A Cloud enterprise architecture for e-governance during public health emergencies

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Abstract

There has been increased demand by the World Health Organisation for strong and agile national and global systems to tackle public health emergencies. The increased scrutiny on different aspects of the public sector and its e-governance is demanding governments to be accountable, transparent, and effective. As public health emergencies require an efficient, multi-sectoral response, the case studies of this paper focus on the public health emergencies in Australia: the bushfires of the 2019-2020 summer and the COVID-19 pandemic in Victoria. This paper has created a novel application of an adaptive enterprise architecture framework to public health emergencies. It suggests the components of agility, collaborative approaches for strategic partnerships, and cloud technologies are key for transforming the public sector's e-governance enterprise architecture. Thus, due to its novelty, this paper impacts the current research in enterprise architecture frameworks for the public sector.

Keywords: Adaptive Enterprise Architecture, e-governance, Public Health Emergencies, Agile, Cloud, Strategic Partnerships

1. Introduction

The World Health Organization's (WHO) recently urged a call-to-action to the heads of governments 'for strong and agile national and global systems for health security, worldwide' (WHO, 2020a) in response to increased occurrences of emergencies and threats to public health (WHO, 2020c; WHO, 2017). A public health emergency is defined as "an occurrence or imminent threat of a health condition caused by bioterrorism, epidemic or pandemic disease, or novel and highly fatal infectious agents or biological toxins, that poses a substantial risk on a significant number of human facilities or incidents or permanent or long-term disability" (WHO, 2008). Australia is one of the many countries that has experienced increased frequency and intensity of public health emergencies in the past decade with issues arising due to climate change such as heatwaves, flooding and bushfires (Pendrey, Beaton, & Kneebone, 2020) to pandemic diseases, most notably with COVID-19 (Windholz, 2020; WHO, 2020b).

These calamities have increased public demand for governance arrangements to be more accountable, transparent and effective in providing immediate response and recovery for nations and its citizens (OECD, 2020). In response to this, public sector organisations have recognized that a proper architecture with enabling technologies such as cloud computing, can help increase communication, transparency, accountability and responsiveness between the government and its citizens through e-governance (Kaushik, & Raman, 2015; Agarwal, Thakur & Chauhan, 2017; Lnenicka & Komarkova, 2019). E-governance is defined as "the public sector's use of information and communication technologies (ICT) with the aim of improving information and service delivery, encouraging citizen participation in the decision-making process and making governments more accountable, transparent and effective" (Agarwal et al., 2017). Therefore, implementing an enterprise-wide technology architecture or enterprise architecture to support e-governance is crucial, especially for democratic countries such as Australia, where citizen's satisfaction with public services form the core of governance (Australian Government Productivity Commission, 2020). Enterprise architectures (EA) are 'blueprints' for systematically defining an organization's current (baseline) and desired (target) environments (Bellman & Rausch, 2004) to help strategically and operationally identify the gaps. It is increasingly used by private business organizations as well as public sector organizations in order to better align their ICT resources with the overall business strategies and to gain maximum value from their ICT systems.

Therefore, this paper will consider EA as the backbone for e-governance architecture. Previous research in this area have been limited to discussion around factors required for adoption and implementation of EA in public sectors (Agarwal et al., 2017; Ahmad, Drus, & Kasim, 2020; Bakar, Harihodin & Kama, 2016), factors required for emergency and disaster response for all actors in emergency management (Bharosa & Janssen, 2015) and generic EA framework for emergency management (Noran, 2014). This paper investigates a critical area lacking in research of an e-governance architecture adaptation specific to public health emergencies and attempts to answer the research question:

How do e-governance architectures adapt to public health emergencies?

Firstly, the paper analyses the current use of EA in public sectors, especially in the management of health emergencies. Secondly, it considers a COVID-19 case study in Victoria and proposes a suitable EA governance arrangement leveraging cloud technologies for the same. Finally, the paper concludes with a bushfire case study to demonstrate the ability of the proposed model to adapt to various public health emergencies. In recognition that each country's public sector is unique in its application of EA and supporting technologies, this paper limits the recommendations scope of its case studies to an Australian context with inspiration from other countries.

2. Problem description with supporting case analysis

Previous research has found multiple issues during each stage of adoption, implementation and utilisation of EA in the public sector. The adoption of EA is complicated due to the presence of fragmented, isolated and siloed systems in organisations (Peristeras & Tarabanis 2000, Agarwal et al., 2017). Further issues occur during the implementation and utilisation phase in public sectors even with a plethora of EA information. These issues include a lack of understanding of EA concepts, lack of organisational awareness and framework utilisation, partial fragmentation leading to interoperability issues between services, scalability, and lack of commitment by the workforce (Olsen & Trelsgård 2016;

Bellman & Rausch, 2004; Kaushik & Raman, 2015; Ahmad et al., 2020). In essence, these caveats of siloed, isolated and fragmented systems and architecture can still be found at multiple stages of the increasing progress of EA in governments across the world (Kaushik & Raman, 2015).

