VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

SCHOOL OF INFORMATION MANAGEMENT

ICT Infrastructure Environment

Skill Source by Provisioning Type

A research study presented
by
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Abstract

Local government organisations all over the world are moving to cloud and outsource providers. While there are many frameworks available to assist IT Managers with managing cloud and outsource providers, there are no guidelines for the workforce planning and organisational change involved in changing sourcing arrangements.

This study partially fills this gap by profiling the changing requirements for skill sourcing across different provisioning scenarios – in-house, outsourced and cloud providing for an 'apples to apples' comparison and study of staffing levels and organisational change impacts.

The general trend emerging is that the optimal source of:

- Soft skills (relationship management and governance) is the organisation
- Specialist skills such as network, database, technical, etc is the platform provider

The services, roles and skills necessary for effective infrastructure management in small to medium sized local government organisations were defined and verified with a perceived move from 'guru' to 'relationship manager' as the platforms were moved to external provisioning.

All skills rated highly to an organisation regardless of the platform provisioning type with methods of keeping the in-house skills current including training, certifications, forums, conferences, third party/vendor engagement. Skill currency guidelines, in the form of challenge mitigations, are provided.

Keywords: Cloud computing, Outsourcing, Resourcing, Skills, Capabilities, Infrastructure

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1 Introduction

Local government organisations all over the world are moving to cloud and outsource providers. While there are many frameworks available to assist IT Managers with managing cloud and outsource providers, there are no guidelines for the workforce planning and organisational change involved in changing sourcing arrangements.

This study is intended to fill this gap by exploring the types of capabilities/skills required by an organisation under different infrastructure platform provisioning arrangements (in-house, outsource and cloud) and where these skills should be sourced (the organisation, platform provider, other).

The subject of the research will be guidelines that will assist IT Managers to:

- Determine skills requirements for the different infrastructure platforms,
- Identify skills gaps
- Identify the best source for filling these gaps

The research questions that need to be answered to build the guidelines are:

1. *What are the skills, competencies and result areas required for effective operation and management of the infrastructure environment in small/medium local government organisations?*
2. *What is the optimal source of these skills in the different infrastructure platform arrangements of in-house (on-premise), traditional outsourcing and cloud computing?*
3. *How is hollowing of these required skills prevented under an outsourced (traditional or cloud computing) arrangement?*

We start with a literature review to determine and define the:

- Terms used in this study – IT outsourcing (both traditional and cloud computing), Infrastructure and skills (competencies and capabilities)
- Capabilities and skills required to effectively manage and support an infrastructure environment.

This also informed the questionnaire approach for collecting data from knowledgeable experts in the field.

Once the research instrument had been built the questionnaires were distributed, responses received, the data analysed and focus groups undertaken to discuss and provide richness to the structured questions.

The final step is an analysis and discussion of the results – the most appropriate skills to retain in-house in the different infrastructure platform environments, together with some recommendations for keeping these skills current and relevant.

2 Literature Review

This section explores the current literature, both academic and practitioner, to determine and define the terms used in this study (IT outsourcing – both traditional and cloud computing, infrastructure, skills and capabilities) to enable the research instrument (a structured questionnaire) to be built. An important outcome of this review was to establish the infrastructure competencies required to effectively manage and support an infrastructure environment.

The data gathering was based on this competency model and also served to confirm and refine that model.

We expected there would be a proliferation of both academic and practitioner literature on outsourcing and cloud computing. We also expected that there would be much academic literature available defining the terms skill and capability in general. Analysis of the available literature indicated that while the terms were well addressed, there had been few studies that investigated the changing role requirements and the skills mix required to manage organisational infrastructure in different environment provisioning types.

2.1 IT Sourcing

This section of the literature review will define the infrastructure platforms that will be the subject of this study – in-house, also known as on-premise, outsourcing and cloud computing.

2.1.1 In-House

In-house, or on-premise, is defined as a computer environment that is on the premises of the organisation (Wikipedia, 2015). The advantages of on-premise computing (GFI Software, 2010) are:

Control

Data stored and handled internally

Dedicated maintenance/support staff

High investment pays off over time

In-house or on-premise is described as fully-owned servers and hardware, often physically located within an organisation premises, however, can include hosting solutions where the organisation own and manage with the host providing power, bandwidth and physical security (Amundsen, 2011).

2.1.2 Outsourcing

Outsourcing is the delegation of business processes to an external provider that owns, manages and administers the processes based on defined and measurable performance metrics (Woodall, Gurney, Newham, & Scott-Jackson, 2009) (Dhar, 2012). It is also described as the trade in arm's-length purchase of services, not necessarily via electronic mediums (Bhagwati, Panagariya, & Srinivasan, 2004) or the transfer of operations to third parties, while retaining responsibility (McCormick, 2011).

According to Dibbern et al. (2004) the term IT sourcing means obtaining IT services, including management of resources and activities performed in providing those services. Four different types of IT sourcing are (Dibbern, Goles, Hirschheim, & Jayatilaka, 2004):

General Outsourcing:	Responsibility for one or many areas is given to a third party
Transitional Outsourcing:	A third party is given responsibility for any/all of the phases (legacy system management, transition to new platform/system, stabilisation and management of new system) when migrating technology platforms
Business Process Outsourcing:	The vendor is given responsibility for an entire business process(es)
Business Benefit Contracting:	A contractual agreement in terms of benefits a vendor will provide and the payment based on delivery of the benefits

IT outsourcing can also be described as the delegation of processes to a third party that manages and administers the processes to measurable performance metrics (Dhar, 2012) – a very similar description to that of Dibbern et al. (2004).

The practice, in the form of wholesale outsourcing of IT functions, became popular in 1989 when Kodak engaged three outsourcing partners to run the IT operations for the organisation (Lacity, Willcocks, & Feeny, 1996).

2.1.3 Cloud Computing

Cloud computing is outsourcing that allows consumption of IT services on a pay per use basis (Dhar, 2012). It has been provisioned by outsourcing vendors to meet demands for efficient, economical and flexible delivery of IT services (Dhar, 2012) as per the business benefit contracting outsourcing model (Dibbern, Goles, Hirschheim, & Jayatilaka, 2004) described above.

The term 'cloud computing' was born around 2006, initiated by Amazon.com and adopted quickly by several of the large technology companies (Yang & Hsu, 2011). Google's CEO, Eric Schmidt's, use of the term in 2006 resulted in discussions within the information technology industry (Suo, 2013). Within Information Technology (IT) it can be described as on demand access to a shared pool of computing resources (e.g. networks, servers, storage, applications and services) (Garrison, Kim, & Wakefield, 2012) and scalable IT services via the Internet on a pay-per-use basis (Yang & Hsu, 2011).

2.1.3.1 Key Characteristics

Suo (2013) offers the following characteristics as key to recognising and defining cloud computing:

On-demand Service – Services or computing capacity made available as needed

Ubiquitous Access – Services are accessible everywhere (the Internet)

High Scalability – Computing capabilities are provisioned dynamically (scaled up and down on demand

Pay-per-use – Charge for actual usage only, not by subscription

Location Independence – Physical location of data and service is not known

No upfront commitment – Allows businesses to start small and increase as required.

The literature definitions of cloud computing (refer previous section) imply that these key characteristics are correct. However, in some instances, the location of the cloud is known and chosen specifically to meet legislated location requirements e.g. the Tax Administration Act 1994 requires organisations to keep sufficient records in NZ (Inland Revenue, 2010) meaning the location of the cloud must be known if cloud computing services are to be utilised.

Although "cloud computing" shares these characteristics, there are many variants. Clouds can be managed externally, in-house or as a hybrid of in-house and external. More and more services are being offered in the cloud, including (for example) databases (Linthicum, 2014).

2.1.3.2 Service Models

The academic literature indicates that Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (Saas) are the three cloud computing service models that currently exist (Suo, 2013) (ASG Software Solutions, 2012) (Ryan & Loeffler, 2010) (Hunter, 2014) (Garrison, Kim, & Wakefield, 2012) (Yang & Hsu, 2011) although more and more cloud-based services are emerging.

Infrastructure as a Service (IaaS) – allows access to fundamental computer resources e.g. processing, storage, networks (Ryan & Loeffler, 2010) (Hunter, 2014). Vendors providing this type of service include Amazon Web Services, IBM Cloud and Rackspace (Lawler, Joseph, & Howell-Barber, 2012)

Platform as a Service (PaaS) – allows access to platforms, upon which, customers can build software applications (Ryan & Loeffler, 2010) (Hunter, 2014). Vendors providing this type of service include Microsoft Windows Azure and Google App Engine (Lawler, Joseph, & Howell-Barber, 2012)

Software as a Service (Saas) – allows access to software applications, running on cloud infrastructure, via the Internet (Ryan & Loeffler, 2010) (Hunter, 2014). Vendors providing this type of service include Cisco Webex and Salesforce.com. (Lawler, Joseph, & Howell-Barber, 2012)

The service models are structured in a hierarchical manner as depicted in figure 1 (Dhar, 2012). Although applications run in the SaaS layer, organisations may take advantage of these without being concerned about the underlying layers – provision of these other layers will be transparent to the user. Similarly, organisations can take advantage of a cloud provided platform to build applications without having to know the infrastructure in detail.

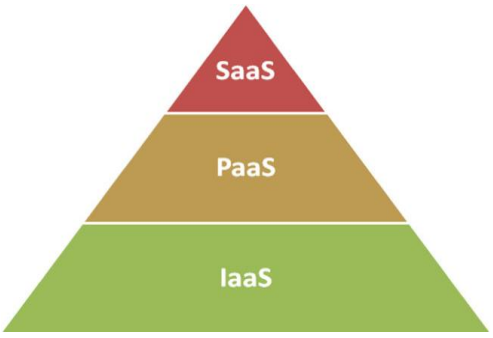

Figure 1: Three layers of cloud computing

The practitioner literature suggests that further services such as Desktop as a Service (DaaS), Office Productivity as a service (OPaaS) which is emails, etc, Telephony as a Service (TaaS) are emerging. It is unclear whether these are true cloud services in terms of the definitions as parts of these offerings look more like the traditional outsource model e.g. hardware leasing of desktop equipment rather than pay per use.

2.1.4 Cloud computing vs Outsourcing

On the surface, it appears that cloud computing and IT outsourcing are very similar. The commonalities include cost reduction, risk minimisation, global scale, fast time to market, applications delivered by a third party (cloud service provider), 24 hour support, backup and disaster recovery availability (Dhar, 2012) (McCormick, 2011).

