Comput Syst Sci & Eng (2020) 4: 257–269


International Journal of
Computer Systems
Science & Engineering

# A Digital Start-up Project - CARM Tool as an Innovative Approach to Digital Government Transformation

**S. Green***

*Directorate of Materiel Logistics, CASG, Australian Department of Defence*

The digital revolution impacts modern workplaces through constant advances in technology. This study uses a digital start-up project experience to demonstrate how a Digital Government Transformation can be beneficial. The increase of administrative requirements, compliance, and capability readiness has prompted the development of the **Digital start–up project** known as the **CARM Tool** (Compliance, Assurance and Risk Management). CARM introduces a low risk low cost and high productivity solution, which can directly and immediately benefit stakeholders in a large complex government enterprise. It aims to elevate staff performance, customer service and provide qualification between financial statements, asset management and alignment with the Digital Government Transformation strategy. The digital start-up inspired, innovative CARM tool is an original idea developed by the author to utilise emerging technologies to modernise and consolidate the manual-based business processes and legacy systems, to improve visibility and accountability within the enterprise and to advance workforce skills throughout the organisation. In this paper, the author presents a detailed start-up project approach that draws the public sector specifically Defence into the digital transformation age through the innovative CARM tool from concept, to prototype to game-changing enterprise modernisation.

Keywords: Digital start-up project, CARM Tool, Compliance Assurance Risk Management, Blockchain, Digital Government Transformation

## 1. INTRODUCTION

The fundamental purpose of digital transformation is not just to digitise an existing business operation but to re-imagine an entirely different business approach that places technology at its core, an integration of processes and siloed departments within the enterprise where each silo holds their own hierarchy (Gill, 2018).

The Compliance Assurance and Risk Management (CARM) tool is developed to remove risks related to financial accountability and capability readiness within the enterprise. *"We've got 21$^{st}$ century technology and speed colliding head-on with 20$^{th}$ and 19$^{th}$ century institutions, rules and cultures"* (Lovin 2011). This succinctly highlighted the need for technological advances within a traditional workplace environment. Large enterprises such as Defence have previously shown little benefit in operations when implementing big IT projects, which are often expensive and extend over long periods. Adopting appropriate advanced technology would significantly improve functionality in terms of workload, productivity, and high order strategic decision making, particularly in the areas of financial auditing, compliance, assurance and risk management.

This paper presents an innovative approach implementing a digital start-up mentality for the CARM tool development, as a showcase to accelerate Digital Government Transformation (DGT) for the Australian Department of Defence (DoD). It will not only assist in eliminating inefficient processes but also will proactively reduce the operational risks within the DoD and undertake a more agile approach step-by-step leading enlarge project scope leading to high confidence from stakeholders. The case study utilised in this paper is known as a CARM tool. It is used to reduce the mandraulic efforts in finance and asset auditing against Defence policies.

*stuart.green3@defence.gov.au

## 2. ISSUES LEADING TO THE INNOVATION OF DIGITAL START-UP PROJECT – CARM TOOL

Across the world, with billions of annual government funded Defence enterprises, billions of assets held within finance and inventory systems, risk to such public sector enterprises may exist in the form of negative audit findings. As an example, in 2004, the Australian Department of Defence's external audit agency expressed a lack of confidence in the materiel organisation within the department and placed findings against it with qualified statements. This led to new performance metrics, policies and processes being developed to rectify the audit findings at a cost of approximately AUD $110,000,000 and took over 10 years to rectify the situation. By 2014 the findings were removed, and Defence had regained the confidence of external auditors to appropriately manage business. However, very little was learnt. This cause and effect environment was realised and operational for several years.

Recently, DoD is fast tracking back to potential financial qualification of statements once the governance regime was lifted. The DoD was placed in a position that arose as a direct result of lack of root cause investigation, a distinct lack of robustness of business processes, a poor compliance network, and a lack of foresight into emerging technologies that are the key risk factors for failure in compliance, lead to capability risks, current and emerging operational risks, and reputation damage.

An extensive and complete new framework of compliance and assurance risk management method was established as an extremely reactive response to the critical position that was identified pertaining to Australia's DoD financial statements.

The author believes the singular and only way to improve the compliance and assurance is to conduct an appropriate and effective Root Cause Analysis (RCA) utilising big data from the collective evidences held within the DoD including scans, emails, values, volumes, contracts, invoices, roles and responsibilities and so forth, including data from finance and inventory systems, across different networks. There is a need to adopt modern technologies such as Artificial Intelligence (AI) for machine learning of big heterogeneous data for RCA, blockchain for immutable single source of truth, geospatial interfaces for situation awareness, and mobile technology for real time tracking, situation aware and reporting. The author believes that utilising modern technology, development, and progression in the environment of Compliance and Assurance (C&A) across logistic and financial transactions is the only way forward within the Australian CASG (Capability Acquisition and Sustainment Group). To start-up this idea, the author utilised the digital start-up project main concepts as a method, and this idea received stockholder-buy-in and the project commenced in record time.

The motivation of the digital start-up project is proffered as an alternative to the traditional "big-bang approach", also known as the overlord approach. This existing approach has led to difficulties in requirement definition at the commencement of large complex projects, and difficulty recruiting subject matter experts both internal and external to the organisation. The overlord approach creates difficulties controlling product delivery not only on time and within budget but also obtaining useful deliveries along the life cycle of large complex project development.

An example of a recent one-stop-shop Enterprise Resource Planning (ERP) platform procurement at Australia's Department of Human Services was a billion-dollar contract over five years to plan the integration of major government health and social security systems, which resulted in failure and cancellation of the project.

The 'overlord' approach contrasts with the digital start-up as it does not respond with such fast progression and responsiveness to the end user. According to Steve Blank and Bob Dorf (2012), the start-up is "*a temporary organization designed to search for a repeatable and scalable business model*." By comparison, the track records of start-up companies in the world led by innovation founders, digital start-up projects within the public sector have been driven and funded by a handful of innovators and visionary leaders. Digital start-up projects, often with small investment, give the team an opportunity to develop, test, and validate their ideas.

Digital start-up projects have their main assets linked to technological investments. Their value proposition is based on projects that are simultaneously contributing to and feeding off technological changes. The projects result in innovative services and developers keen to experiment in order to solidify the project's relevance. Digital start-up projects should be a new way to adapt to rapid changes in technology offerings and customer needs, while controlling R&D costs (Khanfir, 2018).

## 3. DIGITAL START-UP PROJECT DEVELOPMENT METHODOLOGY FOR CARM TOOL

The digital start-up project management methodology has three key elements, namely:

a. Anticipation of a **long journey** with many fast delivery life cycles with many small Digital Start-up projects, such as CARM's modules of national vehicle management, stocktake auditing, inventory pricing, external purchase and so forth. Each small project implementation is going through many life cycles of being successful fast, fail fast, fix fast, step-by-step towards stakeholder satisfaction, thus leading to Digital Government Transformation (DGT) that could make an eminent impact on the modernisation of the enterprise. This is represented in Figure 1

b. The framework requires **continuous development and synchronisation of three sets of capabilities**:

   - Cognitive capability;
   - Technology capability; and
   - Enterprise capability.