Taiwan's e-governance had a proactive response to COVID-19 which was widely lauded and came largely from the country's experience in handling a previous public health emergency - the SARS outbreak, and partly from its digital governance infrastructure and high coordination of actors (Yen, 2020). However, this is not the case for all governments. The following case study of COVID-19 in Victoria was analysed to substantiate a relevant framework for e-governance.

THE RESURGENCE OF COVID-19 IN VICTORIA, AUSTRALIA

Due to the resurgence of COVID-19 in Victoria, a major change was implemented to the government's systems architecture to better deal with the second outbreak. Victoria's enterprise architecture was evident in the IT Strategy action plan and highlighted a weak communication process with little to no information on the implementation of the same (Department of Premier and Cabinet, 2016). Moreover, it currently lacks the ability to quickly adopt new systems on demand in emergency, transient situations such as the COVID-19 pandemic. The second lockdown in Victoria was announced on 7th July, 2020 and despite the introduction of tighter restrictions, the number of daily positive cases continued to increase. An inquiry into the COVID-19 Hotel Quarantine Program occurred, which inconclusively determined that mismanagement of the hotel program resulted in the increase of cases (Blakely, Thompson, Carvalho, Bablani, Wilson & Stevenson, 2020). On September 8th, 2020 a Salesforce®[1] system was introduced to improve existing contact tracing processes. This system is a cloud-based interface designed to allow case managers and patients to easily upload details about patient location timeline and information of their contacts. This automated and integrated approach aims to cover the whole contact tracing process - from receiving a positive result, interviews, follow-up calls to clearance of cases and contacts (Parliament of Victoria, 2020). The four main advantages are:

- Contacts are notified automatically (notifications are sent by the system through SMS or email).
- Information is accessible for everyone, hence, reduces the risk of case managers following up with the same contacts, or of contacts being missed.
- The integration of information allows the identification of potential overlaps to prioritise them. Moreover, it allows for the integration of information from different suburbs and cities in Victoria.
- Health authorities have an up-to-date and holistic view of the contact tracing progress to make informed decisions.

2.1 Analysis of case study

[1] Salesforce is a trademark of Salesforce.com, inc., and is used here with permission."

While this public health issue goes beyond technology, the Salesforce system will make contact tracing more efficient. However, this is just one out of many services that could be automated and integrated to help manage future outbreaks and even other public health emergencies. Consideration into the issues of adoption, implementation and utilization of enterprise architecture in the e-governance of Victoria is important to consider for future services to adapt to public health emergencies. Two key issues were identified in the case study regarding EA:

1. ***Slow adoption of services putting the state in a slow position for effective contact tracing***
   The assumed fragmented, isolated and siloed systems could have led to a lack of data integration creating a weak contact tracing process. Moreover, individual suburbs or cities systems in Victoria might be successful in their contact tracing however, these systems might not integrate well with one another.

2. ***Lack or weak communication between stakeholders from different business units, suburbs and cities***
   Lacking communication was particularly evident inside the quarantine hotel inquiry, where it determined the improper stakeholder management occurred (Coate, Neal, Elleyard & Ihle, 2020). Therefore, the siloed data and poor communication, contradicts the aim of the state of Victoria for greater transparency and accountability. Thus, while EA is evident in Victoria's IT strategy plan, its rigid approach has amplified these issues.

3. Enterprise architecture selection

Since reconsideration of the most suitable EA approach and process, given public health emergencies, is required, this section will consider the most widely adopted approaches to assess their suitability. Most mainstream EA practices are not flexible to face and deal with imminent threats and emergencies in this environment because of their long-term view of creating cumbersome processes and overheads. This results in an inability to deliver results early (Gill, 2014; Alzoubi & Gill 2020; Korhonen, Lapalme, McDavid, & Gill, 2016). This was also evident in the case study, since the adoption of Salesforce did not occur immediately when required. A non-adaptive, linear architecture approach is evident with the Department of Defense Architecture Framework (US Department of Defense, 2010), Federal Enterprise Architecture Framework (US Federal Government, 2013), and Ministry of Defense Architecture Framework (MoDAF) (UK Ministry of Defense, 2020).

The Open Group Architecture Framework (TOGAF®[2]) is currently the most prominently used EA framework for organizations (Carr & Else, 2018). It uses an iterative approach for its architecture development (Buckl et al, 2011), which includes preliminary requirement phase, and provides continuous requirement management. However, it fails to provide a continuous EA service adoption process to support the governance structure, which is necessary for managing evolving situations and problem landscapes. Thus, TOGAF is unsuitable for addressing the aforementioned problem.

Service Oriented Architecture (SOA) is an architecture framework dependent on principles that are relevant to the case study. Notably, SOA principles of composability and loose coupling is relevant to the case study, where services can be

[2] TOGAF is a registered trademark of The Open Group.

easily integrated into the architecture when required, (Blal, Leshob, Gonzalez-Huerta, Mili, & Boubaker, 2018). However SOA does not tackle the rate at which adoption occurred. Thus, this approach does not attempt to resolve the requirements for agility in a public health emergency.