The differences, summarised in table 1, are not that striking, allowing the conclusion to be drawn that cloud computing is the next evolution of outsourcing, bought about to meet customer demands for efficient, economical and flexible delivery of IT services from outsourcing partners (Dhar, 2012).

Cloud Computing	IT Outsourcing
Control is retained. Third party building blocks managed by organisations Governance, coordination and management activities reduced	Control of decision making and business processes transferred to third party provider, requiring high levels of project management, coordination and governance.
No upfront costs. Transparent pay per use model, with short contracts	Initial, upfront costs with long contracts. Costs often hidden.
Just in time capacity planning – flexibility on demand increasing/decreasing resources	Services not necessarily on demand – greater lead times and planning required
Uses cloud applications and infrastructure	High levels of customization possible
Private/Public cloud options available from most vendors	Specifies location, protection and access

Table 1: Summary of cloud computing and outsourcing differences (Dhar, 2012)

Nevertheless, there are important differences, particularly with regard to the degree of customisation available. Our study sets out to examine whether these (apparently fairly superficial) differences results in different skill requirements in the customer organisation and may also offer some insights and extensions to this comparison.

2.1.5 Summary

In-house or on-premise infrastructure is fully owned and managed by the organisation. The advantages are a high level of control, data stored and handled internally, dedicated maintenance/support staff and the high investment pays off over time (GFI Software, 2010).

Outsourced Infrastructure is the delegation of business processes to an external provider that owns, manages and administers the processes based on defined and measurable performance metrics (Woodall, Gurney, Newham, & Scott-Jackson, 2009) (Dhar, 2012). The characteristics are decision making control passed to the outsource vendor, initial upfront costs with long contracts, services not on-demand, high levels of customisation possible and location, protection and access is specified (Dhar, 2012).

Cloud computing is the bringing together of different technologies and business practices including broadband communications, software as a service and outsourcing (Connection Research, 2012). It is the new name for outsourcing that is delivered via the internet on a pay per use basis. The concept has grown as a result of the changes being made by outsourcing vendors to meet demands for efficient, economical and flexible delivery of IT services (Dhar, 2012)

It encompasses the infrastructure (IaaS), platform (PaaS) and software (SaaS) 'as a service' offerings that are structured in a hierarchical manner (Dhar, 2012):

Software	Built on the platform layer
Platform	Built on the infrastructure layer

In general cloud computing is the provision of services whereas outsourcing is more of an arm's-length arrangement (Bhagwati, Panagariya, & Srinivasan, 2004). Table 2 provides a high level summary of in-house, outsourced and cloud.

Area	In-House	Cloud Computing	IT Outsourcing
Control	Organisation	Organisation	Third Party
Costs	Upfront. Pays off over time	Pay per use model	Upfront with long contracts
Capacity	Handled Internally	Just in time/On demand. Flexible	Not on demand. Long lead times
Customisation	Yes	No – one size fits all	Yes
Location	Known	Usually unknown	Known

Table 2: Summary of in-house cloud and outsourcing (Dhar, 2012) (GFI Software, 2010)

2.2 Infrastructure

Infrastructure is defined as a set of resources that form the foundation that the business depends on (Byrd, Lewis, & Turner, 2004).

In order to understand the mix of skills required to effectively manage and support the infrastructure under different provisioning scenarios, it is necessary to establish what roles exist and what skills and competencies are required of these roles. This topic was more contested than expected, and further, has received little attention in the academic literature. We were not able to identify any widely agreed definitions and frameworks. As a result it was necessary to conduct our own data gathering, review and synthesis of a range of sources to derive the roles, skills and competencies that should be included in our study.

We recall the first research question:

> *What are the skills, competencies and result areas required for effective operation and management of the infrastructure environment in small/medium local government organisations?*

In order to answer this question it was necessary to establish first established those services considered to be infrastructure services followed by the roles required to perform the services.

2.2.1 Services

To establish the services academic sources and a major request for proposal (RFP) for infrastructure services were reviewed. In combination, these provided a range of perspectives in services required.

2.2.1.1 Academic Sources

Information Technology (IT) infrastructure is the underlying IT capability, usually managed by the infrastructure team, for building business applications (Broadbent & Weill, 1997).

In 1997 Broadbent & Weill identified the following six core infrastructure services and 17 additional infrastructure services

Core Infrastructure Services

1 Manage corporate communication network services
2 Manage organisation messaging services (e.g. email)
3 Recommend IT architecture standards
4 Establish security, disaster recovery and business recovery planning for organisation infrastructure
5 Provide technology advice and support services

Additional Infrastructure Services

6 Support and maintain large scale data processing facilities
7 Manage organisation applications and databases
8 Perform IS project management
9 Provide data management advice and consultancy
10 Enforce IT architecture and standards
11 Manage business unit specific networks
12 Identify and test new technologies for business purposes
13 Manage and negotiate with suppliers and outsourcers
14 Develop business unit specific applications
15 Implement security, disaster planning and recovery for business units
16 Provide management information electronically
17 Manage organisation data and standards
18 Manage business unit specific applications
19 Develop and manage online and/or electronic data linkages to suppliers and customers
20 Develop a common systems development environment
21 Develop information system planning for business units
22 Provide technology education services (e.g. training)
23 Develop multimedia operations (e.g. videoconferencing)

Table 3: Infrastructure Services (Broadbent & Weill, 1997)

In 2002 Weill, Subramani & Broadbent grouped all IT Services, including those considered infrastructure, into 10 capability clusters split between physical layer (purple) and management oriented capabilities. Figure 2 depicts these capability groups:

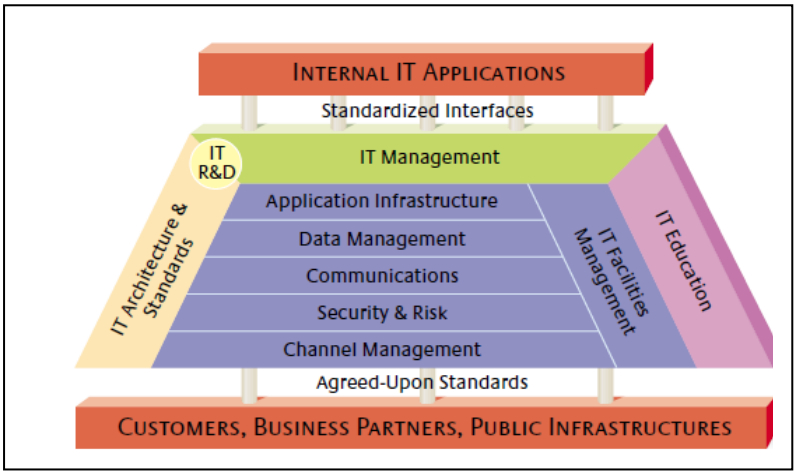

Figure 2: IT Service Capabilities (Weill, Subramani, & Broadbent, 2002)

These capability groups are defined as:

Physical Layer Capabilities

Facilities Management	Coordinates and spans the physical infrastructure layer. Includes provision of servers and environment for new system development. Integrates other five physical infrastructure layers
Application Infrastructure	Applications that are standard across the organisation and grouped into a shared service layer (e.g. enterprise systems – ERP, human resources).
Data Management	Management of data assets independent of the application (e.g. database administration) Storage management
Communications	A network that links all points within an organisation Provides the gateway to electronic channels (e.g. voice, video) and is connected to the backbone network
Security & Risk	Protection for the organisations brand, reputation, data and equipment (e.g. firewalls, policies, encryption)
Channel Management	Electronic links to customers and business partners (e.g. web sites, emails). Integrates all channels to deliver a single customer picture.

Management Oriented Capabilities

Management	Includes information system planning, project management, service level agreements, vendor negotiation.
Education	Enterprise system and technology specific training
Architecture & Standards	Information technology policies (e.g. interface protocols, application technologies)
R&D	Research and development to assist with creation of business value and track trends

Table 4: IT Service Capabilities (Weill, Subramani, & Broadbent, 2002)

2.2.1.2 Request for Proposal (RFP)

Important insights about infrastructure services can be obtained from RFP documents seeking to outsource these services. A number of councils in the Wellington region joined forces in late 2013 and asked for responses to a Shared ICT Infrastructure Services request for proposal (RFP). This RFP document was published on the NZ Government GETs tenders system on 4th July 2014. In this document infrastructure services was defined as the following groups with functions as shown in figure 3:

Services Desk and Integration

Mobile

Desktop

Network

Infrastructure Management

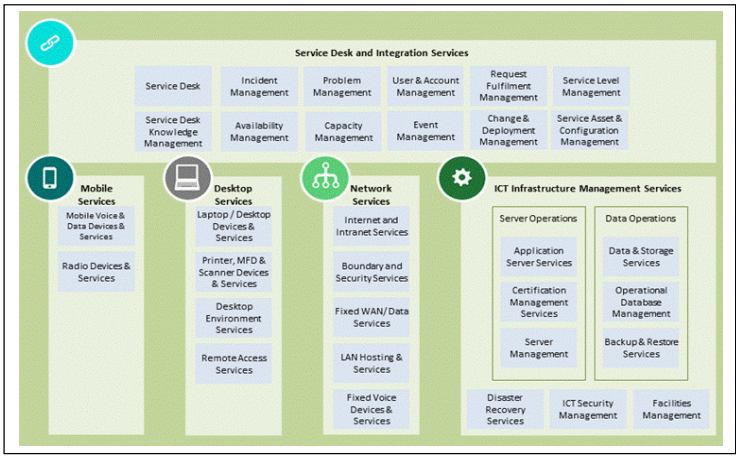

Figure 3: Wellington Regional Shared ICT Infrastructure Services – Scope (Greater Wellington Regional Council, Porirua City Council, Upper Hutt City Council, Wellington City Council, 2014)

2.2.1.3 Summary

The RFP definition includes everything except business applications. The definitions gleaned from the literature indicate that infrastructure services can cover all information technology services including business applications. As such, it appears that infrastructure services can mean different things to different organisations and/or have been refined over the time – much of the literature reviewed indicating a very wide ranging definition was more than ten years old.

For the purposes of this study, Infrastructure Services will be defined as management and support of the physical infrastructure (e.g. servers, switches, software such as email and security) namely network and infrastructure management. The service desk is considered out of scope for this study. This includes desktop, mobile and integration services (refer Section 2.2.2 Infrastructure Roles)

2.2.2 Roles

Having established the infrastructure services (refer Section 2.2.1 Infrastructure Services) the roles associated with provision of these services was determined. As academic literature in this area was limited an analysis of the ICT structure charts of organisations with similar characteristics to those included in our study was performed.

