

Using Service-Oriented Architecture to Navigate the COVID-19 Pandemic for Knowledge-Based SMEs

Harrison Thompson
University of Melbourne
hthompson1@student.unimelb.edu.au

Alex Whitehead
University of Melbourne
awhitehead1@student.unimelb.edu.au

Yixin Lan
University of Melbourne
yllan@student.unimelb.edu.au

Fangfang Jia
University of Melbourne
fangfangj@student.unimelb.edu.au

Fen Qin
University of Melbourne
feng@student.unimelb.edu.au

Abstract

With the business world being thrown into chaos due to the spread of COVID-19, many firms have been thrown into operational dismay. While some larger organisations have been able to smoothly transition to remote operations to comply with new recommendations and legislation introduced by the Australian Government, some small and medium-sized enterprises (SME) have not been as well equipped to make a fast transition. This paper researches the ways that enterprise architecture (EA), specifically a service-oriented architecture (SOA), can help to allow businesses to continue operations in the face of the COVID-19 pandemic, and disaster scenarios. To complete this study, a range of academic articles were assessed to ascertain the benefit of adopting SOA from a business perspective, both to respond to crises and deliver positive returns during normal operations. The findings of this research were clear, with SOA presenting itself as an appropriate option for businesses, particularly knowledge-based SMEs such as law firms and consulting practices, to maintain business continuity during times of crisis such as COVID-19.

1. Introduction

Disaster scenarios are an essential consideration when planning for business continuity and in designing the overall enterprise architecture (EA). Generally seen by managers as 'pie in the sky' in nature, disaster scenarios and force majeure events are enormously disruptive when they do occur. Companies who have not seriously considered the resilience of their EA, and how a disaster scenario would affect business continuity, are particularly at risk when they arise (Biemborn et al., 2008).

A current example that has sent shockwaves through the business world is the COVID-19 pandemic. A true disaster scenario, COVID-19 has forced governments to restrict movement and social interaction, which has tested business capability and resilience from an EA perspective. For organisations, it is critical to consider how their EA has responded to the challenges presented by COVID-19. A common weakness for many small and medium-sized knowledge-based enterprises has been the inability to quickly and effectively shift their operations from centralised to decentralised. This deficiency is likely the result of these organisations not understanding and appreciating the significant value of an effective EA in navigating a disaster scenario (Armour et al., 1999).

This study explores the value that enterprise architecture (EA) and Information and Communications Technology (ICT) can provide organisations facing a disaster scenario, particularly a pandemic that restricts human movement. Specifically, the issue of using service-oriented architecture to navigate the COVID-19 disaster scenario for knowledge based small to medium-sized enterprises (SME) will be addressed. To investigate this concept, the benefits and challenges of adopting a service-oriented architecture (SOA) will be examined. Further, the critical planning and development, and governance implementation strategies will be evaluated to determine the appropriacy of a SOA in mitigating the negative consequences that an unexpected disaster can have on an organisation. This analysis aims to address the research question: *How can a SOA be implemented to resolve the challenges posed by disaster scenarios, such as the COVID-19 pandemic?*

2. The purpose of enterprise architecture

2.1. Enterprise architecture and its benefits

Enterprise Architecture forms a high-level view of an enterprise's processes and IT systems, illustrating how they interact to facilitate various business functions and goals (Tamm et al., 2011). As such, EA provides the platform that enables capability, and actors within organisations to execute strategic objectives. To help participants achieve organisational goals, EA projects aim to align the technological resources available to an organisation and structure them in such a way that makes the processes that are performed more efficient and effective (Niknejad et al., 2019). An example of a popular EA design method that has grown in sophistication over the last twenty years is service-oriented architecture (SOA) (Goebelbecker, 2019).

There are four key benefits associated with having a well-crafted and considered EA including, organisational alignment, information availability, resource portfolio optimisation, and resource complementarity (Tamm et al., 2011). Considering the operational boundaries imposed during a pandemic, the two critical benefits are organisational alignment and information availability.

Case Study – Small to medium-sized Law Practice

Small to medium-sized enterprises have a significant role in the global economy. In Australia, SMEs are defined as any organisation with less than 200 employees. These organisations generate approximately 33% of GDP and 70 per cent of total employment (Dwivedi et al., 2009). Considering the sizable contribution of SMEs to national production and employment, the effects of the COVID-19 pandemic has challenged these businesses and the Australian economy significantly.

