders' Engagement*

Current plan: Reputable IoT platform providers are present in Australia i.e. Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), IBM Watson, Samsung Artik, Cisco IoT Cloud Connect, HP, Salesforce, Hitachi, etc. They offer popular solutions e.g. Smart Home, Smart Farm, Smart Fleet [1]. Australia has also put forward to reduce complexity of IoT hardware importation. Support and guidance will also be provided to local start-ups, academia, and government agencies in order for them to collaborate with each other.
Assessment conclusion: Advanced.

21. *External Partnerships and Collaboration*

Current plan: Studying how IoT platform partners generate profit and collaborate with them mutually to anchorage their unique abilities [1].
Assessment conclusion: Advanced.

22. *Public and Government Engagement*

Current plan: Public institutions have been cooperating with one another in IoT e.g. Commonwealth Bank of Australia (public) and University of New South Wales (public), Data61 (public) with Royal Melbourne Institute of Technology (public), etc. [1]. IoT-related government mandates would also be issued to implement

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IoT use cases along with its data regulation [1].
Assessment conclusion: Advanced.

**4. Dimension**: Ecosystem Openness and External Collaboration

**KPI:**

*23. Value Chain Openness*

Current plan: Open systems and standards are advocated in the roadmap in order to adjust to IoT developers' and customers' bespoke needs.
Assessment conclusion: Advanced.

*24. Inclusiveness and Participation for Third Parties : Value-Adding Data from External Sources or 3rd Parties*

Current plan: Consolidating Information to deliver experiences of products and to create new services [1].
Assessment conclusion: Basic. The current external data integration could have more use cases, for example, weather forecast data can be queried to trigger watering sensor in a smart farm.
Plausible benchmark: IBM IoT [29].

*25. Openness of Business Models*

Current plan: The Australia's IoT ecosystem will consolidate multidisciplinary teams that would work together and share profit [1].
Assessment conclusion: Advanced.

*26. Open Source Strategy*

Current plan: One of the goals of Australia's IoT is to export their "home-made" IoT solutions to international market, hence their solutions need to be comply to widely accepted international standards. This motivation has directed the IoT roadmap to use open source frameworks related to software, APIs, communication standards, and cybersecurity [1].
Assessment conclusion: Advanced.

**5. Dimension:** Marketplace and Business Impacts

**KPI:**

*27. Business Models*

Current plan: Creating values for IoT customers gradually through technology and data-driven innovations while also profiting IoT innovators [1]. Portfolio investor's way of thinking has also been promoted to encourage company leaders to be patient and confident with the establishment of Return on Investment (ROI) in IoT business.
Assessment conclusion: Advanced.

*28. Market Readiness and Monetization Mechanisms : Sale Package*

Current plan: IoT products/services are updated over the air (OTA) harmoniously [1].
Assessment conclusion: Advanced.

*29. Business Benefits*

Current plan: Business benefits will be continuously expanded by evolving customers' needs, which would be catered by both business-to-business (B2B) and business-to-customer (B2C) IoT sellers [1]. Additionally, IoT innovators/developers will also get share of business profit.
Assessment conclusion: Advanced.

*30. Market Competitiveness*

Current plan: Convey real-time and rising needs in a predictive fashion [1].
Assessment conclusion: Advanced.

*31. Legal Issues*

Current plan: Customer protection is promoted through the adaptation of Australian Consumer Law Policy Framework for consumer-level IoT [23].
Assessment conclusion: Advanced.

*32. Privacy, Security, Trust and Ethical Issues : Data Expiry*

Current plan: Since locally-controlled on-premise data centres for storage purpose are included in the roadmap, therefore data retention can be maximum [1].
Assessment conclusion: Advanced. However, data compression may be considered for efficient storing of data
Plausible benchmark: GE Predix [28].

*33. Privacy, Security, Trust and Ethical Issues : Tenants' Regulated Data Sharing*

Current plan: Government has a key role to play in addressing the challenge around balancing this use in a safe and ethical manner. Government must work to support the development and deployment of privacy-preserving data-sharing frameworks suitable for IoT services, while also working with industry groups to develop regulations and set minimum standards around how personally identifiable data is managed (for example, around transparency and consent, as well as storage and transmission). [1].
Assessment conclusion: Advanced.