Organisation charts from Porirua City Council (Porirua City Council - HR Department, 2015), Marlborough District Council (Marlborough District Council - CIO, 2015), Kapiti Coast District Council (Kapiti Coast District Council - IT Manager, 2015), Queenstown Lakes District Council (Queenstown Lakes District Council, 2015) and Wellington City Council (Wellington City Council - BIT Manager, 2015) have been synthesised to determine the generalised IT department structure for the study target group (NZ Local Government) shown in figure 4.

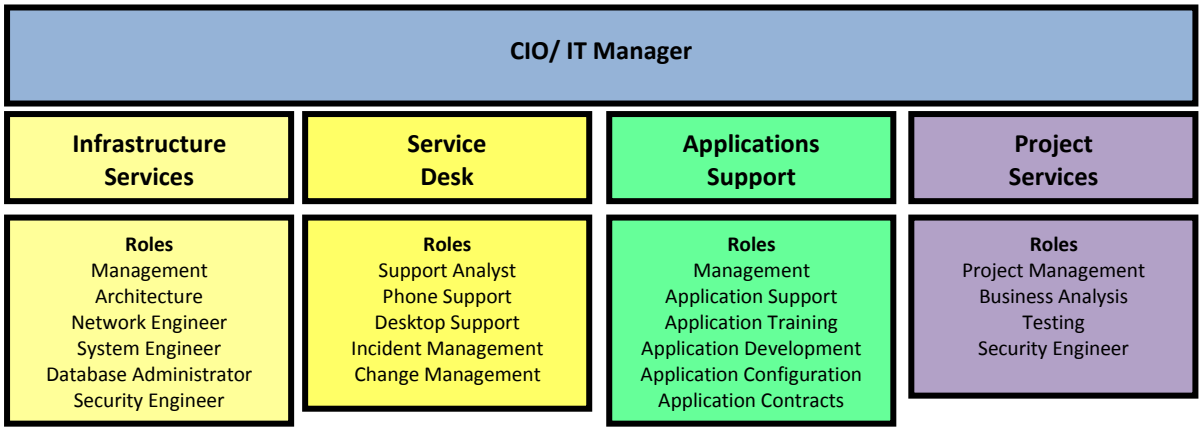

Figure 4: Generalised IT Organisational Structure

The service desk and infrastructure services have been assigned a similar, although not the same colour to depict that some, not all, of the organisation charts analysed included service desk as part of infrastructure services.

2.2.2.1 Summary

An organisation must have sufficient core IT capability to ensure changing technologies and services may be exploited to achieve business advantage (Feeny & Willcocks, 1998). Cloud IaaS is described as a platform virtualisation environment (servers, space, and network equipment) as a service (Laribi & Didi, 2014).

In terms of IT infrastructure and the literature reviewed there is sufficient flexibility in the definition of Infrastructure Services that the definition can be altered within the boundaries to suit the situation. For the purposes of this study sufficient core IT infrastructure capability will focus on the Infrastructure Services area of the generalised IT organisational structure (figure 4). The roles covered will be the Infrastructure Management, Network Engineer, System Engineer, Database Administrator and Security Engineer roles. The Service Desk area, sometimes included in the definition of infrastructure, will not be included in this study. This may be the subject of future research.

2.2.3 Skills/Competencies

Having defined the term infrastructure and the infrastructure roles within an IT department, it was necessary to determine the skills and competencies that are required to perform those roles.

Competence is related to an individual's suitability for a role in terms of the skills required for that role (Leigh, et al., 2007). A competency is described as individual's ability to perform a task (Drisko, 2014). Skill, on the other hand is described as "the ability to do something well" (Ward, 2012). These definitions lead to the conclusion that performing a competency well can be considered a skill. As such, for the purposes of this study, it should be considered that the words competency and skill can be interchanged as the intention of the study is to determine the skills required with an assumption that these will be done well.

The Australian Computer Society lists the skills for each of the infrastructure roles as described in the following table:

Infrastructure Skills						
	Management	Architecture	Network Engineer /Admin	System Engineer /Admin	Database Administrator	Security Engineer
Management						
General IT	X		X			
Programme	X					
Project	X		X			
Relationship						
Vendor	X					
Stakeholder	X					
Technical						
Specialist		X		x		X
Programming					X	
System Install/Decomm			X	X		
Architecture						
Enterprise	X	X				
Solution	X	X				
System						
Integration		X	X			
Design		X	X	x	X	
Network						
Support			X	X		
Design		X	X			
Planning			X			
Security						
Information			X			X
Administration						X
Database						
Design					X	
Administration					X	
Management (Data)					X	
Governance/Consultancy						
Consultancy	X					X
Assurance						X
Governance	X					X

Table 5: Infrastructure Roles/Skills (Australian Computer Society, 2013)

These skills are further defined by examples gleaned from the literature, in particular the Core Competencies by Role details provided by Place Recruitment (Place Recruitment, 2015). This document is a synthesis of customer requirements and job descriptions for the roles described and are used by the recruitment organisation when advertising for these roles.

Category (Australian Computer Society, 2013)	Skill (Australian Computer Society, 2013)	Example (Place Recruitment, 2015)
Management	General IT	Contract and people management, best practice definition, industry standards, infrastructure relationship and interdependencies, capacity planning
	Programme	Understanding business needs
	Project	Meeting information and business needs, technology evaluation, cost benefit analysis,
Relationship	Vendor	Contract management, service level agreements
	Stakeholder	Stakeholder Management
Technical	Specialist	Backup and recovery
	Programming	System updates, customisations
	Installation/ Decommission	System installs and removals
Architecture	Enterprise	Vision and development of technology environment
		technical standard development and adherence, expert advice,
	Solution	Interprets requirements, tool evaluation, application design
System	Integration	infrastructure relationship and interdependencies, coordinates platform interactions and communications
	Design	Software configuration, deployment, tuning and documentation
Network	Support	Monitor network performance
	Design	Requirements consultancy, recommend network approaches, system design, optimum routing design
	Planning	Identify capacity needs
Security	Information	Communication – existing and potential issues, review and inform business plans
	Administration	Risk assessments, threat controls, anti-virus software
Database	Design	Model and prototype design,
	Administration	Configuration, monitoring, optimisation, tuning
	Management	Security/integrity policies and procedures, disaster recovery
Consutlancy	Consultancy	Technical design, industry standards
Governance	Assurance	Environment reviews, health checks
	Governance	Control, oversight

Table 6: Infrastructure Skill Examples

2.2.3.1 Summary

Table 5 provides a list of the skills necessary to run and manage an infrastructure environment. Table 6 provides examples to clarify the responsibilities within these skills. These lists are used as the base of the research instrument for determining the level of skill necessary to run and manage the infrastructure environment under different provisioning scenarios – in-house, traditional outsourcing, cloud computing.

2.3 Conclusion

The literature review has provided definitions for all the terms used in the research question, IT sourcing, including traditional and cloud computing, infrastructure as well as skills and competencies. For the purposes of this research a summary of these definitions are:

In-House Computing	Servers and hardware are owned and managed by the organisation
Outsourcing	Servers and hardware owned by organisation and administered/managed by third party based on measurable performance metrics
Cloud Computing	Outsourcing that is delivered via the internet on a pay per use basis with the services procurement managed by the organisation
Infrastructure	Services, Roles and Skills/competencies for the effective support and management of an infrastructure environment. The final skill categories addressed in this study are: Infrastructure Management Network Engineer System Engineer Database Administrator Security Engineer
Competency/Skill	Suitability and ability to perform a role

These definitions and skills are used to inform the research instrument.

3 Research Question(s) and Objectives

The intention of this research is to develop guidelines to assist IT Managers with making the decision on staff requirements under different infrastructure provision arrangements. It will also provide recommendations on how to keep the skill levels relevant to prevent the hollowing effect that can occur when infrastructure is outsourced.

We have established the roles, skills and competencies required for effective infrastructure management as per question 1:

1. *What are the skills, competencies and result areas required for effective operation and management of the infrastructure environment in small/medium local government organisations?*

We recall our second and third research questions were:

2. *What is the optimal source of these skills in the different infrastructure platform arrangements of in-house (on-premise), traditional outsourcing and cloud computing?*
3. *How is hollowing of these required skills prevented under an outsourced (traditional or cloud computing) arrangement?*

4 Research Approach

This section describes the approach taken to the research as well as the limitations of the research.

4.1 Process

Only users who owned and used a smart phone were selected for this study.

4.1.1 Treatment Groups:

Two separate groups were approached to participate in this study:

Local government and associated organisation IT Managers – nine participants

Private sector IT Managers – two participants

Both groups were given the same initial treatment – a questionnaire.

All participants were known to the researcher and were approached personally to participate with no reward offered for participation. All were of a similar age group – late 40s through to mid fifties with all but one local government participant and one private sector participant being male. This gender bias is typical of IT Management and therefore not considered a shortcoming of this research. The limited number of participants was a constraint brought about by time and access to the individuals.

Nevertheless, despite the small numbers overall, all the participants are experts in their field and include representation from five of the six councils in the Wellington, New Zealand, region. As a result, we believe our findings are highly representative.

4.1.2 Protocol Development

Data was gathered using structured, written interview questions (i.e. a questionnaire) that were completed by the expert informants. The questions were developed based on some initial research (literature review and discussions) to determine the roles that are included in a typical infrastructure team and the skills that are associated with these roles as well as a review of the literature to define the terms used: in-house, outsource, cloud, competency/skill, etc.

Upon completion of the first draft of the questionnaire, a pilot test was performed using one local government IT manager and one associate of the research supervisor. The results indicated the questions were confusing, and that asking for a percentage response would provide data that was richer than a simple yes/no response.

A second draft of the questionnaire was developed and reviewed by the researcher based on the pilot information and the same IT Manager used to pilot the new questionnaire as well as a review by the research supervisor. Feedback was again provided that indicated further clarification was required.

A third draft of the questionnaire was developed, reviewed by the researcher and the research supervisor and was deemed to be acceptable to proceed. This third draft included an additional section (skill importance rating) that was introduced as a means of verifying the optimal skill sourcing responses.

This final questionnaire is provided in Appendix 1 of this document. Alongside this questionnaire, the participants were provided with a Participant Information Sheet (Appendix 2) and a Participant Consent Form (Appendix 3).

4.1.3 Trustworthiness Strategies

The trustworthiness strategies employed when building the questionnaire were based on the accepted four criteria: credibility, transferability, dependability and confirmability (Shenton, 2004). The strategy invoked against each of these criteria is shown in Table 7.