In the face of state and national level lockdowns that restrict human movement and business activity, organisations that can operate remotely have been able to respond rapidly to the realities of the changed business world. To assist the exploration of the research question, a SME 30-employee legal practice that could benefit from the adoption of SOA will be analysed. This fictitious Legal Practice engages with a range of individual clients and local businesses, and services these clients in person. A preference towards short-term decision making, combined with a lack of understanding about the value delivered through modern EA practices has prevented the organisation from planning an overhaul of their information systems and architecture – as is the case with many SMEs (Ghahramany Dehbokry and Chew, 2014). Given the stay at home orders and social distancing regulations, the business is unable to facilitate normal operations and has been transitioning to remote consultations. However, this presents security and privacy risks, and operational inefficiencies, as the firm does not have an EA that supports an operational model that can facilitate remote working.

2.1.1. Organisational alignment

Organisational alignment is critical to operational and strategic success as it ensures that all functions within a firm are striving to achieve the same goal (Henderson and Venkatraman, 1993). This congruent approach to business can help to develop synergies across business units that reduce wastage in time and effort, and ensures that tasks and processes executed by actors within the value chain are consistent with the overall strategic plan of an organisation (Gregor et al., 2007).

The importance of organisational alignment in a pandemic is that it ensures that there is a shared purpose between all parties in the organisation. This congruent focus helps responsiveness and agility in the face of adversity (Erl, 2016). For example, since the emergence of COVID-19, many well-aligned organisations have been able to transition to telecommuting practices - which otherwise may not be possible without a well-designed EA.

2.1.2. Information availability

Information availability is vital for the enterprise to perform tasks and duties. Information and data are the commodities that drive daily business practice in many knowledge-based professions. If an unexpected disaster leaves information in a position where it is not accessible, interpretable, relevant, and accurate, then firms cannot operate effectively (Wang and Strong 1996). Well-considered EA design can help deliver increased information availability by leveraging technologies such as cloud-computing to ensure that data is both accessible and available to credentialed sources.

The importance of information availability in a disaster scenario is that it allows managers to enact continuity plans, and employees to continue to perform their duties. Continuing with the pandemic scenario, if information is not available from remote working places, operations are more likely to fail, and firms will be at risk of being unable to perform revenue-generating activities. Therefore, it is critical that there are strong organisational plans for disaster scenarios, and that information availability is top of mind when designing an EA (Tamm et al., 2011).

2.2. EA approach: Service-oriented architecture

SOA is an architectural approach that has a business process focus and uses systems of services to complete business tasks and activities (Erl, 2016). SOA breaks down business processes and functions into individual services, and though each service has its own purpose, the services within a SOA are interoperable (Niknejad et al., 2019). This structure involves application services communicating with each other and sharing packages of data. This sharing occurs via an Enterprise Service Bus (ESB), which facilitates the transfer of a data output from one service to become the input of another (Hirschheim et al., 2010). An important feature of SOA is that services are operated by the user over the internet. The internet aspect of SOA provides the required EA functionality of users being able to access services and information remotely, which is vital during a pandemic.

The service focus of SOA is a true advantage for SMEs as it gives them a significant amount of control in the construction of their service offering (Yoon and Carter, 2007). The control offered through SOA means that organisations can intimately match their business needs to the services that they decide to provide. Greater business understanding from IT departments also helps them to optimise the applications it wants to use to deliver services (Hirschheim et al., 2010). Further to this, SOA places a strong focus on providing services that add value in specific ways, avoiding the provision of functionality for the sake of capability (Erl, 2016).

Finally, strong governance and security measures are required to successfully use SOA in an organisation due to heavily web-based services (Hirschheim et al., 2010). However, greater investment in security and governance maturity are a worthwhile cost to achieve the flexibility and modularity SOA provides, which is vital in times of a disaster (Niknejad et al., 2019).

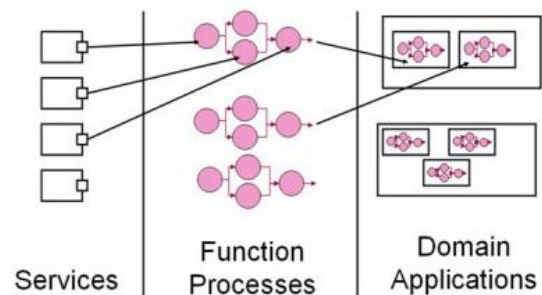


Figure 1 – Basic illustration of a SOA (Shin & Kim, 2008)

3. Organisational benefits of SOA adoption for service-focused businesses

Service-based businesses, particularly those that share SME characteristics, should invest in shaping their EA to reflect a service orientation, as it allows them to maximise the value of their IT budgetary spend. For most SMEs, the adoption of SOA will have three key benefits, all of which deliver value in both the short and long-term regardless of the challenges that the business and broader economy are facing. These three distinguished benefits are decentralisation, scalability, and improved support of business processes (Abelein et al., 2009).