*34. Privacy, Security, Trust and Ethical Issues : Technically and Legally Compliant IoT Platform*

Current plan: Security compliances will be taken care of by federal-level official security agencies i.e. CERT Australia's Joint Cyber Security Centre (JCSC), Australian Cyber Security Growth Network (AustCyber), and Australian Cyber Security Centre (ACSC/CSOC) [1].
Assessment conclusion: Advanced.
Plausible benchmark: IBM IoT [29], Sri Lankan and Malaysian governments [32]

*35. Experience Readiness Level : Rule Activity Management (Programmable Rule)*

Current plan: Various IoT solutions are to be deployed i.e. construction, manufacturing, healthcare, mining, agriculture, fishing, and forestry [1]. However, it is unclear whether the default scenario rules are programmable or not.
Assessment conclusion: Basic. It should be explicitly mentioned whether the rules are configurable and whether both action-based and schedule-based rules are supported.
Plausible benchmark: SAP Leonardo IoT [30].

*36. Experience Readiness Level : Self Navigation for Reporting and Data Analytics*

Current plan: All proposed IoT solutions feature reporting and analytics capabilities [1].
Assessment conclusion: Advanced.
Plausible benchmark: Microsoft Azure IoT [26]

*37. Experience Readiness Level : Comprehensive Reporting and Data Analytics*

Current plan: It has been prepositioned to

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consolidate technical and business data to automate and enhance IoT-related decision making and synchronize market situation with IoT orchestration [1].
Assessment conclusion: Advanced.
Plausible benchmark: IBM IoT [29] and C3IoT [31]

38. *Holistic Innovation*
Current plan: Offering personalisation and context and trigger network effects between products and services, which cover extra benefits such as pricing, scaling, intellectual property ownership, and branding [1]. The IoT adoption framework has also been devised to explicitly coordinate among federal, state, and district governments.
Assessment conclusion: Advanced.
Plausible benchmark: Sujono & Nainggolan [40], Reddy & Rao [41], Wyżgolik & Budzan [42].

**6. Dimension:** Societal and Economic Impacts

**KPI:**

39. *Indirect Revenue Generation*
Current plan: Profit generation includes iterating earnings, creating new commercialization models and profit sources [1].
Assessment conclusion: Basic. Indirect revenue sources are implicit and need to be clearly devised in the plan.

40. *Employment Macro-Impact*
Current plan: It is forecasted the Australia's IoT platform could build future-proof companies that would be able to scoop international markets and in effect would open more jobs and projects [1]. More projects may also spawn new start-up companies that would drive the economy even further.
Assessment conclusion: Advanced.

41. *User Worktime/Life Impact*
Current plan: The planned use cases would solve popular community issues, for examples, undersupply of consumable resources, obesity, chronic illnesses, crowded cities, environmental pollution, and many more [1].
Assessment conclusion: Advanced.

42. *Targeted Social Groups*
Current plan: The mobile coverage in Australia blankets 99% of whole population, therefore most market segments and diverse demography of people may benefit from Australia's IoT platform [1].
Assessment conclusion: Advanced.

**7. Dimension:** Policy and Governance Impacts

**KPI:**

43. *IoT Ecosystem Promotion and Competitiveness Safeguard*
Current plan: Australia's IoT platform is being promoted by local professional body called Australian Computer Society (ACS) that incites industrial players, government agencies, and academia [1]. The establishment of IoT platform may also improve the global competitiveness of industrial areas where Australia is historically thriving at, such as agriculture, fishing, and forestry. While it may also boost the manufacturing area performance where it has been in downside trend in the past three (3) decades.
Assessment conclusion: Advanced.

44. *IoT Standards Promotion*
Current plan: The radio frequencies (z-wave) currently used by smart home use case in Australia are different from the ones used by sensors and actuators produced in US and European countries. This may prohibit deployment in case sensors and actuators from those countries are required - although alternatives may be available [1]. Globally, there has been lack of coordination in IoT communication protocols, security specifications/requirements,
Assessment conclusion: Basic. More international standards should be complied to regarding device specifications and countries should consolidate more on device specifications standards.