Criteria	Strategy Invoked
Credibility	Participants were asked to rate the importance to the organisation of each skill sourced Two pilot tests using the questionnaire were performed with feedback resulting in updates that were reviewed and incorporated Areas provided where participants could add to and/or provide comment on the research questions Participant background and experience known Participants clearly made aware of purpose of the research – discussions with researcher and background described on the instrument Focus group held to discuss the initial findings
Transferability	Context described and shortcomings (small participant group) discussed in the report
Dependability	Importance rating question included to verify sourcing responses Research process described in depth in the resulting report
Confirmability	Research shortcomings described in report Research process described in depth and an audit trail produced

Table 7: Trustworthiness Strategies Invoked

4.1.4 Process Flow

Once the questionnaire was deemed suitable to proceed, the participants were selected from a group of peers and colleagues of the researcher. After an initial discussion with each participant outlining the purpose of the research, the questionnaire was completed privately by each participant and emailed to the researcher.

Upon completion, each questionnaire was evaluated for correctness where it was discovered that one of the local government and one private sector response did not hold sufficient information to be used in the research. The two responses were eliminated. Having eliminated one of the private sector responses the other also then needed to be cast aside to avoid identification, resulting in only local government and associated organisation responses being considered. Refer to the Data Analysis – Participant section of this document for further information.

The responses on the remaining eight questionnaires were then analysed (refer to the Section 5 – Data Analysis of this document for descriptions and results) with findings drawn (refer to the Section 6 – Findings of this document) based on the outcome of the analysis.

A focus group was convened to discuss the initial results from the data analysis. Five of the participants were selected to take part in the focus group. These participants were selected based on geographic location to make it easier to convene a face to face meeting. Three of the five participants declined the invitation due to prior engagements and one of the participants did not turn up at the meeting despite accepting the invitation. This left only one participant in the focus group that included both the researcher and the research supervisor.

While disappointing as time did not allow further meetings to be convened, the one participant did agree to proceed with the focus group, have the conversation recorded and included in the research report. Had time allowed, subsequent focus groups would have been convened involving most of the participants – all responded to the focus group participation question positively.

4.1.5 Audit Trail

Figure 5 shows an audit trail of the research process.

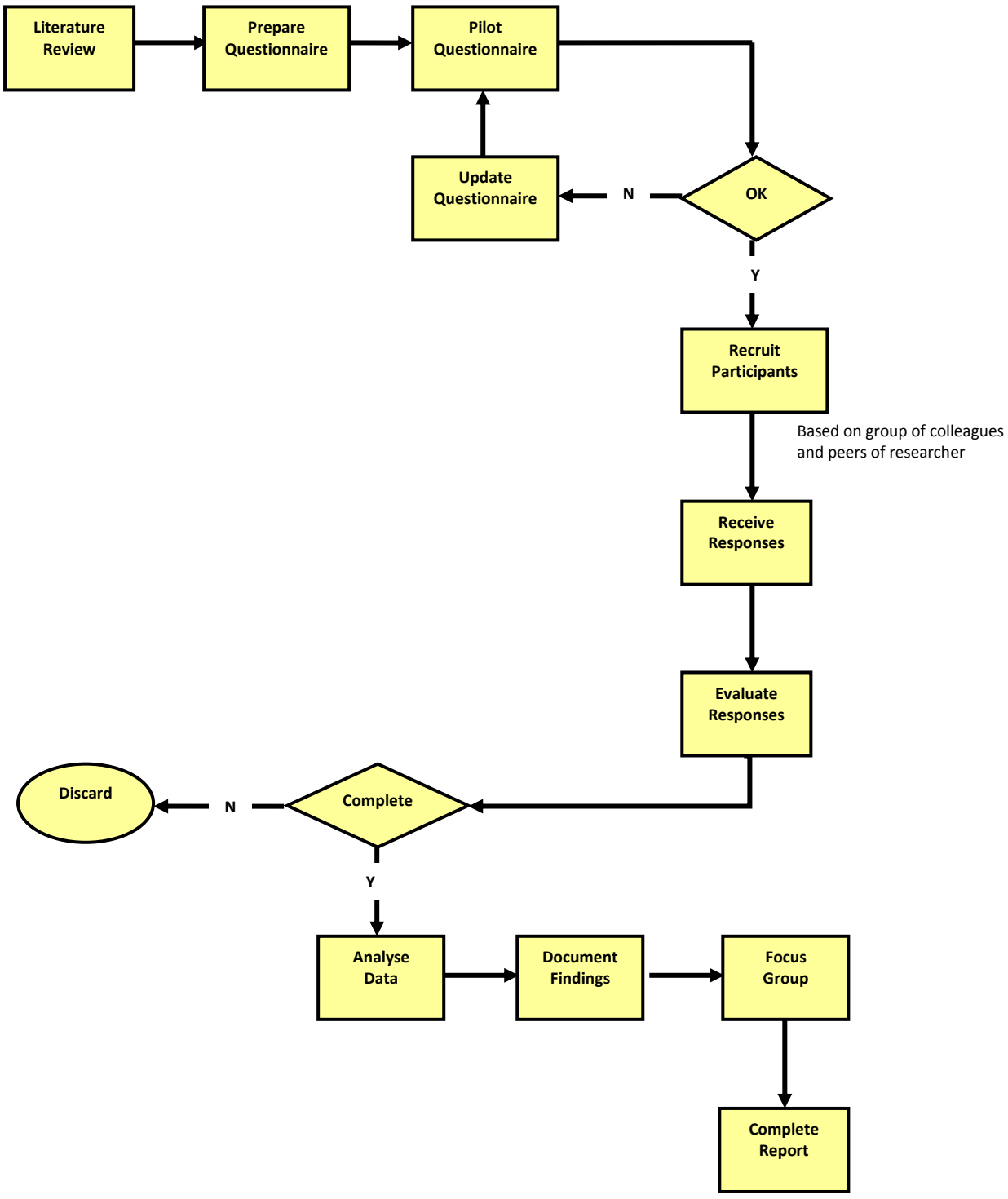

Figure 5: Research Process Audit Trail

4.2 Limitations

The research was limited to a small group of participants known to the researcher. While there was a mix of organisations covered (local government and associated organisations as well as private sector) the quality of the responses resulted in only local government and associated organisations being included in the results.

This research also did not accommodate hybrid situations (in-house/cloud, could/outsourced, etc). It would be impossible to capture the endless variations of hybrid platform provision so this research was performed from the perspective of a pure (100%) platform provision (i.e. 100% cloud provided, 100% outsourced or 100% in-house). In reality this is unlikely to occur as no matter how pure an infrastructure may be there will always be some component that is provisioned differently (e.g. in-house provisioned infrastructure platform that runs Microsoft 365 – a cloud service).

5 Data Analysis

The data gathered via the questionnaire (Shown in Appendix 1) covered the following areas:

Infrastructure Skills

Participants – overview of the participants as a whole

Participant Organisations – size, current infrastructure platform source, etc

Current Skill Sourcing – mix of skill sourcing that the participant organisations currently have to support the infrastructure platform

Optimal Skill Sourcing – mix of skill sourcing the participants considered were required to support the various infrastructure platforms, namely in-house, outsource and cloud

Skill Importance – Perceived importance of an infrastructure skill to an organisation

Skill Currency – Challenges and mitigations to keeping skills within an organisation current

The data has been analysed and discussed within these categories in the following sections.

5.1 Infrastructure Skills

Participants were given opportunities to describe any infrastructure roles or skills that were not included in those gleaned from reviewing the literature. For both role and skill, no new areas were offered. Some of the participants did list items in the areas provided, however, these had already been included (e.g. network, servers) elsewhere in the questionnaire.

5.2 Participants

The limited number of participants (eleven) was a constraint brought about by time and also the purpose of the study. The target group was limited to peers of the researcher (local government and associated organisation IT Managers as well as the private sector). All participants were known to the researcher and were asked to contribute. There was no reward for participating.

Although the small number of participants is potentially a limitation, all experts in their field, have all been employed in their current role for more than two years and have extensive experience (a minimum of six years) in the infrastructure area. As such, we believe this is a highly representative sample of the target group – local government in New Zealand.

Responses were received from all nine of the local government and associated organisation IT Managers, as well as two private sector IT managers – 100% response rate.

One private sector participant did not complete the skill importance rating section and omitted to respond to a number of other questions. As such the responses from both private sector participants have not been used as it would be easy to identify the remaining private sector participant.

One Local Government participant did not complete the 'ideal world' (proposed) section resulting in only eight participant responses being considered.

For the purposes of anonymity, the local government associated organisations were treated as local government. These include council controlled organisations. Future research could be undertaken to determine how similar or different the local government associated organisations are to the local government organisations themselves in this area.

Similarly, although this research was aimed at local government sector, had the two private sector responses been sufficiently valid to be included, it would have provided an idea on whether further research exploring the differences and similarities between local government and the private sector in this area would be warranted. It does not detract from the actual results.

5.3 Participant Organisations

There was a good spread in terms of the size of the organisation. The employee numbers range from 1600 through to 140. Table 8 shows the range in terms of numbers in each small (<200), medium (200 – 500) and large (>500) category.

Category	Employees	Number of Participants	Number of Organisations
Large	(> 500)	2	1
Medium	(200 – 500)	4	4
Small	(<200)	2	2

Table 8: Participant Organisation Size

The percentage of staff employed within ICT in these organisations ranges from 2.14 – 7.43, with a general trend being the larger the organisation the higher the percentage of the employees work within ICT. A summary of the OECD determined percentage of ICT staff as a share of total employment based on Australian, Canadian and European labour force surveys, September 2015 is shown in Figure 6. This shows that the organisations surveyed were within the bounds of normal in terms of the percentage of staff employed within ICT.

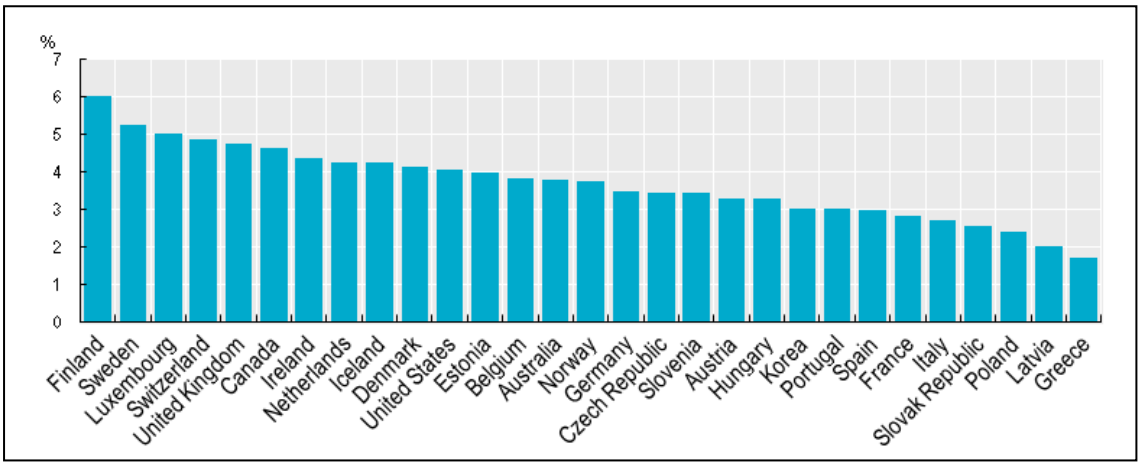

Figure 6: OECD ICT Staff Percentages (OECD, 2015)

All, except one, of the participating organisations is anticipating changing how the infrastructure is provisioned. Most of these indicate some cloud engagement, leading to the conclusion that cloud is becoming more and more viable and popular as an infrastructure provisioning option.