3.1. Decentralisation

Decentralisation is an important characteristic of SOA. As the services within an organisations service catalogue are modular, and accessed via the internet, the need for a user to be in a certain location or environment to access the services is removed (Sacha et al., 2010). This functionality is critical for SMEs, particularly through COVID-19, which has seen isolation in the form of social distancing become standard practice in Australian states

and territories (Health, 2020). The ability to leverage decentralisation to continue operations from remote locations is paramount for the success of any business, but particularly in the case of a SME law practice, as it facilitates the continued completion of revenue-generating activities without a significant decrease in efficiency, speed, and quality (Erl, 2016). Furthermore, decentralisation allows firms to quickly pivot to working remotely, which is essential in COVID-19 like situations where change can happen without notice, and at a significant scale.

3.2. Scalability

The architectural characteristics of SOA facilitate the ability to integrate cloud solutions easily, which can help with scalability of applications, as well as infrastructure and storage needs (Kress et al., 2014). Cloud services such as Infrastructure as a Service (IaaS), and Software as a Service (SaaS), are typically featured in a modern SOA for a SME (Group, 2020). For a SME, IaaS offers the ability to outsource expensive infrastructure hardware costs, in a very cost-effective manner (Haselmann and Vossen, 2011). This outsourcing ability also allows the SME to pay specifically for what it uses, and increase the capacity of servers and storage as required. This consumption model is vitally important in times of crises like COVID-19, especially if a rapid and swift response is required through government direction or legislation change. From a non-crisis perspective, agile scalability allows for firms to grow successfully, without having to make drastic changes to their EA (Haselmann and Vossen, 2011).

Looking through a SaaS lens, integrating SaaS with a SOA is also an effective way of delivering services to employees. SaaS is a functional way of providing fundamental business functions such as Email, word processing, instant messaging and calendar, and as with IaaS, licenses are very scalable and can be intimately matched to business usage (Microsoft, 2020). This is important for an SME looking to generate a higher ROI on IT investment. Removing typical IT costs such as unused storage and server space, and hardware storage is essential when trying to remove unnecessary expenditure to remain financially viable in difficult economic times generated by COVID-19.

3.3. Improved business process support

SOA allows an organisation to continue to add component processes to their service catalogue, which is an integral part of an EA considering the need for organisations to be adaptive and responsive to changing business practices. The challenges presented by COVID-19 have generally eliminated the ability for many face to face human interactions to occur, which has increased the value of automated business processes to organisations (Abelein et al., 2009). In the SME law firm example, processes typically completed by a human, such as compiling client details, can be easily automated, which can increase efficiency and reduce costs (Groover, 2019). Furthermore, services delivered as part of a SOA can help to reduce data and process replication, which in the short-term can help to reduce storage and licensing needs, and in the long run can help to deliver a greater ROI on IT spend for SMEs (Annal Ezhil Selvi, 2017). This is important particularly in a disaster scenario such as COVID-19, where the shock has caused significant economic impacts that have challenged the financial viability of many small and medium-sized businesses (Craven et al., 2020).

4. Key architectural considerations for effective SOA implementation in SMEs

4.1. Planning and development

Organisations or business units cannot rush the shift to SOA. Proper planning is essential to avoid situations where the to-be architecture fails to achieve its intended objectives (Leppänen et al., 2007). This is particularly important for SMEs, which characteristically do not have an abundance of excess financial resources. Two of the most common causes of a failed EA development include a failure to establish a clear target vision (Mabry, 2008), and an inability to maintain the commitment of senior management (Armour et al., 1999).

Communicating a clear target vision is vital to get all stakeholders in the organisation committed to the purpose of the SOA development (Roach et al., 2011). Establishing this common perspective can be easier for SMEs, given there are fewer influential stakeholders to consider. However, a smaller enterprise means it is critical for all process participants to see value in the project, as each stakeholder group will have significant influence on the overall outcome.