One suggested EA approach to address all the issues identified in section 2 is Adaptive EA. Korhonen *et al.* (2016) explain Adaptive EA as a process of continuous co-evolution of the enterprise to changes occurring within the environment (Gill, 2013). Adaptive EA focuses not only on the enterprise but the environment it is embedded in. Its principles depend on an agile framework which can be better enabled through cloud technologies (Gill, 2014) which is further explained in the rest of section 3 and 4.

3.1 Adaptive Enterprise Architecture

The Adaptive Enterprise Architecture Framework (also known as the "Gill Framework") consists of a toolkit which focuses on defining, operating, managing, and supporting the enterprise adaptation to its environments as shown in Figure 1. It operates by identifying a specific situation and tailoring an adaptive framework to it. The defining phase would be the focus for the context of our problem to establish an adaptive framework in place to address the gaps relating to managing transient environments such as the COVID-19 pandemic. In the defining phase, the adoption of an Adaptive Enterprise service system is driven by three main elements: services, agility, and systems (Gill, 2013). Each element, agility, collaborative services and cloud systems is explained in detail in the following sections.

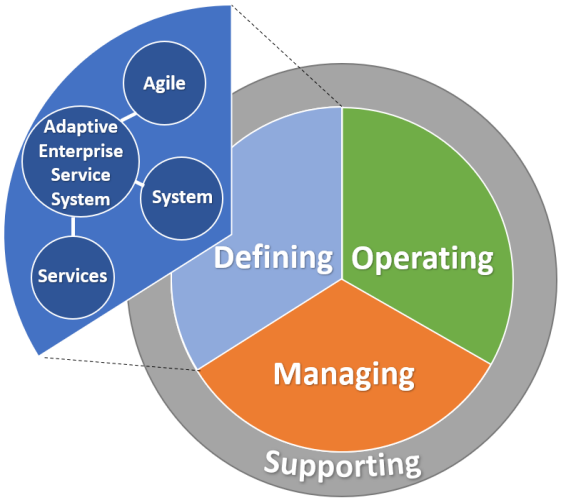


Figure 1: Defining phase in an adaptive enterprise service system (Adapted from Gill, 2013)

3.1.1 Agility and strategic partnerships

Agility involves principles such as presence of quick and flexible response capabilities for enterprise adaption to public health emergencies. This implies that at the enterprise level, the organisation needs to be learning from changes and constantly evolving. This includes implementing various sets of independent services that integrate and collaborate to contribute to value co-creation, and can be added, removed or modified based on the dynamic demands of the enterprise

(Gill, 2013). Multiple digital tools were required and utilised for governing COVID-19 (see Figure 2). Agility, as a key principle in e-governance, would allow shorter iterative cycles of problem-solving, that can help to have appropriate feedback cycles in a collaborative way (Bente *et al.*, 2020).

On an application level, governments often lack the expertise and time to quickly and efficiently develop and maintain agile services to support its citizens during an emergency situation. This is especially true while establishing e-governance structures. EA has been researched to address concerns on cost and time by focusing on architectural deliverables that are most important to solve the business problems without losing cohesive integration of the life cycles (Yuliana & Rahardjo, 2016). Therefore, forming strategic partnerships with technology companies, entrepreneurs and other organisations to cater to the needs of people, improve connectivity and ease the impact of crisis by delivering services, can be beneficial.

Figure 2: Digital tools used during COVID-19

Since public agencies are the first custodian of COVID-19 related data and have the responsibility of publishing statistics in real time, they have formed strategic partnerships with various stakeholders during the COVID-19 outbreak as illustrated in the case study in section 2. For example, the Australian Government collaborated with the International Telecommunication Union (ITU) to ensure networks are robust and available to keep up with the load, Salesforce for contact tracing platforms (Parliament of Victoria, 2020) and several software development companies in order to develop the "COVID Safe" mobile application. Internet service providers have also been commissioned to ensure bandwidth availability and stability for critical functions in hospitals and emergency calls, and to support the dissemination of information to the public through various mediums.

3.1.2 Collaborative services approach

While strategic partnerships can further improve the quicker rate of adoption, fragmentation in systems and communication between the partners still must be addressed to address the continual gap of EA. Within the Victoria case study, the improper stakeholder engagement that occurred could be addressed through a collaborative approach. A collaborative service, as put forth by Maalel & Ghézala (2020), requires a centralised database, an action plan for collaboration, which include plans, methods, ontologies, resource identification, and a general coordinator. Having a collaborative approach for EA can help the enterprise combat this problem. Pulkkinen and Kapraali (2015) in their study illustrate the importance of collaborative EA in the information elicitation phase. An information elicitation method can be used to define baselines for EA and development of requirements.

Specifically in the case study, better long-term results of contact tracing could have been achieved if this system was connected to the patient administration system, since appointments could have been automatically scheduled for testing close contacts. In addition, integration with clinics and hospitals records could provide insights on how each person responds to the public health threat. Moreover, integration with pathology lab systems could allow real-time numbers of test results. Despite possible data security issues, these integrations could bring enterprise-wide automation and better prepare Victoria for future outbreaks and other public health emergencies in the long-run. This Adaptive EA framework is defined from the viewpoint of integrating cloud computing elements. Thus, the cloud systems as a supporting technology will be discussed in the next section.