   The key driver for the continuous development and synchronisation of the three capabilities is the enablement of continuous learning and self-learning for the stakeholder, the system and the enterprise.

c. The framework focuses on ***what*** but not ***how*** This focus enables separation of concerns as lain out in the software

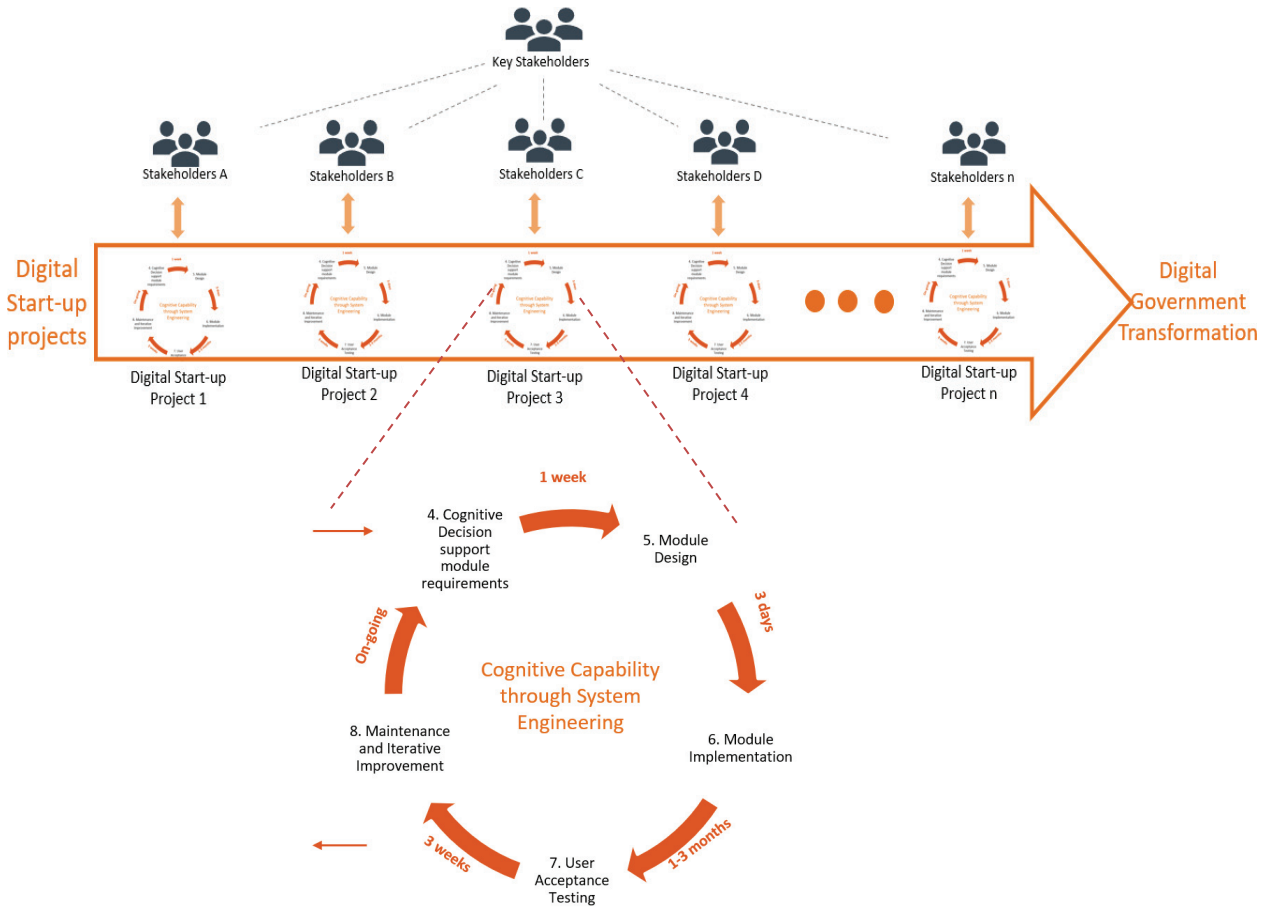



**Figure 1** Digital Government Transformation starts from digital start-up projects

engineering domain. The separation of concerns leads to separation of tasks between the stakeholders and the providers. With traditional approaches to large procurement projects, the enterprise focuses on the stakeholder's knowledge on *what* and *how* the product or service would be undertaken. However, this is not the case in the CARM tool development. The experience with CARM tool, with the Digital Start-up projects' mentality, being low risk, low cost fast deliveries, fast feedback and endorsement help to improve the business, IT alignment and builds trust and the confidence amongst the stakeholders.

## 4. THREE CAPABILITIES SYNCHRONISATION IN THE DEVELOPMENT LIFE CYCLES

In the management of the CARM development, there are three key questions that need to be consistently answered to meet the capability development need. They are:

a) What human cognitive decision making, and self-learning capability have been increased by using the system or the CARM tool?

b) What system capability or the CARM tool can be created and continuously improved to meet the stakeholder demands for timely, accurate, intelligent, and robust data, information, knowledge and decisions from the system or the CARM tool?

c) What enterprise performance, objectives, and capability readiness can be achieved by the system or the CARM tool?

Therefore, we define the development and synchronisation of the three sets of capabilities as:

1) **Cognitive Capability**: there is continuous development and synchronisation of the cognitive capability of the workforce or stakeholders enabling them to continuously ***see understand*** *and* ***learn*** enhancing the ability to use emerging technologies for business operations and achieve improved decision making, as well as a capability to adopt Artificial Intelligence (AI) leading to better human performance, productivity and efficiency

2) **Technological Capability**: there is continuous development and synchronisation of technology capability for speed, accuracy, security and automation within the system allowing for utilisation of emerging technologies including improved blockchain speed and security, AI analytic accuracy, Geo-Spatial intelligence, and Mobile Platforms to culminate in a progressive and functional tool within a continuous improvement developmental program with digital start-up projects.

3) **Enterprise Capability**: there is continuous development and synchronisation of the enterprise's capability through

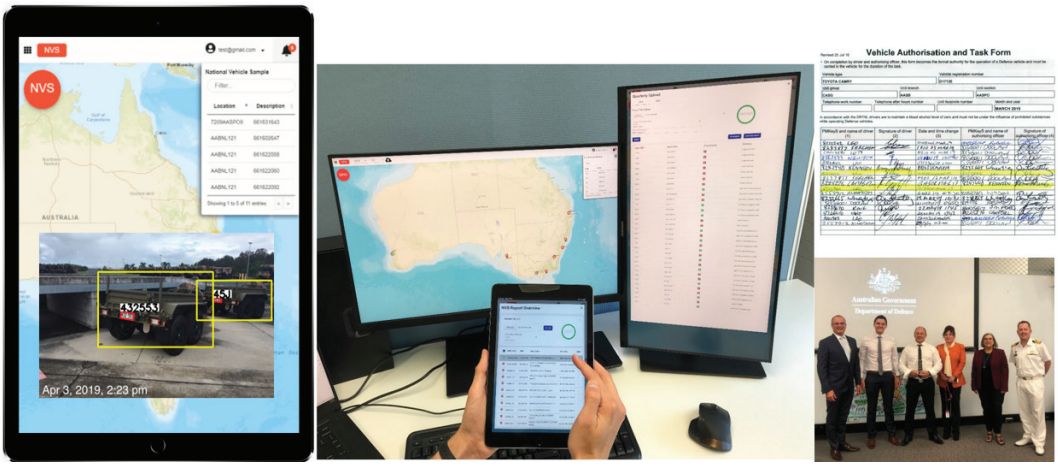



**Figure 2** The CARM tool using digital start-up project concepts, leading to step-by-step workforce and workplace digital transformation

digital start-up projects and enablement of the organisation to manage its resources. By leveraging its resources such as finance, data, knowledge and people, an enterprise can execute a low risk, low cost, high productivity strategy, and gain an advantage over competitors. Here, capabilities focus on the ***step-by-step learning loop*** *and* ***progressive building of capabilities*** to manage resources as the key enterprise assets, ensuring a digital culture transformation that gives meaning to its actions and the enablement of greater leadership and management capability to support co-innovation for workplace modernisation and digital transformation.

## 5. CARM TOOL – THE START-UP PROJECT MANAGEMENT APPROACH

Through engagement with subject matter experts, domain users, and academic researchers as well as graduates from the Australian Defence Force Academy, the CARM tool was strategically planned to commence the digital start-up mentality, with an incremental module development. Such an approach, in the context of both parties on both sides of the IT procurement lead to the unified understanding of all issues, clearer business requirements, better business processes, greater accountability and the like with lower risk, lower cost and higher productivity for the enterprise. Figure 2 presents the CARM Tool operation automation and digitization powered by mobile computing.