All the participating organisations currently own the infrastructure, with six of the eight also currently managing that infrastructure. The location of the infrastructure is mixed with the majority currently housing that infrastructure in house.

5.4 Current Skill Sourcing

Figure 7 shows the skills sourcing arrangement the participating organisations currently have in place. The heavy reliance on in-house staff across the full range of skills is as expected based on the current infrastructure platforms of the organisations (i.e. infrastructure is generally owned and managed within the organisation).

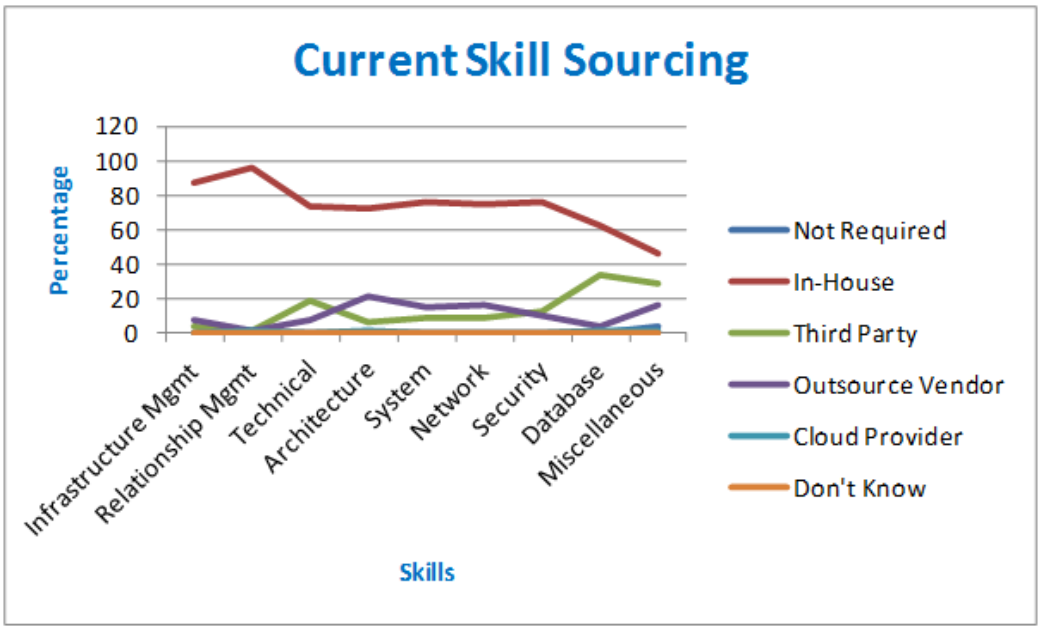

Figure 7: Current Skill Sourcing

5.5 Optimal Skill Sourcing

The 23 skills identified that are required to support an infrastructure environment have been grouped into the following ten categories and the data analysed within each of these categories, as well as overall.

Infrastructure Management

Relationship Management

Technical

Architecture

System

Network

Security

Database

Consultancy

Governance

5.5.1 Infrastructure Management

This skill area consists of General IT Management (e.g. contract management, resource management, planning), Programme Management and Project Management. Figure 8 shows the optimal sources of the infrastructure management skills across the platforms.

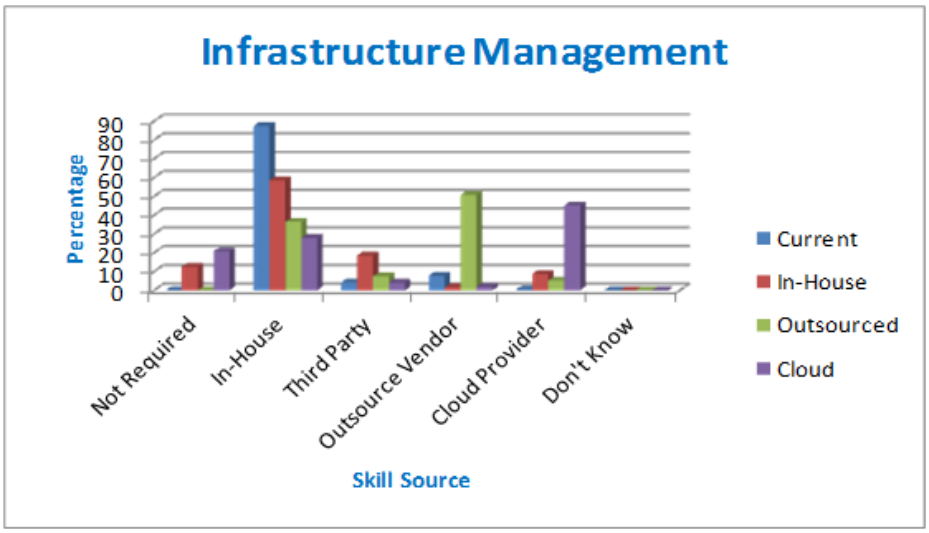

Figure 8: Infrastructure Management - Optimal Skill Sources

This source of this skill aligns with the platform provider with a relatively high percentage (35% – 45%) of the skill being retained in-house even under the outsourced and cloud platform scenarios.

5.5.2 Relationship Management

This skill area consists of vendor and stakeholder management. Figure 9 shows the optimal sources of the relationship management skills across the platforms.

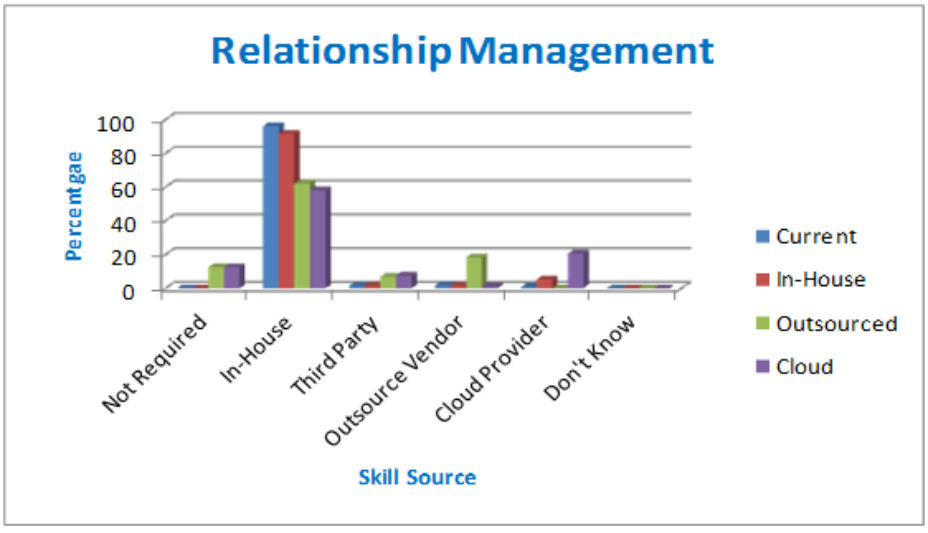

Figure 9: Relationship Management - Optimal Skill Sources

Regardless of the platform the majority of this skill will be retained by the organisation. In the outsourced and cloud platform scenarios, a very small percentage of the skill is sourced from the platform provider indicating relationship management is two way.

5.5.3 Technical

This skill area consists of specialist (e.g. product specific knowledge – active directory, SQL Server), programming and installation/decommission. Figure 10 shows the optimal sources of the technical skills across the platforms.

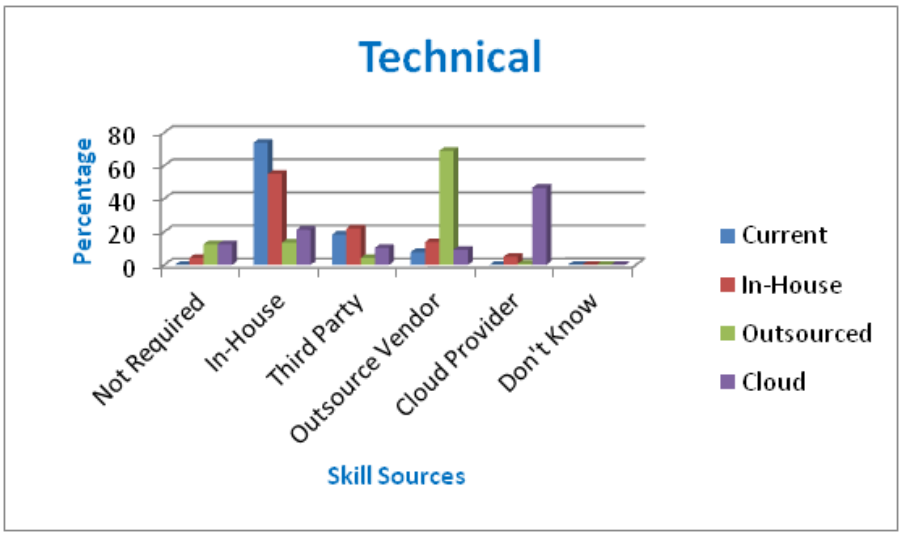

Figure 10: Technical - Optimal Skill Sources

The research shows a definite trend in the technical skill being provided by the platform provider with minimal levels of this skill being retained within the organisation.

5.5.4 Architecture

This skill area consists of enterprise and solution architecture. Figure 11 shows the optimal sources of the architecture skills across the platforms.