3.1.3 Leveraging cloud systems

An adaptive EA has been identified in section 3 as important to align e-governance architecture with its purpose of greater effectiveness and communication through accountability, and transparency. An EA with proper supporting technologies can provide a blueprint and a holistic view of the enterprise that can help the organisation deploy solutions and gain value. A key strategic technical consideration for many businesses is the decision to have smaller IT centres locally and having the bulk of the IT and services on the cloud, where its primary benefit is that cloud adoption helps the business focus more on their core competencies (Raj & Periasamy, 2011). Salesforce was identified in the case study as key to help with agility and to focus on the core business of contact tracing.

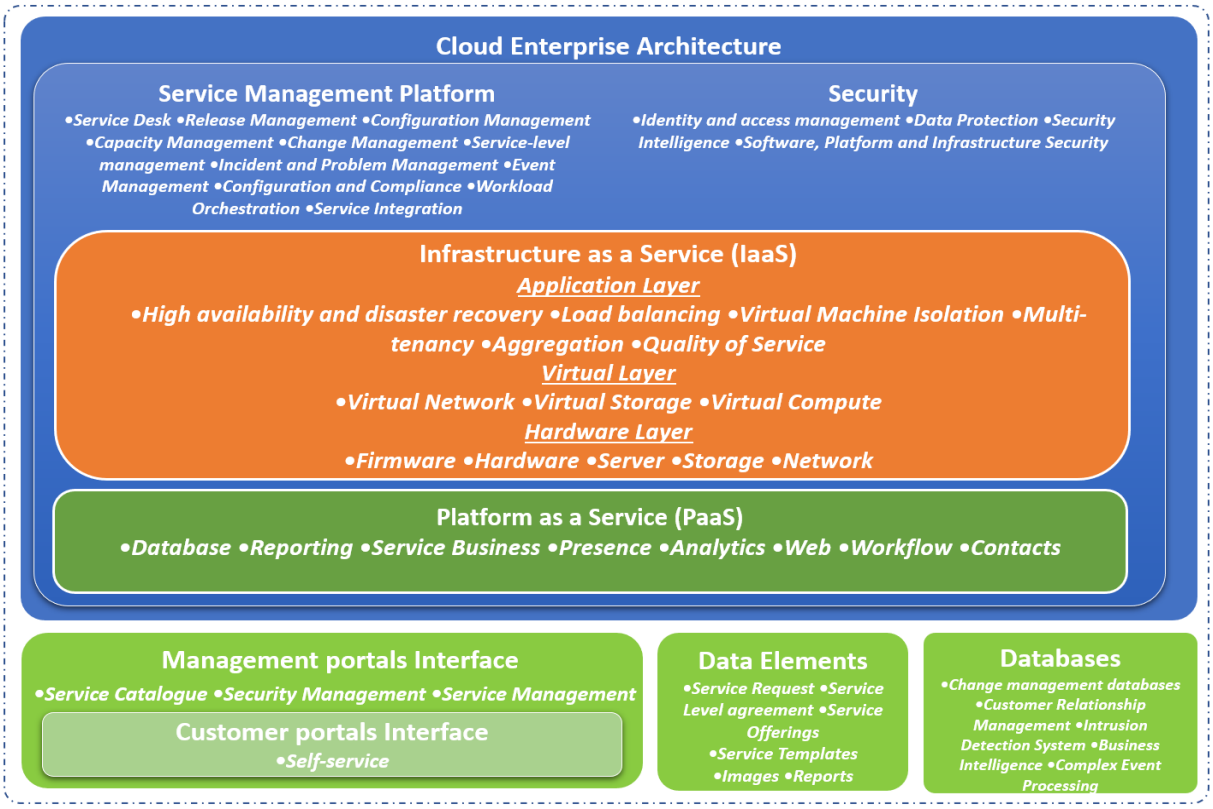


Figure 3: Architectural elements of enterprise private cloud adaptation (Adapted from Raj & Periasamy, 2011)

To discern cloud technologies' importance, consideration of the components of EA is required. Based on the EA frameworks of Zachman and other authors, Mahmood (2011) suggests that business architecture, application architecture, data architecture, and technical architecture as the minimum components of core enterprise architectural representations. More importantly, he suggests using different cloud offerings to build these architectures since this can refocus an organization's capability to its core competencies. Firstly, using cloud IaaS and PaaS offerings is required to build the technical layer (architecture) and the data layer, using SaaS offerings is required to build the applications layer, and using other specialized Cloud provisions such as Management as a Service, for the business layer of an EA. (see Figure 3). Thus, cloud technologies can change the way solutions are developed, sourced, deployed and managed in government enterprises.

Out of the three key layers of cloud computing, IaaS (Infrastructure as a Service) can be considered as the foundation layer which mainly consists of devices such as processors, servers, storage devices, databases, and network facilities and provides hardware related service to the end user (Strømmen-Bakhtiar & Razavi, 2011). IaaS can play a significant role in the deployment of cloud components and ensure security of services, availability of real time updated information across various device platforms, as well as help with robustness and business continuity.