The photo on the top right of the Figure 2 presents the existing manual-based method. The photo on the lower right of the Figure 2 is of the innovation award to the author with the team and the panel judges including Deputy Secretary of CASG DoD Tony Fraser.

CARM is an Open Platform within the CASG DoD that shares audit findings, scheduled corrective action to be taken, individual asset availability, values and volume discrepancies, stock reports, warehouse inventory, and stock item owner accountability in terms of compliance and assurance performance. It provides situation awareness in real time, the information visibility will trigger continuing improvement, and inspire joint solution development for better performance. To date, there is no such data visibility support from unit to base, from warehouse to headquarters.

The risk representation in CARM tool is as follows; a) Red indicates “totally non-compliant” or the performance is considered “very poor” or “high impact list”; and b) The dark green represents “compliant”, or performance categorised as “very good”.

Zoom-in and zoom-out assists visualisation of why, who, what and where regarding problems, to carry out trend analysis through track and trace of performance including corrective actions, same mistakes over time, Register to Floor, or Bin to Register (type of audit). It also allows one to compare and contract with other peer groups, encouraging peer learning, GAP analysis, bench-marking and self-assessment - a truly One-Defence.

CARM is a mobile solution that provides real time asset information, location, and proof of existence. It allows seamless auditing, real time counts and re-counts from physical locations, type brief note, evidence capturing by voice or image, including transferring the data from the papers or Excel sheets, carrier detail, audit officer, counting officer and recorder of names and signatures. This can save up to half a day per person for each audit and there are over 1000 audits in each financial year of AUD $1.5m types of assets.

### 5.1 The Early Development of the CARM Start-up Project

The case study trialling the CARM start-up project was small, in a sense that it started with half an A4 page of project requirements from the author, one of the key stakeholders, plus a one hour lecture at the Australian Defence Force Academy and regular weekly meetings for the first three months. It was also drawing from the student projects with 80+ student participants. It came with enough supporting documents and availability of the subject matter expertise at any point in time to help understand stakeholder requirements quickly and precisely. Both parties appreciated the importance of well-defined issues and problems to be solved. The quick proof-of-concept prototype delivery gave confirmation that the project was on the correct path to be endorsed by the stakeholders.

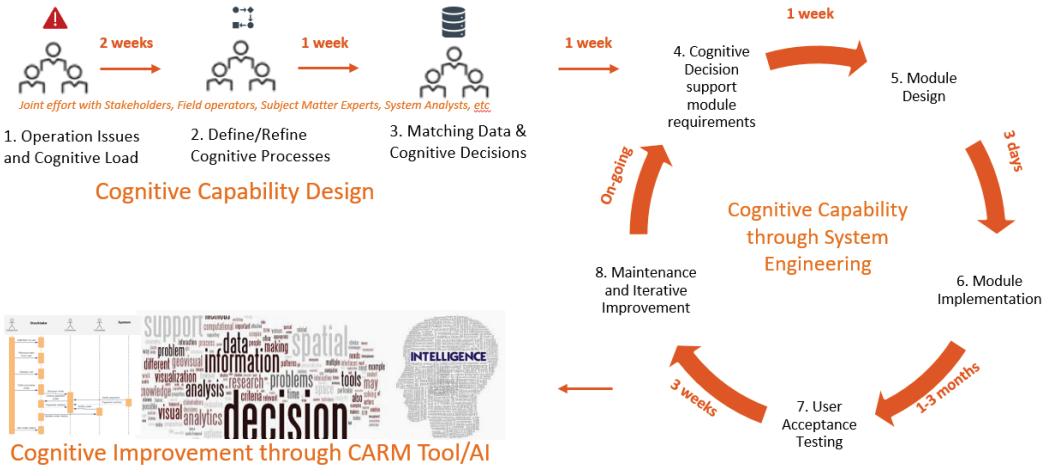



**Figure 3** Cognitive capability synchronising throughout the CARM tool development

The rapid delivery, once every three weeks, allowed an iterative feedback loop enabling 'fail fast and fix fast'. Stakeholders were in control of the progress and the development team at the Australian Defence Force Academy was gratified when the stakeholder was satisfied with the results achieved.

## 5.2 The Cognitive Capability Synchronisation

Improvement in the system design and development aims to mitigate human performance shortfalls while maximising system effectiveness. The framework includes important relationships to the utilisation of the engineering principles and allows stakeholders including subject matter experts, workforce specialists, end-users, and the hierarchy of program managers and executives, to work together with the system analysts to define the requirement and contribute design ideas and gain feedback on the prototype systems for the CARM tool. A conceptual representation is shown in Figure 3.

The cognitive capability synchronisation has the following dimensions:

A. **Cognitive Capability Design** – In order to ease the human mental load required to perform tasks such as identification of stocktake non-compliance risks and emerging risks, the cognitive capability is designed to understand and improve processes. An understanding of the data required can be addressed through the new CARM tool to support operation or business decisions.

B. **Cognitive Capability Computing** - Through System Engineering, an engineering life cycle is presented from planning, design, implementation, testing, and maintenance to continuing system improvement, 'fail fast and fix fast', to meet the demand for the cognitive decision support in a complex and dynamic operation environment.

C. **Cognitive Improvement** - Through CARM Tool Artificial Intelligence, the result of the CARM tool will be identified, capturing and managing trustworthy data sources and decision support to help the workforce to manage operational risks. The human element is an integral part of all transactions and is supported by the CARM tool cognitive decision AI module, data and decision on the roles, responsibilities and accountabilities can be retrieved at the point-of-need.

### 5.2.1 Cognitive Capability Design for Cognitive Decision Support

In the case of DoD, risk management is conducted through compliance testing its policies, business process testing for risk identification, measurement and elimination. Compliance can be executed through business process testing against Risk Controls. Measurement of risks can be conducted through scheduled and unscheduled CARM Audits. The CARM Audit process checks compliance against the CARM policy, which is extracted from enterprise agreed business process policies and transactions.

The author led a team and developed a complete operational risk measurement matrix that can be used for risk quantisation, measurement, and cognitive decision support, as shown in Figures 4 and 5.

The Risk Metrics Cube developed by the author, for cognitive decision support is shown above where each slide addresses one particular risk. The top 40 risks needing to be addressed within the CARM tool are mitigated to improve enterprise performance and capability readiness.

### 5.2.2 Cognitive Capability Computing

The first digital start-up project undertaken in DoD as a real-world operational environment, used the CARM tool and referenced the *Risk Metrics Cube* to conduct a risk management analysis. It utilised automated business process testing against DoD's policies. The key challenge was to automate processes to reduce human mental load assessing big data for decision making.

The CARM tool implemented the *Risk Metric Cube*, a set of business process risks, controls and testing methods coupled with 100+ flowcharts. This CARM policy developed was an abstraction from the Australian Defence Logistics and Supply Chain Manual.