Business unit managers are also critical to the success of a SOA implementation. In the context of an SME, this will require upper-level management to commit time and financial resources to ensure the project is completed

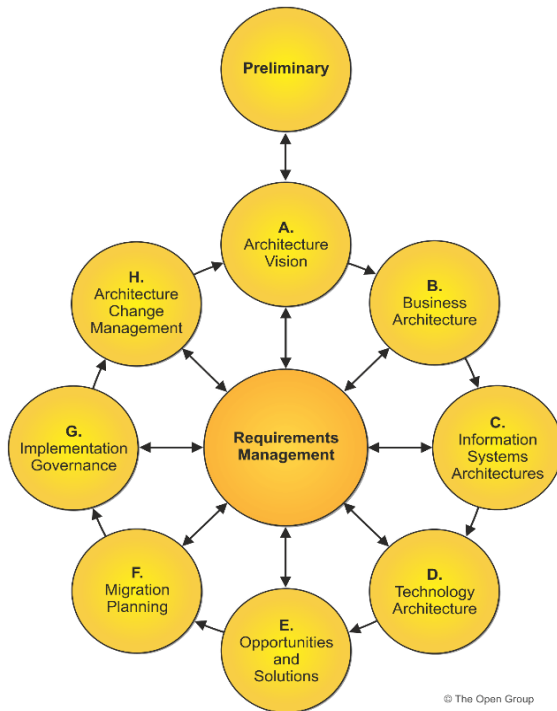


Figure 2 - The TOGAF® 8-Step ADM Cycle
(The Open Group, 2020)

as intended (Alluri, 2009). Reluctance to commit fully to the project would likely result in the project being abandoned completely, or failing to meet its key requirements, which for many firms would cause significant financial distress (Mabry 2008). To mitigate the risk of these factors becoming problematic, establishment of a clear implementation plan is required. An industry-standard tool that can be used to help guide EA development is The Open Group Architecture Framework (TOGAF®¹) (Pulkkinen, 2005). TOGAF® includes an Architecture Development Method (ADM), which is a framework SMEs can use to develop EA.

The main ADM concepts that would specifically address the potential problems mentioned above include the establishment of an "architecture vision" (Pulkkinen, 2005, p. 5) and constant re-evaluation of requirements. With the architecture vision being set at the initial stages of the ADM planning cycle and being based on various business requirements and user stories, the enterprise is encouraged to ensure this mission is communicated clearly and accepted by stakeholders before proceeding with the development (Zhao and Yao, 2010). By re-evaluating requirements at each phase of the ADM, the SOA project is more likely to address the evolving needs of the business and maintain the commitment of senior management (Brown et al., 2006).

4.2. Governance

While SOA does not necessarily mandate a switch to cloud-based IT infrastructure and services, this is a modern approach that deals with the challenges presented by the COVID-19 pandemic. Transition to a cloud-based SOA will inevitably present new challenges for enterprises (Alluri, 2009), especially for SMEs with limited technical resources and change management experience (Castro-Leon et al., 2007). To combat these challenges, organisations must manage the implementation and operation of the new SOA with a suitable ICT governance framework. ICT governance frameworks help organisations design structures, processes and relationships that help achieve its desired objectives (Iden and Eikebrokk, 2014). A prominent ICT governance framework is ITIL®², which is a governance framework known for its ability to enhance service management outcomes - thus aligning with the operational context of many knowledge-based SMEs (Cater-Steel et al., 2006). ITIL® can also be flexibly implemented as required by organisations and is relatively simple to apply, which is essential for SMEs lacking access to IT expertise resources (Mendelez et al., 2016).

4.2.1. Practical ITIL® application for the case study Legal Practice

As part of its SOA design, the SME Legal Practice plans a shift to cloud-based IaaS for its database, alongside the development of an internal web portal that securely centralises various applications for employees.

The most important concern with a shift to a digital architecture is the security and privacy of the data shared internally and externally. The Legal Practice should begin by including a relevant ITIL® guideline as part of its application of the governance framework. It will then be important for the organisation to implement plans and procedures that will allow its SOA development to conform with the ITIL® guideline. Key ITIL® guidelines that should be considered by the Legal Practice when managing security and privacy risk through SOA development include:

¹ TOGAF is a registered trademark of The Open Group.

² ITIL is a registered trade mark of AXELOS Limited. All rights reserved.