3.1.4 Key consideration for adoption of cloud technologies

The highly scalable virtual infrastructure of the cloud environments enables simplified service industrialization and delivery (Raj, 2013). Gill *et al.* (2014) through their study, highlight the importance of having an appropriate strategy and roadmap in place for Cloud transformations. They highlight the need for an adaptive EA approach for a holistic

strategic plan for incremental cloud adoption. Other key factors to consider when incorporating cloud technology to an enterprise architecture are scalability and reconfigurability (Ramachandran, 2011). These will create the key benefits for a public sector enterprise architecture, as it will enable the EA to adapt and accommodate changing requirements of the public sector across different organizations.

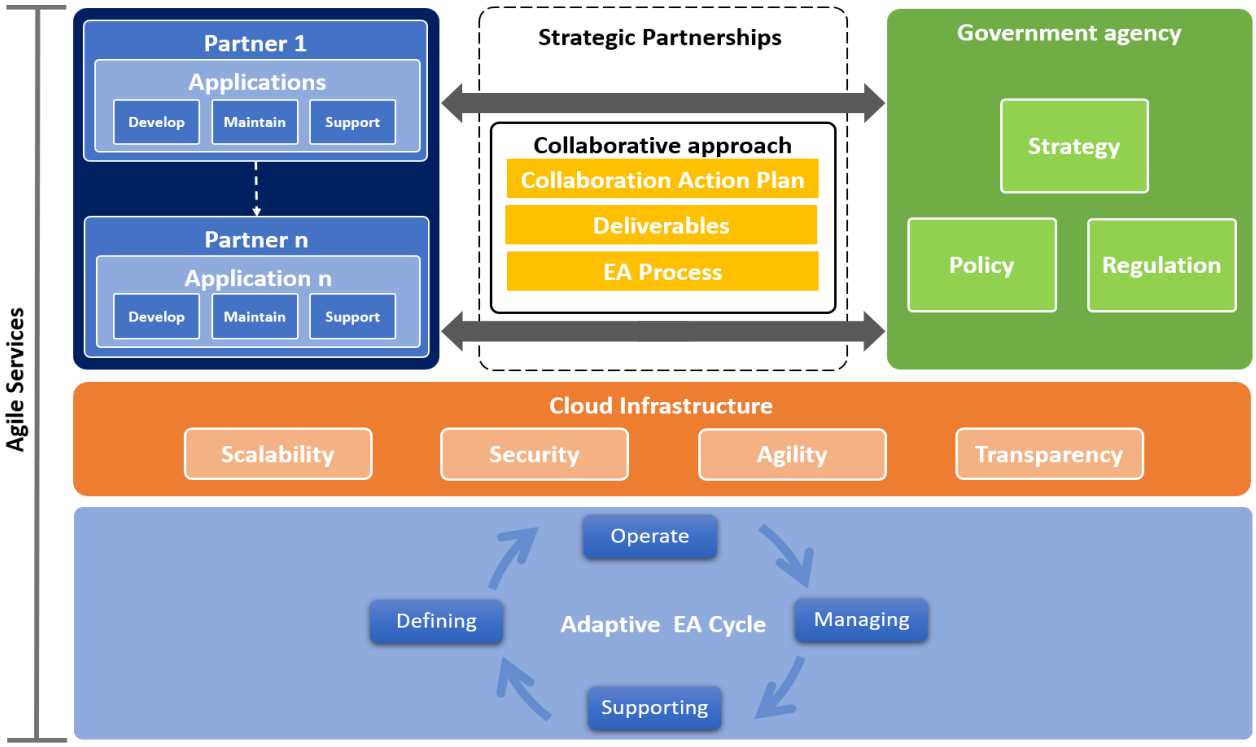
Masuda and Viswanathan (2019) highlight the benefits of incorporating aspects of cloud implementation with Adaptive Enterprise Architecture. In this proposed architectural model combining cloud and adaptive EA, business logic of systems (business layer) is implemented along with collaborative services arising out of strategic partnerships. This will give the overall architecture both the positive characteristics of agility, and cloud technology. Event Driven Business Processes Communication Enabled and Cloud-Impacted Business Processes (Raj & Periasamy, 2011) are other concepts that can be combined with cloud implementation to further enhance its usage in an EA setting. Raj & Periasamy recommend deploying an enterprise private cloud within organizations as an entry point towards adopting cloud technologies. This approach can be used in the public sector to explore the capabilities and potential of cloud within a more secured and controlled organizational environment.

4. Recommended framework

Based on the previous analysis, an adaptive EA framework is proposed which includes the three elements described in section 3.1 to achieve agility. As shown in Figure 4, this can be achieved through three different levels:

- Strategic partnerships at the application level with a collaborative approach: the development of strategic partnerships between the government agency (such as Victoria) and partners (such as Salesforce) will quickly and efficiently help in the development of agile applications.
- Leveraging cloud systems at the infrastructure level: supporting technologies such as Cloud could provide a holistic view of the enterprise and help the organization gain value.
- Enterprise-wide level: the adaptive EA cycle ensures enterprise-wide agility for a quick and flexible approach to public health emergencies.