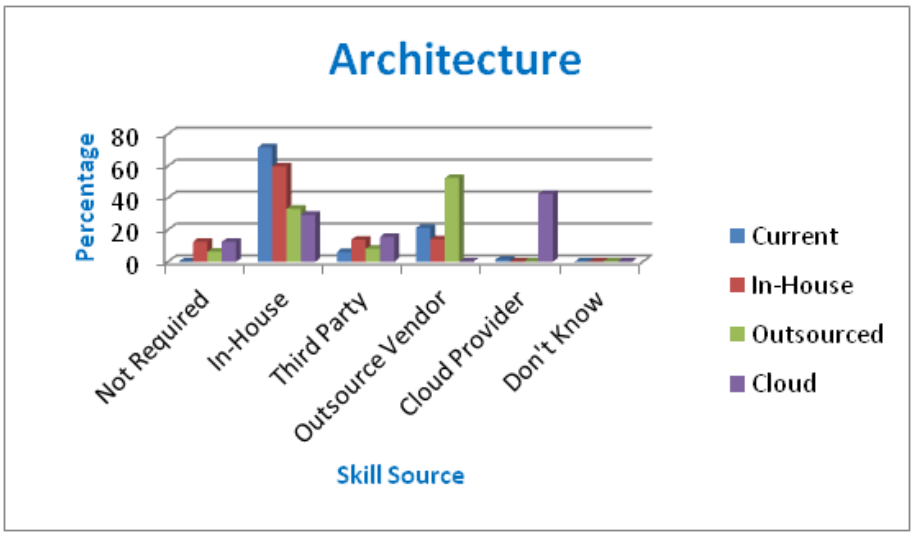

Figure 11: Architecture - Optimal Skill Sources

A reasonable percentage of the architecture skill is retained in-house regardless of the platform, although in the outsourced and cloud scenarios this responsibility appears to be shared between the organisation and the platform provider.

5.5.5 System

This skill area consists of system integration and design. Figure 12 shows the optimal sources of the system skills across the platforms.

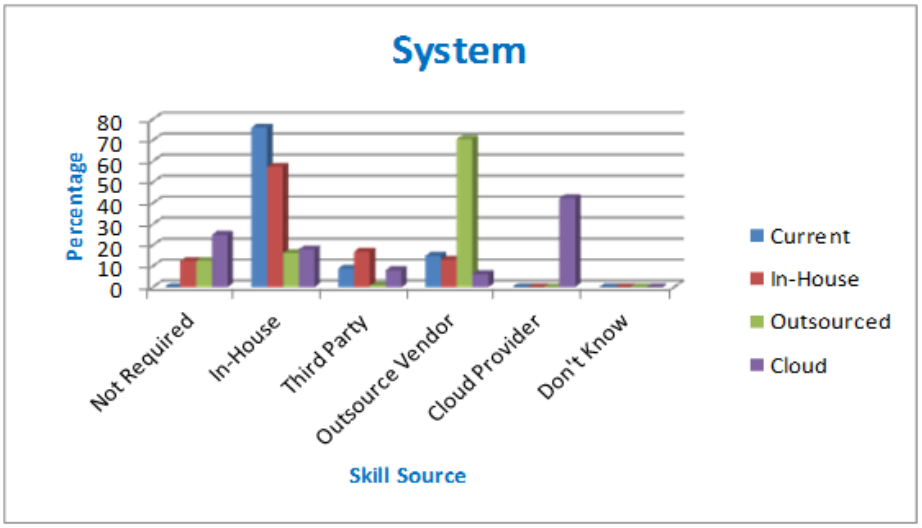

Figure 12: System - Optimal Skill Sources

The research shows a definite trend in the technical skill being provided by the platform provider, particularly under the outsource scenario, with very minimal levels of this skill being retained within the organisation.

5.5.6 Network

This skill area consists of network support, design and planning. Figure 13 shows the optimal sources of the network skills across the platforms.

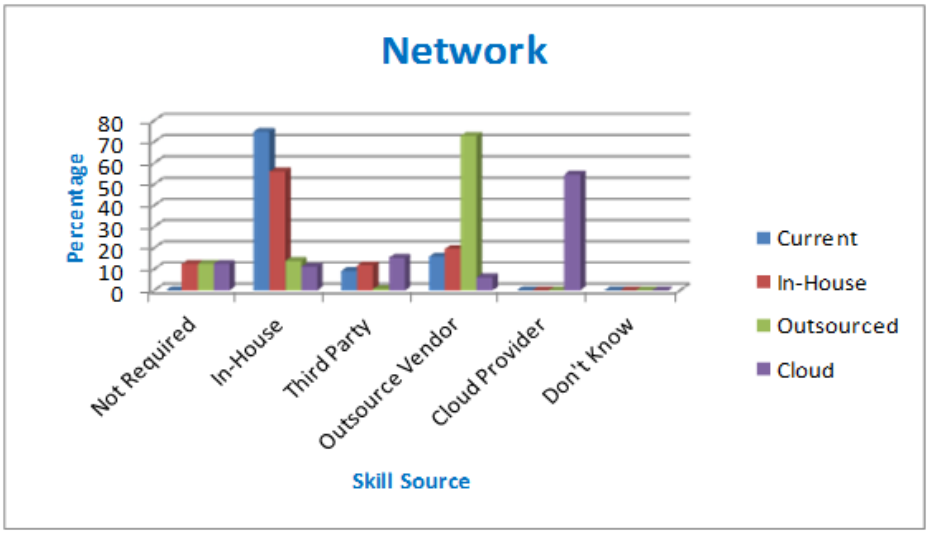

Figure 13: Network - Optimal Skill Sources

Again the research indicates this skill is predominately sourced from the platform provider with a very low percentage of the skill being retained in-house.

5.5.7 Security

This skill area consists of security information and administration. Figure 14 shows the optimal sources of the security skills across the platforms.

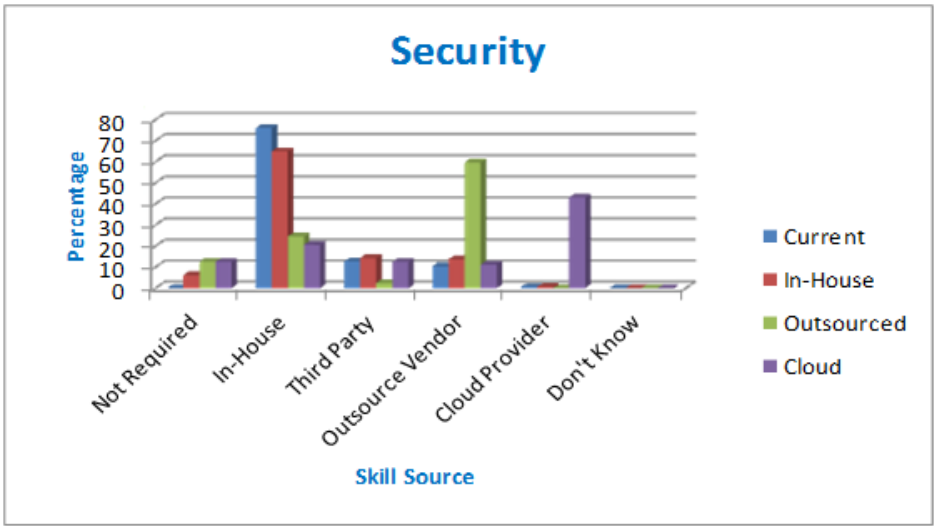

Figure 14: Security - Optimal Skill Sources

The research again shows a definite trend in the security skill being provided by the platform provider, particularly under the outsource scenario, with very minimal levels of this skill being retained within the organisation.

5.5.8 Database

This skill area consists of database design, administration and management. Figure 15 shows the optimal sources of the database skills across the platforms.

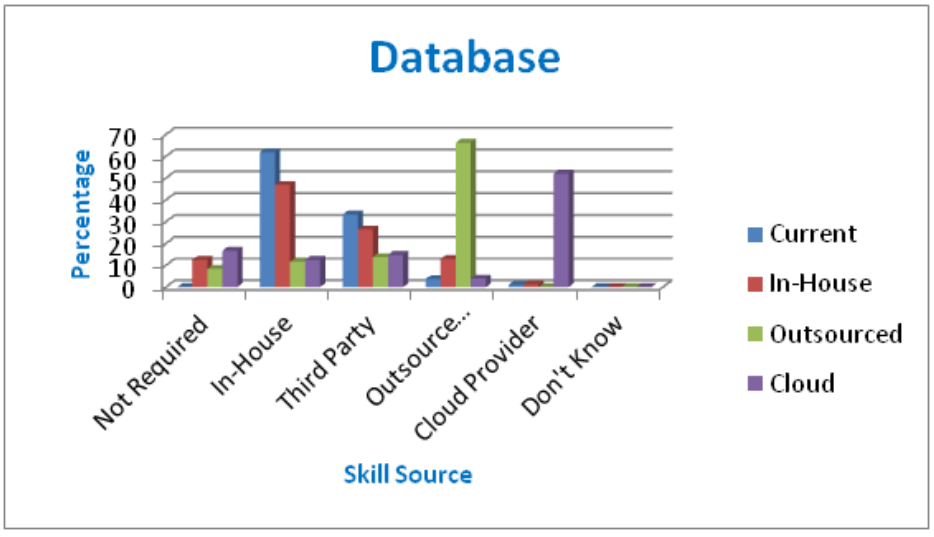

Figure 15: Database - Optimal Skill Sources

The research shows that the database skill is predominately sourced from the platform provider with the organisation sharing a small percentage with a third party provider.

5.5.9 Consultancy

This skill area consists of specialist consultancy in all infrastructure areas. Figure 16 shows the optimal sources of the consultancy skills across the platforms.

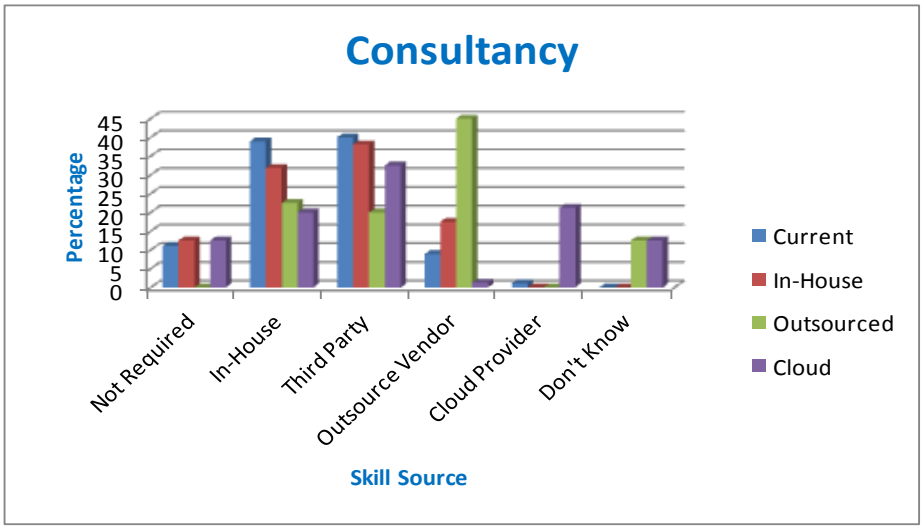

Figure 16: Consultancy - Optimal Skill Sources

The research is indicating that an organisation would retain a good percentage of this skill in-house regardless of the platform provider even though there is more use of third parties for sourcing this skill than most of the other skill areas.