- The Legal Practice should "put in place, maintain and enforce an effective information security policy." (Brewster et al., 2009, p. 120)
- The Legal Practice should "ensure that new architectures, technology, processes and measurement methods are implemented correctly." (Brewster et al., 2009, p. 127)
- The Legal Practice should "carry out regular risk analysis and management exercises to determine the potential for failure and identify and implement appropriate responses that meet agreed business continuity targets." (Brewster et al., 2009, p. 115)

5. The short and long-term business value of SOA

EA projects are often delayed by SMEs because they require substantial time and resource investment. Furthermore, they are typically not a priority in the mix of other business costs and capital expenditure opportunities. For many SMEs, EA development and investment are perceived only to offer longer-term benefits that are hard to understand and quantify. The combination of these two factors makes an EA project seem ambitious and unrealistic (Armour et al., 1999). However, with the COVID-19 pandemic forcing organisations of all sizes to reconfigure their operations and architectures to survive, there is an immediate-term pressure for businesses to adapt accordingly, particularly SMEs who may have ignored updating their EA in the past. COVID-19 presents a unique situation where there are tangible, short-term business outcomes that can be realised by transitioning to SOA. In addition to the immediate benefits, the organisation would yield substantial positive outcomes realised in the long-term from this change.

5.1. Short-term value of SOA during a disaster scenario

The implementation of SOA can add short-term business value across a variety of business dimensions, both financial and non-financial. For a firm that relies on a physical engagement with clients, a shift to SOA would better enable the organisation to continue operations remotely. It is this business agility that is valued when organisations face unexpected and seismic changes to their operations, such as the disruptions generated from the effects of a pandemic (Biemborn et al., 2008). The ability to be agile during difficult times is vital, as it can help to define and build positive reputational characteristics that resonate with clients such as reliability and stability (Babbitz et al., 2020). These qualities help to build trust and solidify business relationships in times of crisis (Baker, 2020).

To continue with the Legal Practice as a specific example of how this benefit could be realised, the SOA implementation could incorporate a shift of the critical business database to a cloud-based Infrastructure as a Service (IaaS) storage system. This data might otherwise only be accessible from the office premises, restricting the ability for consultants to work from home. Despite the additional investment required to implement a transition to SOA (Kryvinska et al., 2011), the business can expect to benefit by being able to continue servicing its clients remotely, navigating the uncertainty that the COVID-19 environment has caused, and lowering the risk of losing clients to competitors. Due to the business continuity that SOA facilitates, the Legal Practice would continue to perform activities that generate revenue and continue to meet business obligations with stability, such as paying staff wages. Keeping a sense of normalcy for staff is critical to short-term success, as supporting employees and continuing to allow them to perform their usual duties can have positive psychological benefits as it reduces the amount of disruption they face in chaotic circumstances (Morin, 2019). Continuing to provide employees with a sense of purpose and job security can also lead to greater staff retention, important to a business attempting to remain viable in difficult economic circumstances (Arachchillage and Senevirathna, 2017).

5.2. Long-term benefits built from a short-term response

On the other side of the COVID-19 pandemic, businesses who adopt a SOA will also realise the range of longer-term benefits associated with modernised EA. Firstly, a shift from physical ownership approach to cloud-based IT infrastructure will minimise ongoing maintenance and operating costs, and reduce wastage arising from excess computing capacity (Lagerstrom and Ohrstrom, 2007). A cloud-based infrastructure provider, such as AWS, allows the organisation to pay only for the storage capacity that they need, and this can be adjusted at any time to satisfy changing demands (AWS, 2019).

The SOA approach also encourages the reuse of applications to fulfil the requirements of multiple services, reducing the incidence of "redundant functions" (Biemborn et al., 2008, p. 2) and saving the organisation financial

resources. For example, if the needs of the Legal Practices clients evolved in such a way that new service lines were required, a SOA would first consider whether existing applications can be combined to produce the desired outcome before further investment is required (Choi and Kim, 2008).

6. Conclusion

The COVID-19 pandemic has highlighted the importance of sound business continuity planning, particularly for SMEs. The ability to be able to respond quickly and effectively to disaster scenarios is profoundly important to the life and survival of knowledge-based SMEs. It is found from the research completed that commitment to EA development, specifically in the form of SOA is the best way to enable an adequate response to a disaster scenario for a SME. This is due to the key functionality that SOA provides, including an easy transition to remote working, and practical integration with cloud-based infrastructure and software services. Above all, SOA provides a logical and modern architectural platform that is appropriate for the needs of a typical SME, in the short and the long-term.

Case Example

Perhaps the Legal Practice identified that there was an increasing demand in the market for legal services that assist business owners to set-up a company structure. A component of this process is setting up an Australian Company Number, and the Legal Practice has established that clients would pay for this service. A SOA might consider how existing web-based applications (e.g. SaaS client web portal, and an Australian Securities and Investments Commission API) could be integrated through the Enterprise Service Bus to automate and streamline this process for a scalable roll-out of a digital solution.

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