Figure 4: Suggested Adaptive Enterprise Architecture Framework (adapted from Masuda and Viswanathan, 2019)



4.1. Victoria case study final recommendation

The two key issues discovered in the Victoria case study can be easily resolved with the proposed framework. Strategic partnerships can reduce the potential for slow adoption of required services (1) such as the adoption of the Salesforce system. The fragmentation in systems and stakeholders (2) can be solved through a collaborative approach underpinned by a Cloud infrastructure.

4.2. Application of framework to other public health emergencies

The proposed architecture can be applied to other areas in public health emergencies. An analysis of a case study is conducted to substantiate the appropriateness of the proposed model in dealing with bushfires crisis across Australia.

DEVASTATING BUSHFIRES IN AUSTRALIA

By the beginning of 2020, around six million hectares had been burned, mainly in the states of New South Wales and Victoria. This year's bushfire season was considered as the most severe on record in Australia (Campbell, Jones, Williamson, Wheeler, Lucani, Bowman & Johnston, 2020). Institutions responsible for delivering emergency response services often underperform due to lack of proper interoperability and collaboration (Noran, 2014). Hence new innovative, holistic and integrated solutions are necessary to solve these new challenges. It is also essential to mention that weak collaboration appears to be a major obstacle in achieving suitable emergency response preparedness as well (Noran, 2014).

Similar to the COVID-19 response, the bushfires also demand government services to rally citizens and support workers in managing the bushfires, relocation settlement away from critical zones, rehabilitation and donation campaigns among others. The proposed framework in this paper can be applied to the bushfire case study at all three levels (application, infrastructure and enterprise level) with very little change except for differences in the type of services, which may again be developed by the strategic partners already engaged. This framework can also be used to collaborate with governments and organisations in other countries for various other public health emergency scenarios due to its modular and adaptive nature.

5. Conclusion

The bushfires and the COVID-19 pandemic have highlighted the need for evolving governance systems in Australia, since the nature of such emergencies are transient and ever changing. Understanding the landscape of this, and responding to the circumstances, must be done in a quick and effective way. The best way to do this is to establish an adaptive enterprise architecture backed by cloud technologies and engaging strategic partners capable of developing, maintaining and supporting the services necessary to support citizens and reduce the impact of threats. Cloud technology ensures transparency, security of citizen's data and mobility for the availability of services, with minimal to no down-time. The proposed model thus supports the World Health Organisation's call to action in response to global public health threats.

References

Agarwal, R., Thakur, V., & Chauhan, R. (2017). Enterprise Architecture for e-Government. In *Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance* (*ICEGOV '17*) (pp. 47–55). *Association for Computing Machinery.* https://doi.org/10.1145/3047273.3047330

Ahmad, N. A., Drus, S. M., & Kasim, H. (2020). Factors That Influence the Adoption of Enterprise Architecture by Public Sector Organizations: An Empirical Study. *IEEE Access (8),* 98847-98873. https:// 10.1109/ACCESS. 2020.2996584.

Alzoubi, Y. I., & Gill, A. Q. (2020). An Empirical Investigation of Geographically Distributed Agile Development: The Agile Enterprise Architecture is a Communication Enabler. *IEEE Access, Access, IEEE, 8,* 80269–80289. https://doi.org/10.1109/ACCESS.2020.2990389

Australian Government Productivity Commission. (2020). *Report on Government Services 2020: D Emergency management.* https://www.pc.gov.au/research/ongoing/report-on-government-services/2020/emergency-management

Bakar, N. A. A., Harihodin, S., & Kama, N. (2016). Assessment of Enterprise Architecture Implementation Capability and Priority in Public Sector Agency. *Procedia Computer Science, 100,* 198-206. https://doi.org/10. 1016/j.procs.2016.09.141.

Blakely T., Thompson J., Carvalho N., Bablani L., Wilson N. & Stevenson M. (2020). Maximizing the probability that the 6-week lock-down in Victoria delivers COVID-19 free Australia, https://www.mja.com.au/system/files/2020-07/Blakely%20mja20.01292%20-%2017%20July%202020.pdf.

Beale, J., & Jones, W. (2011). Preventing and Reducing Bushfire Arson in Australia: A Review of What is Known. *Fire Technology, 47,* 507–518, https://doi.org/10.1007/s10694-010-0179-4.

Bellman B., Rausch F. (2004) Enterprise Architecture for e-Government. In: Traunmüller R. (eds) Electronic Government. EGOV 2004. *Lecture Notes in Computer Science, vol 3183.* Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-30078-6_9

Bente, S., Bombosch, U., & Langade, S. (2012). *Collaborative enterprise architecture: enriching EA with lean, agile, and enterprise 2.0 practices*. Newnes.

Bharosa, N., & Janssen, M. (2015). Principle-Based Design: A Methodology and Principles for Capitalizing Design Experiences for Information Quality Assurance. *Journal of Homeland Security & Emergency Management*, *12*(3), 469-496. https://doi.org/10.1515/jhsem-2014-0073.

Blal, R., Leshob, A., Gonzalez-Huerta, J., Mili, H., & Boubaker, A. (2018). From inter-organizational business process models to service-oriented architecture models. *Service Oriented Computing and Applications*, *12*(3–4), 227–245. https://doi.org/10.1007/s11761-018-0246-0.