5.5.10 Governance

This skill area consists of governance and assurance. Figure 17 shows the optimal sources of the governance skills across the platforms.

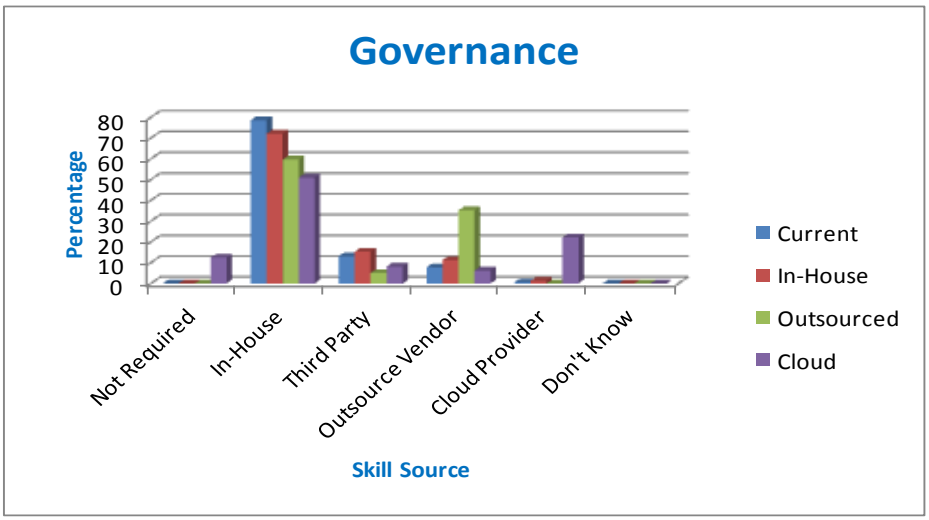

Figure 17: Governance - Optimal Skill Sources

The most appropriate source of governance is in-house regardless of the platform – 86% for both in-house and outsourced scenarios and 78% for the cloud scenario.

5.5.11 Summary

Despite multiple rounds of refinement, and a pre-briefing of participants, we felt there were some issues in interpretation of the structured questionnaire. In particular, although our intention was to concentrate on understanding the *in-house skills* the organisation itself was responsible for under each scenario, the responses (with one exception) showed the percentage of skills that would be sourced from *each provider* under *each scenario*. This perhaps indicates (understandably) that sourcing cannot be understood in isolation, but needs to include the totality of providers. It also indicates the complexity of sourcing scenarios, as it was extremely difficult to capture the range available into an unambiguous structured questionnaire. While our results did not have the full focus we expected on the organisational skills required, they provided a broader insight into the sourcing shifts across the platforms in different scenarios (including the proportion that should be retained in-house).

Overall the trend seems to be that the specialist skills of infrastructure management, technical, architecture, system, network, security and database should be sourced predominately from the platform provider, with a small percentage of this skill retained in-house. The soft skills of relationship management and the governance skills are best retained in-house.

A summary of the optimal sourcing for each platform is shown in figures 18, 19 and 20.

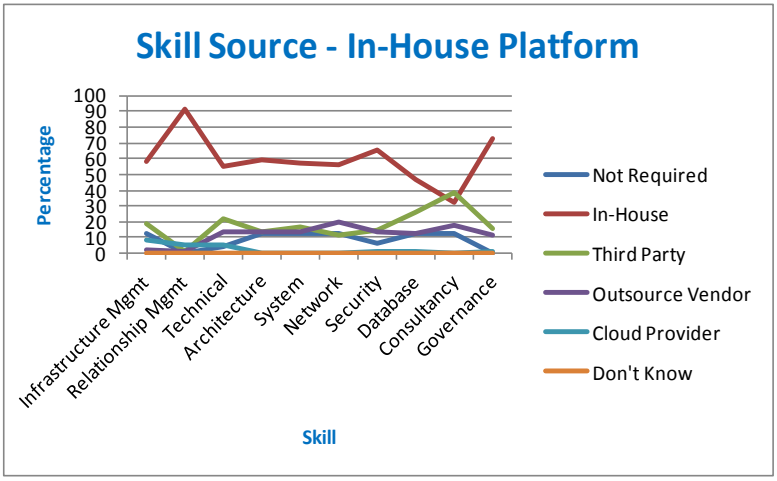

Figure 18: Skill Source - In-House Platform

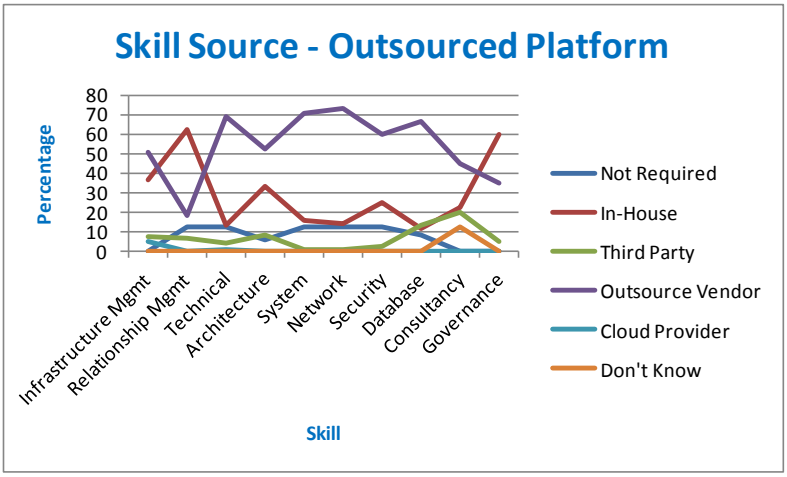

Figure 19: Skill Source - Outsourced Platform

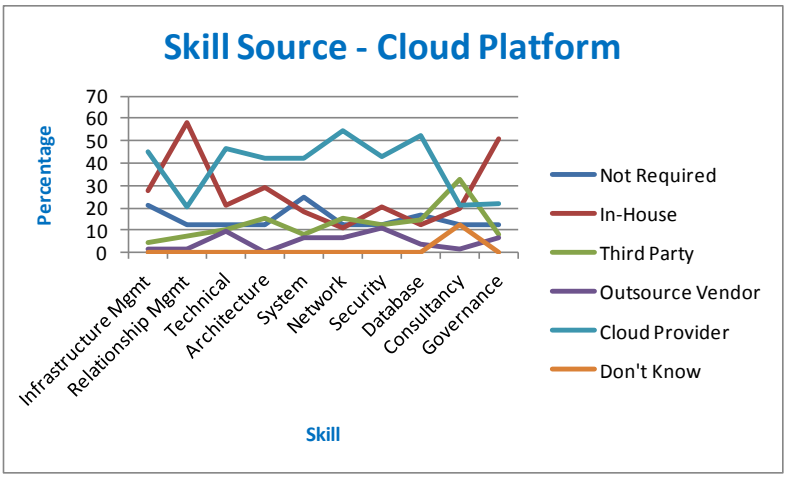

Figure 20: Skill Source - Cloud Platform

These graphs clearly show that the sources with the highest percentage of skill provision align with the platform provider. A small percentage of each skill is retained in-house regardless of the platform. Use of third parties is more prevalent in the cloud and outsourced scenarios.

5.6 Skill Importance

Participants were asked to rate the importance to the organisation of each skill under each of the platform scenarios. The results (refer Figure 21) showed that the all skills were slightly less important in the outsourced scenario than in-house and the skills were less important again under the cloud scenario.

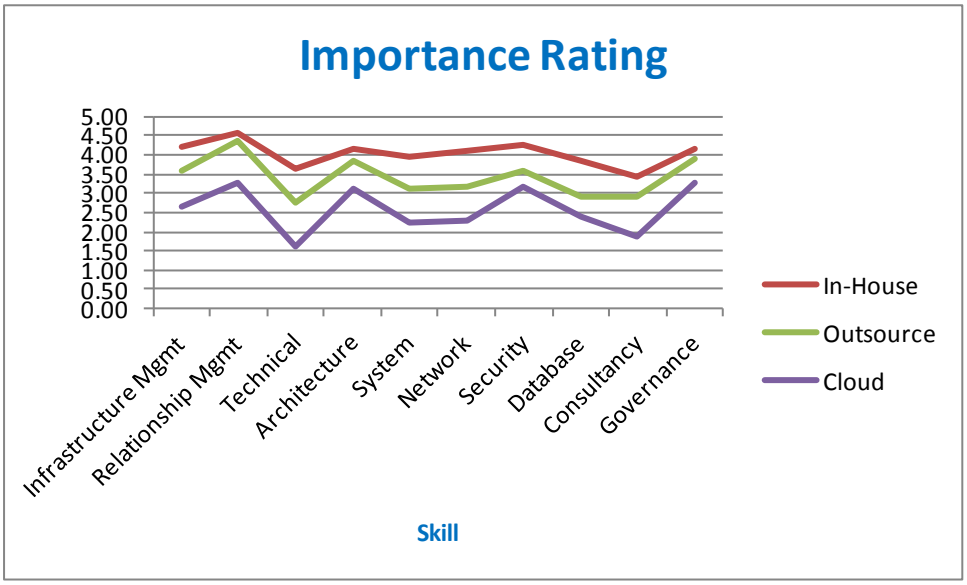

Figure 21: Skill Importance Rating

The intention of the skill importance rating was to confirm the optimal skill sourcing for each platform with the hypothesis being that the more important a skill is to the organisation, the more likely it would be sourced in-house. While the soft skill areas (relationship management and governance) do show quite a high rating, based on the optimal sourcing results it would be expected that these soft skills would rate higher in importance for the outsourced and cloud platforms than the in-house scenario.

5.7 Skill Currency

Semi structured data regarding skill currency was collected in two areas of the questionnaire:

> Question 7: *Please describe the challenges you currently have managing and maintaining skill levels in the infrastructure area and how you overcome these challenges*
>
> Question 33: *Please describe how you would keep the organisational required skills current*

The data was collated and analysed in terms of challenges and mitigations. Themes were generated by coding and grouping the data based on the meaning of the words used. The results of these questions indicated that most of the organisations experienced similar challenges and all had similar mitigations in place. A thematic network diagram that summarises this coding (Tate, Furtmueller, & Wilderom, 2013) is shown in figure 22.