The CARM tool could be implemented by 90+ possible risks that are affecting enterprise performance. There are also emergent risks that are continually identified and added

| Risks | Index | AuditLabel | Risk Controls | Role | Reference | Business Process Testing Method |
|---|---|---|---|---|---|---|
| Stock Take | 1.201 | Key Business Process Control | Each Unit/organisation is to have an approved Stocktake Plan. | Stocktake Manager | ESCM 04.10.02<br>ESCM 04.10.03<br>ESCM 04.10.07<br>ESCM 04.03.19 | The Tester is to verify that the unit holds a signed, authorised and approved copy of the Stocktake Plan MSA1SP for both Cyclic Progressive and Assurance Stocktakes.<br>(1) MSA1SP must be approved and signed by Commander/Manager/Equivalent before approval date in MILIS (MSE1S3). |
| | 1.202 | Key Business Process Control | Count Sheets for initial count and re-counts (MSB1SKA) are to be signed and dated by the Count Officer and Stocktake Recorder. | Stocktake Manager | ESCM 04.10.01<br>ESCM 04.10.02<br>ESCM 04.03.19<br>ESCM 04.10.04<br>ESCM 04.10.02C4 | From the selected samples of completed stocktakes, the tester is to verify that the last page of the count and recount sheets (MSB1SKA) have been signed, (includes printed name and date), by the:<br>(1) Stocktake Count/recount Officer;<br>(2) Stocktake Recorder.<br>Note 1: For NAVY - Stocktakes that are conducted on Ships or Boats can be verified via a signal. The signal reference is to be added to the Findings detail.<br>Note 2: For WMS sites - This is not a requirement for WMS Warehouse Stocktakes. This is still a requirement for SCA Stocktakes in WMS locations. |
| | 1.203 | Key Business Process Control | All stocktake discrepancies recorded on the Stocktake Discrepancy Adjustment Report (SDAR) (MSB1SHB) are to be investigated and details noted on the MSB1SHB for discrepancies that are resolved. | Stocktake Manager | ESCM 04.10.01A<br>ESCM 04.10.02<br>ESCM 04.10.04<br>ESCM 04.03.19<br>ESCM 04.10.02G | If the selected samples contain resolved discrepancies the tester is to verify the following:<br>(1) the original MSB1SHB has been retained;<br>(2) there is a brief reason for resolving the discrepancy for each resolved or partially resolved line on the MSB1SHB;<br>(3) evidence is attached for any lines resolved;<br>(4) the number of resolved discrepancies on SDAR (MSB1SHB) = number of resolved discrepancies on TPR.<br>Note: Defence Stocktake Documentation Evidence Requirements and Standards are outlined in ESCM 04.10.01A. |
| | 1.204 | Key Business Process Control | Prior to adjustment of discrepancies in MILIS the adjustment must be authorised by the relevant Unit Commander/Manager/Contract Authority/SPO equivalent, or an official authorised in writing by the Unit Commander/Manager/Contract Authority, by signing the MSB1SHB. | Stocktake Manager | ESCM 04.10.01<br>ESCM 04.10.02<br>ESCM 04.10.04<br>ESCM 04.03.19<br>ESCM 02.03.01D | If the selected samples contain adjustments the tester is to:<br>(1) verify the authorising signature on the MSB1SHB is that of the Unit Commander/Manager/Contract Authority/SPO equivalent or an official authorised in writing to approve the adjustment of discrepancies resulting from a stocktake (eg. promulgated in Routine Orders, similar Instructions or minute);<br>(2) MSB1SHB was authorised prior to the discrepancies being recorded in MILIS (utilise the MSE1RM screen);<br>(3) ensure that the person authorising the adjustment is different to the stocktake recorder. |
| | 1.206 | Key Business Process Control | The Stocktake Stores Adjustment Voucher (MSA1SI) has been correctly completed and any liability determined by an appropriate Delegate. | Stocktake Manager | ESCM 04.10.02<br>ESCM 04.03.19<br>FINMAN2 Sched 12 | For the samples of stocktakes with adjustments selected the tester is to verify that the:<br>(1) Removed.<br>(2) SSAV has been signed by a Financial delegate to determine the course of action and any liability for loss of relevant property (if required);<br>(3) Removed;<br>(4) Deficiencies > $1000.00 have been investigated;<br>(5) Removed. |

**Figure 4** Manual-based Operational Risk Management Matrix for One of the Risks Measure (Green, 2019)

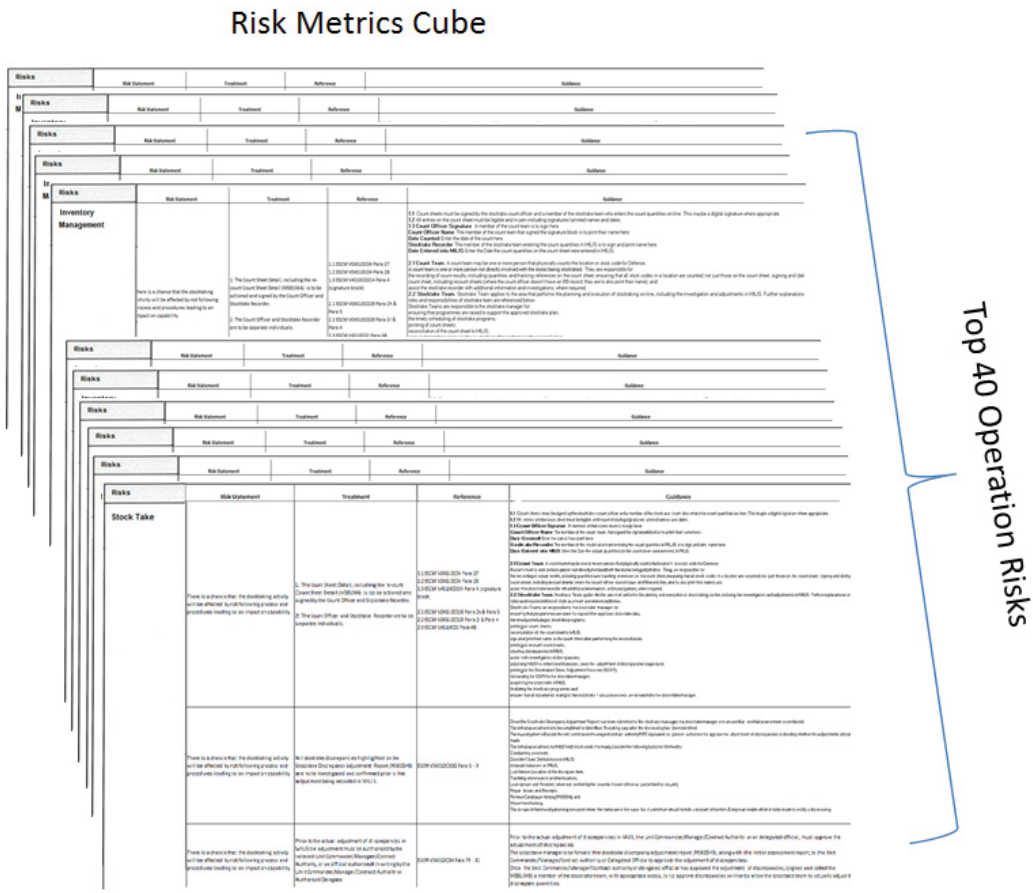



**Figure 5** Risk Metrics Cube for 40+ identified operation risks (Green, 2019)

to the metrics showing its flexibility and adaptability. The current proposed CARM tool deals with the top 40 high risks. The start-up project was successfully implemented on those risks identified in the Auditing and Assurance Check for Stocktakes. The system engineering approach to cognitive support reduced manual-based operations by consolidating all paper-based processes, which ranged from 4,000 to 66,000 pages. The first-round of implementation with 100+ processes were removed through automation. Five hundred pages of manual-based processes on stock-take alone in the e-supply

chain manual were transformed into 90 pages of automated operations and digitization in relation to stocktake processes.

## 5.3 The Technology Capability Synchronisation

Continuous development and synchronisation of the technology capability for speed, accuracy, security, and automation requires continuous innovation in technology development to meet the enterprise's demand. Methods such as AI and blockchain can be utilised.

- The procurer is to provide quality output from the system that addresses key business questions such as what the root causes are, risks and so forth.
- The solution provider is to address the short-comings of the emerging technologies as no tools open source options, or off-the-shelve products perfectly meet the enterprise's needs. The emerging technologies may need customisation, modification enhancement or innovation to fulfil these

CARM tool is adept at integrating blockchain and AI open sources but only does half of the job. The team faces numerous challenges to advancing AI algorithms and private blockchain for CARM tool technology capability to meet the stakeholder demand.