Bondar, S., Hsu, J. C., Pfouga, A., & Stjepandić, J. (2017). Agile digital transformation of System-of-Systems architecture models using Zachman framework. *Journal of Industrial Information Integration*, *7*, 33-43. https://doi.org/10.1016/j.jii.2017.03.001.

Buckl, S., Matthes, F., Monahov, I., Roth, S., Schulz, C., & Schweda, C. M. (2011). Towards an agile design of the enterprise architecture management function. In *2011 IEEE 15th International Enterprise Distributed Object Computing Conference Workshops* (pp. 322-329). IEEE. https://doi.org/10.1109/EDOCW.2011.33

Campbell, S. L., Jones, P. J., Williamson, G. J., Wheeler, A. J., Lucani, C., Bowman, D. M. J. S., & Johnston, F. H. (2020). Using Digital Technology to Protect Health in Prolonged Poor Air Quality Episodes: A Case Study of the AirRater App during the Australian 2019–20 Fires. *Fire*, *3*(3), 40. https://doi.org/10.3390/fire3030040.

Carr, D., & Else, S. (2018). State of Enterprise Architecture Survey: Results and Findings. *EAPJ Journal*. https://eapj.org/wp-content/uploads/2018/05/EAPJ-Special-Edition-State-of-EA-Survey.pdf

Coate, J., Neal, A., Ellyard, R., Ihle, B. (2020). INQUIRY INTO THE COVID-19 HOTEL QUARANTINE PROGRAM. *TRANSCRIPT OF PROCEEDINGS, Melbourne, Victoria, 26,* 1-2272. https://www.quarantineinquiry.vic.gov.au/sites/default/files/2020-09/20200928%20Hotel%20Quarantine%20Program%20-%20Day%2026%20-%20FINAL.pdf

Ghilic-Micu, B., Stoica, M., & Uscatu, C. R. (2014). Cloud Computing and Agile Organization Development, *Informatica Economică, 18*(4/2014), 5-15.

Gill, A. Q. (2012). *The Gill Framework: Adaptive Enterprise Architecture Toolkit*. CreateSpace Independent Publishing Platform.

Gill, A. Q. (2013). Towards the Development of an Adaptive Enterprise Service System Model, *ACMIS 2013 Proceedings*, Chicago, USA

Gill, A. Q. (2014). Applying agility and living service systems thinking to enterprise architecture. *International Journal of Intelligent Information Technologies*, *10*(1), 1-15. https://doi.org/10.4018/ijiit.2014010101

Hauder, M., Roth, S., Schulz, C., & Matthes, F. (2014). Agile enterprise architecture management: an analysis on the application of agile principles. In *4th International Symposium on Business Modelling and Software Design* (pp. 38-46).

Kaushik, A., & Raman, A. (2015). The new data-driven enterprise architecture for e-healthcare: Lessons from the Indian public sector. *Government Information Quarterly*, *32*(1), 63-74. https://10.1016/j.giq.2014.11.002.

Korhonen, J. J., Lapalme, J., McDavid, D., & Gill, A. Q. (2016). Adaptive Enterprise Architecture for the Future: Towards a Reconceptualization of EA. 2016 IEEE 18th Conference on Business Informatics (CBI), 272. (pp. 272-281). IEEE. https://doi.org/10.1109/CBI.2016.38.

Lnenicka, M., & Komarkova, J. (2019). Developing a government enterprise architecture framework to support the requirements of big and open linked data with the use of cloud computing. *International Journal of Information Management, 46,* 124-141.

Maalel, A., & Ghézala, H. B. (2020). *Towards a Collaborative Approach to Decision Making Based on Ontology and Multi-Agent System Application to crisis management*. https://doi.org/10.1016/j.procs.2019.12.172

Mahmood, Z. (2011). Cloud Computing for Enterprise Architectures: Concepts, Principles and Approaches. In Z. Mahmood & R. Hill (Eds.), *Cloud Computing for Enterprise Architectures. Computer Communications and Networks* (pp. 3-19). Springer, London. https://doi.org/10.1007/978-1-4471-2236-4_1

Masuda, Y., & Viswanathan, M. (2019). *Enterprise architecture for global companies in a digital it era: adaptive integrated digital architecture framework (AIDAF)* (1st ed.). Springer.

Moshiri, S., & Hill, R. (2011). Enterprise Architecture Fundamentals. In Z. Mahmood & R. Hill (Eds.), *Cloud Computing for Enterprise Architectures. Computer Communications and Networks* (pp. 21-41). Springer, London. https://doi.org/10.1007/978-1-4471-2236- 4_2

Nam, K., Oh, S. W., Kim, S. K., Goo, J., & Khan M. S. (2016). Dynamics of Enterprise Architecture in the Korean Public Sector: Transformational Change vs. Transactional Change. *Sustainability, 8*(11), 1074. https://10.3390/su8111074.

Noran, O. (2014). Collaborative disaster management: An interdisciplinary approach. *Computers in Industry, 65*(6), 1032-1040. http://dx.doi.org/10.1016/j.compind.2014.04.0030.