45. *Trusted, Safe, Secure IoT Environment Promotion : Multi-Tenant IoT Platform*
Current plan: The Australia's IoT roadmap mentions the involvement of international and local IoT vendors. This collaboration however will apparently be done in silos, and thus is lacking multi-tenancy capability where ownership and permission could be seamlessly distributed.
Assessment conclusion: Non-existent. The multi-tenant model needs to be designed since there is a chance to share data and management quickly and seamlessly.

46. *Impact on SMEs, Start-ups and Young Entrepreneurs*
Current plan: The roadmap embraces and provides start-ups with supportive IoT-stirring facilities, for examples: sandbox to innovate new IoT applications, tax exemption, coworking spaces, and publicly available data provided by government [1].
Assessment conclusion: Advanced.

**8. Dimension:** Community Support and Stakeholders' Inclusion

**KPI:**

47. *Developers' Community Accessibility*
Current plan: Australian IoT-specialized company named Cog has built software to secure IoT devices with government-grade security performance [1]. National-level incubators have also been founded to develop cybersecurity capability bespoke for IoT. The plan also encourages IoT users to evolve to become developers in order to innovate fit-for-purpose use cases or verticals. The generated new solutions could then be marketed outside Australia.
Assessment conclusion: Advanced.

48. *Education Availability*
Current plan: Training related to using IoT use cases has been proposed by utilizing sophisticated means, such as Virtual Reality (VR) [1].
Assessment conclusion: Advanced.

49. *Accessibility Levels*
Current plan: Mobile connectivity including cellular signal reaches 99% of Australia's population [1]. And since telecommunication companies have been involved, for example, one that has attached sensors for Smart Fleet use case, hence accessibility levels are considered comprehensive.
Assessment conclusion: Advanced.

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| 50. *Community Engagement* |
|---|
| Current plan: Australia's Joint Cyber Security Centre (JCSC) exists to unify enterprises, Australian government agencies, and academic sector in order to foster IoT collaboration and share commercial profit [1]. |
| Assessment conclusion: Advanced. |

After qualitatively assessing Australia's IoT extensiveness in the previous table, the scorecard is summarized in the following Table 2.

*Table 2. Summary of KPIs' Maturity Levels*

| Item | KPI Maturity Level | Number of Related KPIs |
|---|---|---|
| 1. | Non-existent | 2 |
| 2. | Basic | 6 |
| 3. | Unsustainable | 1 |
| 4. | Advanced | 41 |

Based on Table 2 above, three (3) underperforming KPIs have been discovered, where they are in non-existent and unsustainable statuses. Affordability of service performance and multi-tenancy capability are unknown and unestablished. This may potentially deliver unpleasant customer experience and makes it harder to share data and manage permission/authorization.

Furthermore, there is an even more worrying KPI that has not been mitigated or in unsustainable status, which is the long-term cost efficiency. This is due to most of IoT sensors still being outsourced from overseas. Considering Australia itself is a continent with huge coverage of land that needs to be covered by IoT sensors, therefore the estimated number of sensors would be highly numerous. Numerous sensors may lead to extremely high cost if they are not manufactured locally.

## 3. OPEN RESEARCH ISSUE

One of the assessment findings infer a research issue that could be studied further. It is on Service Level Agreement (SLA) in multi-tenant cloud-based IoT platform: Different tenant may have different interests and may reside in different countries with contradictory policies. Hence, the necessity for an optimal SLA among them.

## 4. CONCLUSIONS

The discovery and discussion in the previous section infers that Australia is in plausible progress to deliver IoT applications and services with only two (2) KPIs needing immediate improvement. This is further justified by the fact that most of the assessed KPIs are of advanced quality (41 out of 50 KPIs or 82%) and six (6) of them (2%) are of basic quality. Thus, Australia could maintain its status as technologically advanced nation for the foreseeable future. This technological advancement may also solve one of Australia's biggest problems, which is small consumer size for such a huge continent. The expansive and ever-evolving use cases of IoT would create new attractive businesses that may diverse the consumerism in the local population.

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