> *For example; if an existing best-of-breed AI algorithm is utilised for image recognition and interpretation and obtained 70% accuracy over 2 hours to compute 300 folders over 1000 heterogeneous files, the procurer may not be satisfied and request 90% accuracy with less than 30 minutes computation time, a new solution is required.*

To build better CARM tool capability, the team needs to innovate, apply, and improve further or use multiple algorithms, evaluate, and progressively improve the accuracy. The stakeholders may then extend their expectations. This requires the joint effort between the stakeholder and the provider/developer to innovate such as using conjoint multiple AI-based text and document mining and machine learning algorithms to help improve the outcomes to reach the stakeholder's expectations. Inspired by AI, the CARM tool should have the capability to work with multiple data sources and demonstrate root cause analysis – with visibility, transparency, and accountability tracking.

The joint effort needs to continually innovate and believe the private blockchain affords greater trust and security than any database's technology existing in the world. It was decided that the CARM embeds blockchain to store data, filing and certification.

## 5.4 The Enterprise Capability Synchronisation

Enterprises need to meet their objectives including performance, cost, customer services and risk management. CARM tool's implementation and deployment needs to be synchronised with the enterprise's capability. An example is risk management in large complex enterprises such as compliance and assurance with regards to the accurate finance, asset or data/information management, which impacts the organisation's reputation and capability preparedness. However, transaction recording, reporting, tracking, and analysis are the job of big data, either in physical or digital format. An example is the supply chain network in defence logistics and sustainment including multi-dimensional data management, which needs to address the whole capability life cycle amongst military services and joint forces, as well as similar workforces with a hierarchy.

Managing and reporting such data is intensively mandraulic, time-consuming and error prone. There have been no satisfactory tools proposed to support big data management particularly dealing with sensitive areas such as defence logistics. Managing and data reporting not only hinders human performance but also wastes personnel's valuable time away from undertaking higher-order tasks such as strategic planning. With the first digital start-up project investigated using the Australian Department of Defence's asset auditing, the estimated risk elimination is within two years of the deployment.

Digital Government is about all its sectors undergoing digital transformation. The enterprise's operation benefits from a paperless transactional society and promotes full intergovernmental agency within the digital environment. This CARM tool is digitising the processes and operations, as well as using innovative ideas to polarise one single, large, centralised governance body to distributed, self-organised subject-matter clusters or groups. These groupings are part of an ecosystem allowing smaller coalitions that result in impact oriented, agile, and rapid development, and cost less to manage, communicate and govern.

The value of Big Data, both as a business corner stone and a powerful financial driver has become acknowledged and readily accepted. Data that goes un-analysed without any identification of trend or risk is just noise. To succeed in any IT project today, an agile methodology, such as the CARM tool, is the collaboration amongst all stakeholders sourcing appropriate data and extracting impacting anomalies relating to operation world environments is imperative. This will enhance an enterprise's capabilities.

Proof of concept utilising the digital start-up project, an agile approach will demonstrate the veracity and robustness of such an ideology supported by an appropriate and effective Digital Government Transformation framework. A methodology not supported by a solid workable framework is merely a single use program and will lack the capability to be adaptive and affective under a variety of risk conditions.

# 6. INNOVATION STRATEGY AND IMPLEMENTATION FOR CARM TOOL

The Fourth Industrial Revolution represents fundamental changes in all aspects of enterprise, workforce and workplace. The technological driven revolution must be part of future enterprise, integrated and comprehensive, involving all stakeholders in the digital transformation. CARM tool has adopted two leading technologies, AI and Blockchain.

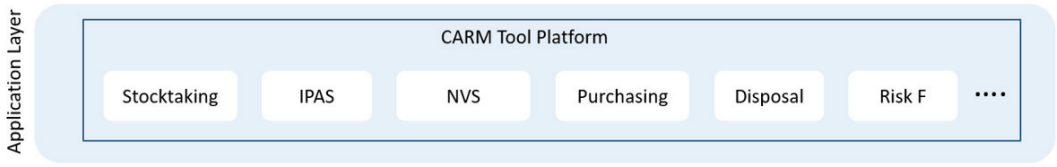



**Figure 6** CARM tool platform and each application is a start-up project

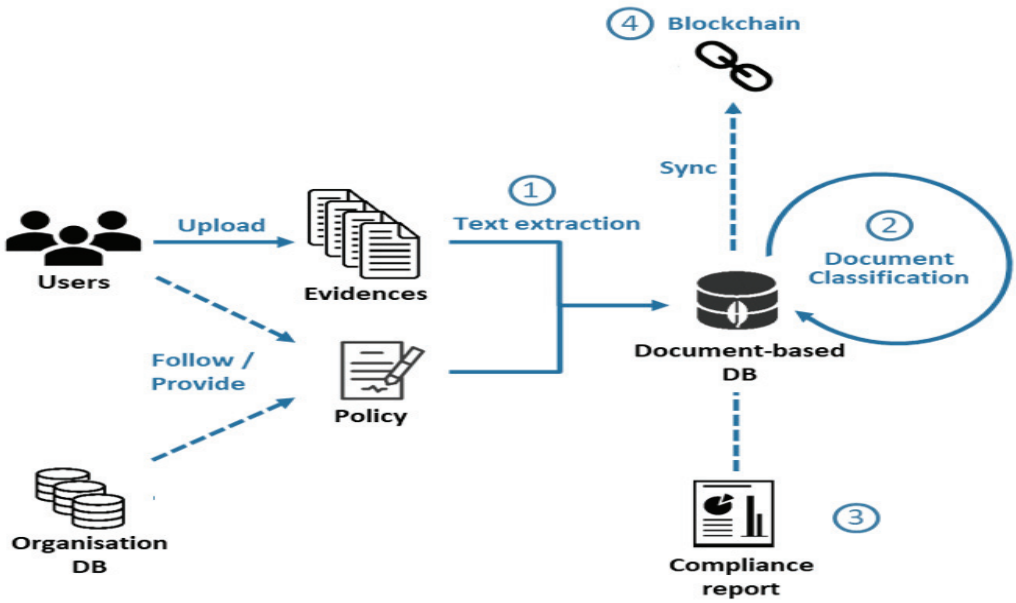



**Figure 7** The CARM AI-based text and document mining

**Artificial intelligence (AI)** – CARM Tool needs to "think" like humans: recognising all heterogeneous files, evidence, documents, trends and patterns, processing information, drawing conclusions, and making recommendations. AI in CARM was successful in terms of analysing patterns for risk identification, Big Data and document reasoning and timely reporting through mobile devices such as iPADs.

**Blockchain** – CARM needs a secure, immutable, decentralised, and trustworthy way of recording and sharing of data and reports with no need to rely on third-party authorities or system providers. The digital currency Bitcoin is the best known blockchain application. The technology has been used in many ways including making supply chains traceable, securing sensitive data anonymously (e.g. medical information), and combating fraud (e.g. electoral voting).

## 6.1 CARM Tool Innovation with AI

CARM Tool is an AI platform with blockchain as a statutory record. It contains many applications and each application is independent in that it does not use the other's data or services much like Apps on the iPhone platform. Each App performs unique self-contained risk control services.

CARM tool's first digital start-up project known as Asset Compliance Auditing in the materiel organisation within the Australian Department of Defence began in mid-2018. The second digital start-up project was the compliance auditing for asset Inventory Pricing and External Purchase Orders (known as IPAS) in early 2019. The third digital start-up project was National Vehicle management (known as NVS) that commenced in late 2019. See Figure 6.

With the CARM tool, text mining and machine learning starts with text extraction, in which data comes from the different unstructured files (evidence and questionnaires). CARM tool classifies the type of document and extract necessary compliance information such as date, price, and description of a purchase to be later automatically matched against policies and processes. This is followed by machine learning for document classification that defines certain types of evidence such as invoices. CARM tool can classify at least ten different types of documents or evidence and each is presented with four features such as file name, file format name extensions such as ".pdf" or ".xls", frequency of words in each document, and text capitalisation. The data is then divided into training and testing data sets in order to improve the accuracy of the automated document classification. Three different machine learning algorithms are applied including the logistic regression, random forest and the multinomial Naive Bayes model. In the example used above, accuracy started at 70% but when continuously improving the algorithms, the CARM tool is able to correctly classify the document type at 95% accuracy. When a new document or file or purchasing evidence is added to the system, the document type is automated, identified and recorded in the CARM tool. This is represented in Figure 7.