OECD, (2020). Responding to Covid19: The rules of good governance apply now more than ever!. https://www.oecd.org/governance/public-governance-responses-to-covid19/

Olsen, D. H., & Trelsgård, K. (2016). Enterprise Architecture Adoption Challenges: An exploratory Case Study of the Norwegian Higher Education Sector. *Procedia Computer Science, 100,* 804–811. https://doi.org/10.1016/j.procs.2016.09.228

Parliament of Victoria (2020). Inquiry into the Victorian Government's COVID–19 contact tracing system and testing regime.
https://www.parliament.vic.gov.au/images/stories/committees/SCLSI/Inquiry_into_the_Victorian_Governments_COVID19_Contact_Tracing_System_and_Testing_Regime_/report/LCLSIC_59-05_Vic_Gov_COVID-19_contact_tracing_testing.pdf.

Pendrey, C. G. A., Beaton, L., & Kneebone, J. A. (2020). General practice in the era of planetary health: Responding to the climate health emergency. *Australian Journal of General Practice, 49*(8), 520–523.

Peristeras, V., & Tarabanis, K. (2000). Towards an enterprise architecture for public administration using a top-down approach, *European Journal of Information Systems, 9*(4), 252-260, https://10.1057/palgrave.ejis.3000378.

Pulkkinen, M., & Kapraali, L. (2015). Collaborative EA Information Elicitation Method: The IEM for Business Architecture. In *2015 IEEE 17th Conference on Business Informatics: Vol. 2,* (pp. 64-71). IEEE. https://doi.org/10.1109/CBI.2015.33

Ramachandran, M. (2011). Component-based development for cloud computing architectures. In Z. Mahmood & R. Hill (Eds.), *Cloud Computing for Enterprise Architectures. Computer Communications and Networks* (pp. 91-114). Springer, London. https://doi.org/10.1007/978-1-4471-2236-4_5

Raj, P. (2013). *Cloud Enterprise Architecture.* London, CRC Press.

Raj, P., & Periasamy, M. (2011). The Convergence of Enterprise Architecture (EA) and Cloud Computing. In Z. Mahmood & R. Hill (Eds.), *Cloud Computing for Enterprise Architectures. Computer Communications and Networks* (pp. 61-87). Springer, London. https://doi.org/10.1007/978-1-4471-2236-4_4

Rouhani, B. D., Shirazi, H., Nezhad, A. F., & Kharazmi, S. (2008). Presenting a framework for agile enterprise architecture. In *2008 1st International Conference on Information Technology* (pp. 1-4). IEEE. https://doi.org/10.1109/INFTECH.2008.4621684

Strømmen-Bakhtiar, A., & Razavi, A. R. (2011). Cloud computing business models. In Z. Mahmood & R. Hill (Eds.), *Cloud Computing for Enterprise Architectures. Computer Communications and Networks* (pp. 3-19). Springer, London. https://doi.org/10.1007/978-1-4471-2236-4_1

Sun, Y., Yuan, Q., & Al-Sarawi, S. (2010). A bushfire monitoring and detection system for smart homes using ZigBee technology. *International Journal of Computer Aided Engineering and Technology*, *2*(2-3), 234-249.

UK Ministry of Defense. (2020, December 12). *Guidance: MOD Architecture Framework.* https://www.gov.uk/guidance/mod-architecture-framework

US Department of Defense. (n.d.). The DoDAF Architecture Framework Version 2.02. https://dodcio.defense.gov/Library/DoD-Architecture-Framework/dodaf20_arch_development/

US Federal Government. (2013, January 29). *Federal Enterprise Architecture Framework Version 2.* https://obamawhitehouse.archives.gov/sites/default/files/omb/assets/egov_docs/fea_v2.pdf

Windholz, E. L. (2020). Governing in a pandemic: from parliamentary sovereignty to autocratic technocracy. *Theory & Practice of Legislation, 8(*1), 93–113. https://doi.org/10.1080/20508840.2020.1796047

World Health Organization. (2008). *Definitions: Emergency.* https://www.who.int/hac/about/definitions/en/

World Health Organization. (2017). *Asia Pacific strategy for emerging diseases and public health emergencies (APSED III) : advancing implementation of the International Health Regulations (2005) : working together towards health security.* http://iris.wpro.who.int/handle/10665.1/13654

World Health Organization. (2020a). *A World In Disorder: Global Preparedness Monitoring Board Annual Report 2020.* https://apps.who.int/gpmb/assets/annual_report/GPMB_AR_2020_EN.pdf

World Health Organization. (2020b). *Emergencies preparedness, response.* https://www.who.int/csr/don/archive/country/aus/en/

World Health Organization. (2020c). *Urgent health challenges for the next decade* https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health- challenges-for-the-next-decade

Yen, W. (2020). Taiwan's COVID-19 Management: Developmental State, Digital Governance, and State-Society Synergy. *Asian Politics & Policy*, *12*(3), 455–468. https://doi.org/10.1111/aspp.12541.

Yuliana, R., & Rahardjo, B. (2016). Designing an agile enterprise architecture for a mining company by using TOGAF framework. In *2016 4th International Conference on Cyber and IT Service Management* (pp. 1-6). IEEE. https://doi.org/10.1109/CITSM.2016.7577466