CARM tool, next, automatically aligns the evidence with the enterprise policies and processes as shown in Figure 7. Regarding the data from the evidence, CARM tool automatically

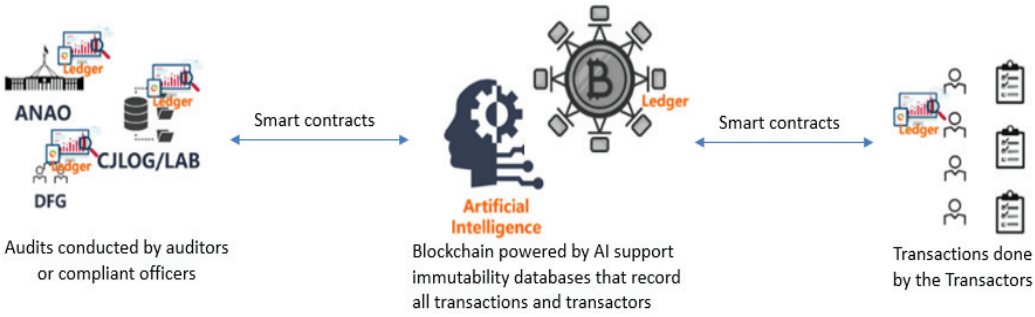



**Figure 8** Representation of the CARM tool blockchain record the audit activities

searches the document using regular expressions to efficiently locate the target values in specific documents. For instance, if there is an invoice with a total price in a foreign currency, the price must be converted using the exchange rate of the date of issue of the invoice or an agreed rate. Therefore, the exchange rate must be extracted from another file. Since the document types are known, the algorithm can look directly at the correct file type and check whether the supporting evidence, such as a purchase order, has been provided followed by confirming whether there has been sufficient evidence for the finance management according to the policy, and then it provides the score of compliance.

This innovation has produced significant results. Using the above example, an audit of 400-purchase orders with heterogeneous document evidence is presented. The audit involves reading folders and individual files such as invoices, purchase orders, emails, requests, currency exchange rates, quantity, quality, in-line with the total cost, including/excluding sales tax, signatures, dates, correct approval authorisations and so forth, and matches these with the finance databases, asset inventory databases and the like. In the example being used:

- Prior to May 2019, auditing of 400 purchase orders would take two auditors two weeks to produce the report, about 140 hours.
- In May 2019, the first CARM tool AI automated results took two hours with 70% accuracy.
- In August 2019, the revised CARM tool gradually improved its AI algorithms. It took about 15 minutes producing 85% accuracy.
- In December 2019, the CARM tool's capability improved. It took less than 10 minutes producing 90%-98% accuracy.

## 6.2 CARM Tool Innovation with Blockchain for Accountability

One key requirement to meet the stakeholder's needs is to include transaction accountability, data security and single source of truth. However, there has been no successful example or case study or tools available to build such a blockchain for an enterprise such as the Defence environment. In addition, the CARM tool has to overcome the following issues of tangibility and non-tangibility.

a. Existing blockchain has been applied to a supply chain to track and trace tangible assets but the CARM tool blockchain also tracks and traces non-tangible assets such as human accountability and enterprise risks.

b. Existing blockchain can track and trace people, assets and the transactions – the Ledger (tangible); where the CARM tool blockchain tracks, identifies, processes risks, compliance, assurance, roles, responsibility, and transactional activities (non-tangible).

c. Existing risk approaches focus on the loss of finance or human resources (tangible asset), where the CARM tool blockchain focuses on the business policies and processes along with operational risk assessment and management in relation to accountability, social responsibility, capability, enterprise reputation and trust (non-tangible asset).

The conceptual representation of the blockchain within CARM tool is shown in Figure 8.

Unlike existing blockchain technology, CARM Accountability Blockchain implemented the following unique features:

1. The Ledger in the CARM tool contains audit transactions such as checks between computer records and physical records, discrepancy findings, corrective action follow up, authorisation for approval etc. See Figure 9.
2. The existing blockchain focuses on the participants of a business network or between enterprises, when CARM focuses on the business and operational network within the enterprise.
3. Smart Contract in blockchain can be defined with regards to physical asset transactions and consensus is to be reached by all parties in the blockchain. In the CARM tool, it is the rules (like smart contract) for compliance and assurance against risks, the consensus that is the compliance against the rules and policies and is not optional.
4. Every participant in the blockchain has an identity or a passport for carrying out transactions, which can be tracked in the CARM tool. It is a private blockchain and it uses authentication, staff ID, security levels and defined permissions.
5. Concurrent auditing can be conducted and tracked by the Transaction Ledger and published within the network.

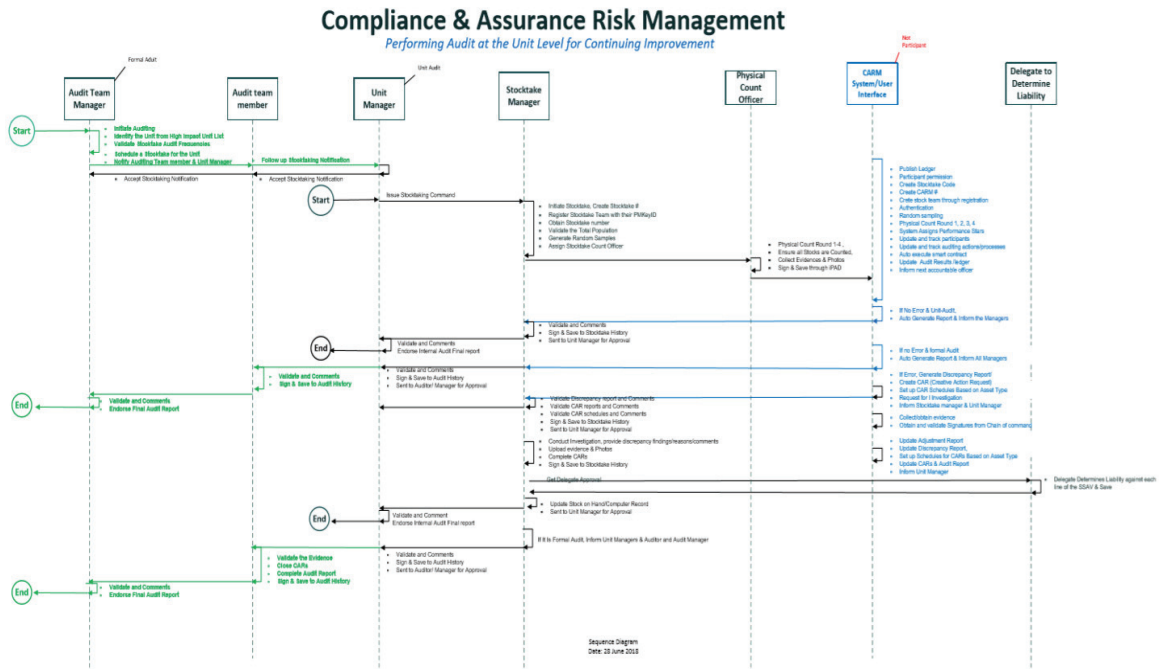



**Figure 9** Concept demonstrator of the Smart Contract for Accountability tracking within the CARM Tool

6. Blockchain for ordered operation is used, unlike existing blockchain that has random transactions from any participant.

The CARM tool is equipped with an Accountability Blockchain, which provides a unique set of capabilities that no other databases or ERP systems within the current enterprise can offer, these include:

- Immutability - No changes can be made to the blockchain ledger, leading to a full auditing trail ensuring the highest level of integrity.
- Transparency - Policy is transparent so everyone can see what the auditing situations and accountabilities are as the output of the CARM tool.
- Accountability - Digital signature / certificate-based signing. Every action in the process is signed with a digital signature. Data sharing with independent auditors such as a national audit office for public sectors ensures accountability.
- Security - High integrity authentication and authorisation with digital signatures provides the ability to assign levels of confidentiality.
- Smart Contracts – Improve data quality through automation: self-executing agreements.

The key innovation of using blockchain in CARM tool is essentially to regulate compliance and assurance policy and risk management through tracking accountability of staff, officers, auditors, authorities and managers with regards to the compliance of the enterprise-wide business processes. One international patent and one Australian patent has been award for this work (Patent # 101818AUV00; PCT/AU2019/050997 and 104802AUV00) in 2018 and 2019.

## 6.3 CARM Tool Innovation with Private Blockchain for Trust

One of the most challenging issues is to build the trust and security for the Blockchain within the enterprise and its alliance and defence industry partners. Public Blockchain achieved networked trust and security. However, in all the financial institutions and Defence sector, the public block is not suitable, due to the sensitive of the data. Therefore, the team needs to innovate a private blockchain for the CARM tool. If it is a "private" blockchain, we need to consider:

1) How can human operators use and trust the CARM tool private blockchain databases?
2) How can human operators experience the *single source of truth*, data immutability, data transparency, and data auditability?
3) How are humans accountable for their transactions?
4) How can humans trust the Ledgers and analytic reports produced from the CARM tool?
5) How can trust be built so that trust between the human operators, the management hierarchy, peer networks, and the big data can lead to efficiency and productivity in transaction processing, reporting, tracking and analysis in this dynamic complex environment?

Many researchers have explored and developed blockchains (Tama, Kweka, Park & Rhee, 2017; Wang, Zheng, Xie, Dai & Chen, 2018) such as blockchain applications in stream data management with IoT (Conoscenti, Vetro & De Martin, 2016), big data management (Karafiloski & Mishev, 2017), cyber security and trust management (Hebert & Di Cerbo, 2019; Khan & Salah, 2018; Seebacher & Schüritz, 2017), and other data

quality aspects (Koteska, Karafiloski & Mishev, 2017; Yli-Huumo, Ko, Choi, Park & Smolander, 2016). The key issues of trust and use of the private blockchain have barely been discussed or successfully implemented in the existing literature (Hebert & Di Cerbo, 2019). The use of the HSE approach to private blockchain system development to achieve trust and accelerate government and large complex enterprise adoptions of private blockchain will be presented.

Due to the lack of documentation and social network support on the private blockchain using open source Hyperledger Fabric, building the trust and security blockchain network through infrastructure design of the trusted private blockchain network commenced here. The blockchain in the context of Hyperledger Fabric is composed of Peers, Orderers, Certificate Authorities, REST API SDK servers, numerous databases and reverse proxies all running inside Docker containers. These components can communicate with each other to form a single Hyperledger Fabric Channel, which forms the blockchain and its ledger and can provide quick blockchain database delivery, testing and feedback.

As an example of CARM blockchain that involves two organisations as a blockchain network, a third trusted party is used to facilitate trust between these two organisations. The purpose of the blockchain network is to provide transparency with asset management data, utilising the key properties of a blockchain such as an immutable and distributed ledger to record the transactions and transactors. To showcase the distributive nature of the blockchain, management of security features, the underlying Public Key Infrastructure (PKI), fault tolerance capabilities and resiliency, or failure with minimal or no consequences, different network entities known as Docker containers via Docker Swarm are used (Becherer, Zipperle, Green, et al. 2020).

Existing solutions of Private Hyperledger Fabric Blockchain deal with keys and certificates in a centralised orderer. Such solutions, however, violate one key significance of blockchain technology being decentralisation through decentralised key management. In contrast, private blockchains rely on centralised key management and the centralised authority. In order to develop a Trustworthy Private Blockchain for CARM tool, a unique PKI in private blockchains is engineered through keys and certificates management to ensure trustworthy communication with the blockchain including hosts, nodes, and participants of organisations.

Through Innovative Trusted Gateways, the Docker containers get authenticated through appropriate credentials in Docker Secrets and enrol their preconfigured organisation administration. The public/private key pair and a signing request for the certificate are generated for each administrator when a gateway is initialised. Each then receives a signed certificate through the blockchain via trusted peers and their supervisors. Trust is then facilitated through a channel, which is a private communication between different organisations or subnets. Each channel contains its own distributed blockchain ledger. The channel creation involves sending the previously generated channel transaction through participants' gateways. Peers of each organisation can then be added to the channel. If an organisation obtained the peer information of another organisation, it would still not be able to join the channel as there is a mismatch between the peer's organisations listed in its certificate. Once complete, the peers and users will be logically connected in a shared channel.

Over a private blockchain, the CARM Tool delivered Keyless Signature Infrastructure (KSI) as the digital start-up project, which provides additional security across the blockchain environment. Data is stored within the blockchain technology. Access will be by way of KSI and depth of data integrations will be profile based. In a contract based intensive environment, utilising blockchain leads to the protection of individual's data and provides the same data to all transactors. This continually provides validation of data integrity. This will permit enterprises like Defence and/or sub-contractors to have the advantage of transparency and management of their data. The blockchain makes every footprint immediately noticeable, regardless of the source. Blockchain protects information without specifically identifying the information itself. The principle behind blockchain is one where all data entered will be available to all stakeholders in the blockchain network pending the user profile. CARM tool enables assessment of different levels of access to data.

Data quality and accountability tracking within the public sector, using blockchain technology, can ensure data integrity and mitigate internal threats to the data. In this way, every occurrence of data use and misuse, discrepancies are detectable and major damage to financial accountability, for example, can be prevented. Blockchain provides real-time alerts to discrepancy of stocktakes or inventory pricing, enabling the auditors such as the Australian Department of Defence's Capability Acquisition and Sustainment Group (CASG) to respond to incidents immediately. CARM Blockchain is an 'industrial strength' private blockchain that guarantees the integrity and security of data privacy of its users and sub-contractors.

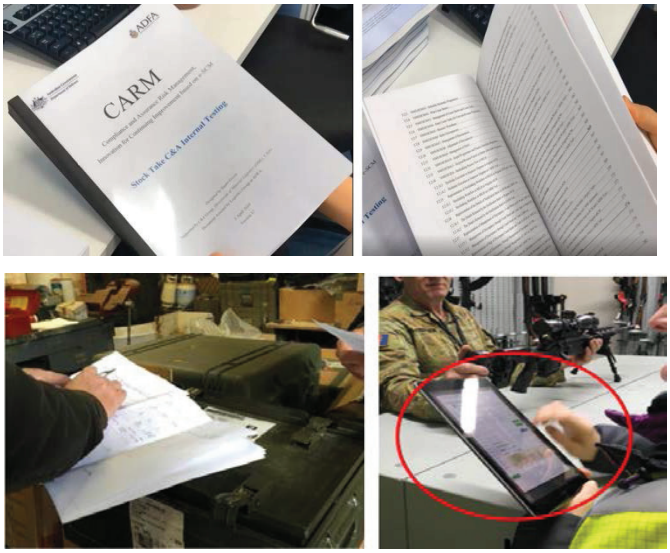
## 7. FIELD TESTING AND THE BENEFIT OF THE CARM TOOL

The first start-up project is the CARM tool stock audit module, through the advanced AI and Blockchain There were 103 manual based stock-take operations that were automated or updated in the CARM tool. A 500-page CARM e-Book provides the details of this digital transformation. This is shown on the right.

A total of ten field trials have been conducted at various Defence bases in Victoria and New South Wales between July 2018 and July 2019. Exceeding positive comments and encouragement was received.

The stakeholder benefits and satisfaction as lain out in each start-up risk module within the CARM tool included immediate and long-term benefits:

1) Immediate benefit: Under existing auditing processes, there was a 75% finding of non-compliance or risk was anticipated. Within the first year of deployment, benefits from the introduction of the CARM tool will see a reduction to less than 5% of each risk measure. The overall objective is for the CARM tool to provide a reduction of risk and manage emerging risks with the aim of sustaining a 100% risk free finding in all external and internal audit activities.




| | |
|---|---|
| 1 | 80% less effort for auditors to rectify issues in each quarter |
| 2 | Top 5% errors will be identified in every quarter for continuing improvement |
| 3 | 80% manual operation will be removal |
| 4 | 80% less repetitive task to be conducted by all level of compliance officers |
| 5 | 90% risk reduction with 100% confidence |

2) Long term success plan includes:

| | |
|---|---|
| 1 | Provide real time risk situation awareness |
| 2 | Predict new and emerging risks |
| 3 | Enable senior leaders to be ahead of the risk curve |
| 4 | Embrace intelligent workforce |
| 5 | Improve human and enterprise performance |
| 6 | Support silo information integration and operations |

## 8. MENTALITY TOWARDS THE DIGITAL START-UP FOR DIGITAL GOVERNMENT TRANSFORMATION

A digital start-up project faces many dimensions in the enterprise's mentality. An enterprise must be ready to take risks, change and adapt. The entrepreneurs or innovation leaders within the enterprises must not be afraid of failure, as it becomes a steppingstone to fulfilment. An effective mind-set revolves around the readiness to fail. It means having no fear of change and always knowing adaptation to innovations is inevitable in the dynamic IT industry. In the public sector, having a positive mentality and supportive environment towards digital start-up projects is synonymous with being innovative and able to adapt to the ever-changing economy. It means being extremely purpose-driven, always thinking of alternative solutions, and working at a fast pace. Digital start-ups would benefit greatly from the following mind-sets:

- **Encourage Questions**: Start-up teams encourage questions to challenge concepts and ideas. This makes them more flexible than large enterprises. Questioning helps teams understand the common objectives and establish creative solutions to challenges.
- **Great Start-ups Embrace Change**: With the constant evolution of technology, users and enterprises have greater expectations. With a start-up mentality, enterprises can more readily adapt to digitisation and progressive equipment with agility. Innovators with a healthy start-up mentality strive to incorporate innovations and are risk takers.
- **Act on Innovation**: Digital start-up projects provide personnel with the tools to collaborate as well as assist by providing insight to act upon innovations.
- **Employee Training:** Employees in digital start-up projects are encouraged by the enterprise to develop, research, build on teamwork, think critically and manage change with the objective of reaching long term and changeable goals. CARM tool provides opportunities for employees to learn and grow through critical thinking, change management and leadership to establish skills that foster innovation and collaboration within the organization, the start-ups mentality.

Large enterprises such as governments can greatly benefit from the mentality associated with digital start-up projects and could be applied to address inefficiencies. Encouraging questions could trigger thoughts between mangers and the hierarchy that current approaches might benefit from more agile, effective and productive processes within and amongst agencies through digitalisation. In this way, personnel could be empowered to use digital innovative technologies and processes in their operations. The leadership needs to embrace digital transformation by initiating appropriately skilled training with universities and institutions to ensure its workforce are culturally aligned to the transformation process and on-going activities.

## 9. CONCLUSION

Through digital transformation processes, it can be envisaged that Digital Start-up Projects growth will depend on the way the enterprise builds and combines capacities, and to which extent new rules could be imposed that could produce results or impact the data ecosystem. The Digital Start-up Project considers emerging technologies around data, the digital innovation idea aimed to incorporate compliance, assurance and risk management.

The CARM tool is based on a framework that gives consideration to all aspects of input, numerous variables and the ability to accept numerous sources of data that can be reflected in a flexible tailored output reporting in various forms to suit the relevant audience.

Through data testing and insight from the Australian Department of Defence, the CARM tool has demonstrated root cause analysis and risk prevention for financial gains and extensive time reduction. The CARM tool offers full transparency with the highest quality of data in an instant. The push to input hundreds of previously manual based operations into CARM demonstrated

existing manuals automated and updated as necessary for digital transformation. The tool itself shows enormous potential to impact the capability, financial accountability and compliance of supply chain governance. The CARM tool is currently under further development in Australia.

The elements fundamental to this model are the ability to vary the aspects of risk to be identified and addressed, addressing the expectation placed on the procurer and the ability to effectively and efficiently achieve the desired outcomes and offer the expectation of visibility over the task at hand. To truly justify the success of such a framework, the test must surely be to vary the main players, risks and expectations. Achieving a positive result each time utilising a modular concept would strongly support the robustness and veracity of such a framework.

The CARM framework has produced exceptional results and will continue to provide cutting edge outcomes due to the refined and substantial foundation on which the CARM framework is based.

## ACKNOWLEDGEMENT

The author would like to thank the sponsorship of this work by the CASG MLCOE under the leadership of Director General Ed Louis. The author would also like to thank the innovation award panel judges including Deputy Secretary of CASG Defence Tony Fraser for their recognition, encouragement and inspiration. In addition, the author would like to acknowledge the staff and students at UNSW@ADFA (Australian Defence Force Academy) under the leadership of Professor Elizabeth Chang and Dr Florian Gottwalt who have carried out the implementation and testing of the modules to bring about the realisation of the CARM project.

## REFERENCES

1. Becherer M., Zepperle M., Green S., et al. (2020) "Engineering a Trustworthy Private Blockchain for Operational Risk Management" to appear, *A Framework for Human System Engineering Applications and Case Studies.* Book Chapter, *Editors*: Handley, H.A.H., & Tolk, A., IEEE Wiley USA.
2. Blank, S., & Dorf, B. (2012). *The start-up owner's manual: The step-by-step guide for building a great company*. K&S Ranch.
3. Conoscenti, M., Vetro, A., & De Martin, J.C. (2016) Blockchain for the Internet of Things: A systematic literature review. *2016 IEEE/ACS 13th International Conference of Computer Systems and Applications (AICCSA)*: 1–6.
4. Gill, M. (2018) The true meaning of digital transformation [Recorded by Forrester]. Cambridge, MA, USA. Retrieved from https://go.forrester.com/what-it-means/ep73-true-meaning-digital-transformation/
5. Hebert, C., & Di Cerbo, F. (2019) Secure blockchain in the enterprise: A methodology. *Pervasive and Mobile Computing (59)*, 101038.
6. Hyperledger (2019) *Channels.* Retrieved from Hyperledger Fabric: https://hyperledger-fabric.readthedocs.io/en/release-1.4/channels.html
7. Khan, M.A., Salah, K. (2018) IoT security: Review, blockchain solutions, and open challenges. *Future Generation Computer Systems,* (82), 395–411.
8. Khanfir, M. (2018) *The digital start-up implementation handbook*. Wiki Start Up Business Incubator.
9. Koteska, B., Karafiloski, E., & Mishev, A. (2017) Blockchain implementation quality challenges: a literature. *Proceedings of the SQAMIA 2017: 6th Workshop of Software Quality, Analysis, Monitoring, Improvement, and Applications*. pp. 11–13.
10. Lovin, A.B. (2011) *Reinventing fire: Bold business solutions for the new energy era*, e-Book, Chelsea Green Publishing ISBN: 9781603583725
11. One Defence (2015) First Principle Review, Department of Defence, Canberra Australia.
12. Seebacher, S., Schu¨ritz, R. (2017) Blockchain technology as an enabler of service systems: A structured literature review. In: International Conference on Exploring Services Science. pp. 12–23. Springer
13. Tama, B.A., Kweka, B.J., Park, Y., & Rhee, K.H. (2004) A critical review of blockchain and its current applications. *Proceedings of the 2017 IEEE International Conference on Electrical Engineering and Computer Science (ICECOS)*. pp. 109–113.
14. Wang, H., Zheng, Z., Xie, S., Dai, H-N., & Chen, X. (2018) Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, 14(4), 352–375.
15. Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016) *Where is current research on blockchain technology? —a systematic review*. PLOS one, 11(10), e0163477.