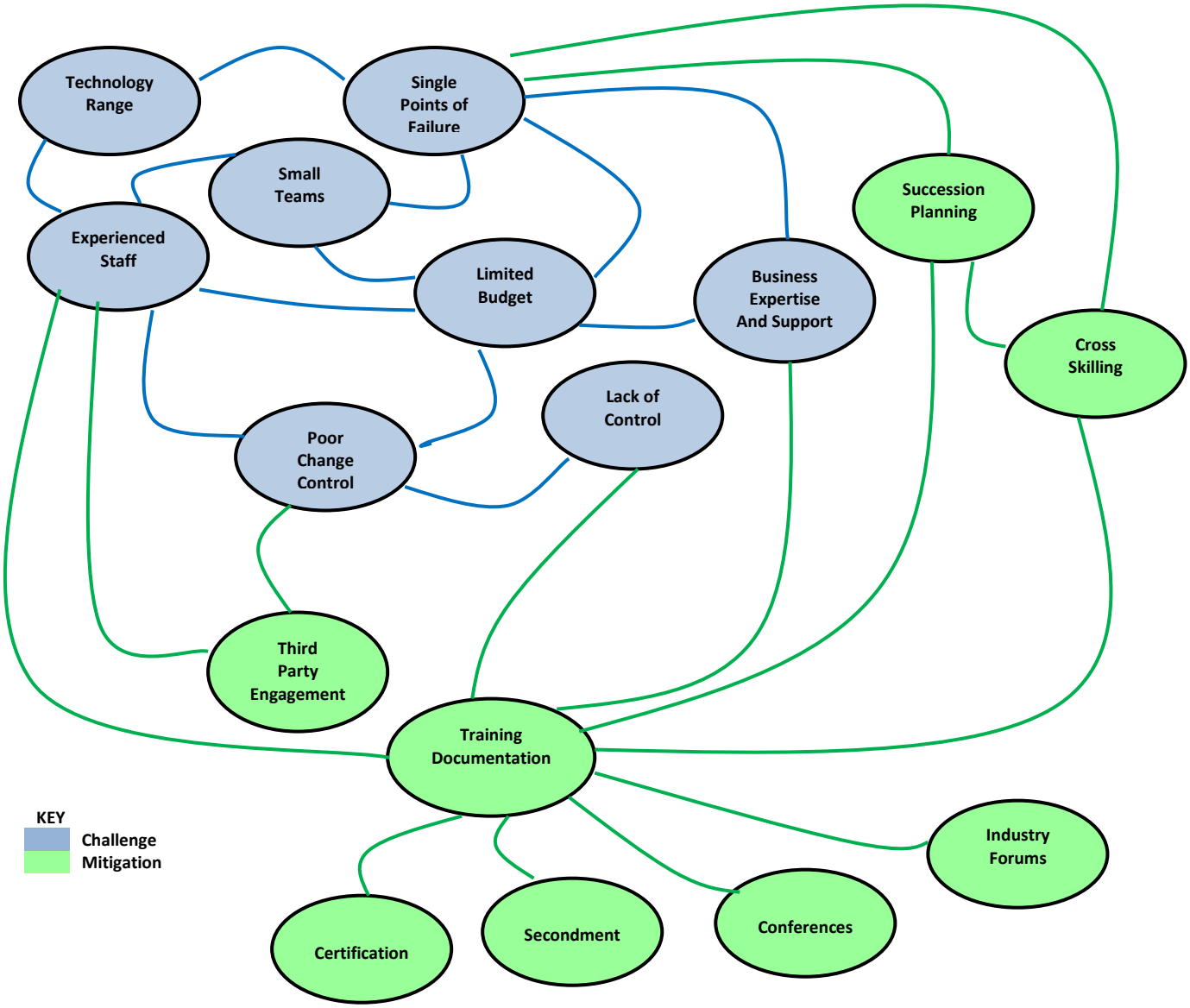

Figure 22: Skill Currency - Challenges and Mitigations

Limited budget is at the centre of the challenges. The *lack of money* leads to the inability to procure *experienced staff* to manage the *number of technologies* to eliminate the *single points of failure* and enable adequate *control* and *business support*. Poor *change control* leading to insufficient *experienced staff* also has an impact on the knowledge levels within an organisation. Responses that evidence this range of challenges include:

> "*Due to the rapid changes, and higher expectation keeping staffs knowledge (and earthly experience) is our greatest challenge*"
>
> "*Breadth of skills required in the digital environment*"
>
> "*Depth of knowledge required*"
>
> "*Due to the tiny size of the team and the range and complexity of our systems, it is necessary to employ senior staff with a broad skill set*"

The themes that emerged from the mitigation data were *succession planning*, *training (*including *documentation)* and *third party engagement*. It seems that the responses were realistic as not one participant mentioned more money as a potential solution indicating knowledge that the budgets cannot be significantly increased. Within this group of participants, the need to operate on minimal budgets is a well known. One of the responses sums this up as "limited budgets".

Responses that indicate third party engagement as a mitigation strategy include:

> "*Outsource the commodities*"
>
> "*Overcome by outsourcing* "
>
> "*Engage vendors to do regular technical briefings*"

Evidence of the high dependence on training and documentation as a skill currency challenge mitigation strategy include:

> *"Ensure that SMEs [subject matter experts] have access to major conferences in their subject areas*"
>
> *"We are mitigating the risk by documenting as much as we can"*
>
> *"Skill levels can always be improved by training and cross skilling"*

6 Findings

Our findings have been described in terms of the research question categories:

Skill Definition:	*What are the skills, competencies and result areas required for effective operation and management of the infrastructure environment in small/medium local government organisations?*
Skill Source:	*What is the optimal source of these skills in the different infrastructure platform arrangements of in-house (on-premise), traditional outsourcing and cloud computing?*
Skill Currency:	*How is hollowing of these required skills prevented under an outsourced (traditional or cloud computing) arrangement?*

6.1 Skill Definition

With regard to the first research question, the study validated the services, roles and skills required to effectively management and operate an IT infrastructure environment. This was determined from the literature and an analysis of practitioner sources. No new services, roles or skills were identified as a result of the questionnaire responses.

Our major, but unexpected, finding was the lack of agreement in terminology and the level of complexity involved in infrastructure sourcing. For example, it is quite possible to have infrastructure managed in-house, database provided on a platform in the cloud with strategic advice about that cloud platform provided by a third party consultant. It is, therefore, very difficult to provide structured questions that capture the range of scenarios our participants were engaged in, or planning.

6.2 Skill Source

Our results gave good insights into major expected changes as to where the required infrastructure skills are likely to be sourced under the different sourcing scenarios: in-house, outsourced and cloud. What we did not clearly identify, perhaps because there is not a clear answer, is the main entity that should be responsible for providing that skill.

There are endless variations of platform provision. Organisations appear to be constantly reviewing and updating the arrangements. In this study, seven of the eight participants are currently working towards a change in infrastructure provisioning – hybrid cloud/outsource in most cases. It is acknowledged that it would be impossible to capture the full range of different possibilities, therefore, for the purposes of this study the responses requested were from a pure in-house, outsourced or cloud platform perspective.

Taking an overview of the questionnaire responses it appears that most participants answered from the perspective of the expected new state and with recognition of the complexity of real environments, rather than 'ideal world'. This is evidenced by responses that indicate some percentage of required skills would potentially be sourced from the:

- cloud provider even for an in-house managed platform
- outsource vendor for a cloud based platform

Overall the study indicates that the soft skills (relationship management, governance and assurance) should be sourced from within the organisation regardless of the infrastructure platform. It was expected that relationship management, in particular, would be mainly sourced from within the organisation, regardless of the platform. The focus group backed this expectation and finding in the following comment:

> When hiring
>
> > "*Technical would be the last skill I would be looking at. Relationship management is really important*"

As the focus group put it *"if you allow it [relationship management] to be outsourced or provided by a third party then you basically lose control over your environment".*

On the other hand, the research shows that the optimal sourcing arrangement for the specialist skills (infrastructure management, technical, architecture, system, network, security and database) is with the platform provider, with a small level of that skill retained in-house. It is expected that this in-house skill level is maintained to keep the platform provider honest. This is evidenced by the participant questionnaire comment "*a certain amount of technical QA is required as part of effective governance, even in outsourced and cloud models"*. This is further confirmed by the following focus group comments:

> "*Definitely need that [technical] skill. It does not have to be 100% but do need to have a fairly high level of understanding*".

In general the skills sourced from the cloud provider in a cloud platform arrangement are slightly lower than that of the outsource provider in an outsourced arrangement. This indicates that there is some understanding that while outsourcing is an arm's-length purchase of services (Bhagwati, Panagariya, & Srinivasan, 2004) or transfer of operations to outsource vendors (McCormick, 2011) it is still more of a partnership arrangement than cloud computing. The following excerpt from the focus group confirms this finding:

> "An outsourced environment is more a business partner, whereas a cloud environment is a service provider"

6.2.1 Importance Rating

Security does seem to be of concern in a cloud arrangement with expertise in this area being sourced from across the spectrum rather than predominantly in-house and the cloud provider as per most of the other specialist skills. Especially in a cloud environment the organisation must be satisfied with the security, privacy and audit commitments detailed in the contract (Ryan & Loeffler, 2010). This importance score for this area was also higher, in relation to scores for other areas, for the cloud platform.

The skill importance rating was inconclusive. The results neither proved, nor disproved the skill source responses and did not offer much insight into skill importance. It did, however, show that each skill was important to the organisation, regardless of the provisioning platform with the importance ratings consistently reducing from the in-house environment, through to the outsourced platform with the lowest rating occurring for the cloud platform. This could be as a result of the closer partnership experienced in an outsourced platform where the skill provision more trusted to the vendor than in the case of cloud. Further research in this area may confirm this theory.

It was surprising to find that the importance rating for the soft skills (relationship management and governance/consultancy, particularly governance) did not back the skill source responses by showing a higher importance rating in the outsourced and cloud arrangements. The focus group was also surprised by this result and offered misinterpretation, explained by the comment: "*We all come from different perspectives*", as a potential reason. Further research or additional focus groups based on this research could explore this perceived anomaly.

6.3 Skill Currency

The research echoes concerns that have previously been voiced with regard to outsourced public sector IT – that a high level of outsourcing can result in a "hollowing out" of technical skills in small public sector organisations (Tate, Johnstone, Toland, & Hynson, 2007). How to retain the skills necessary to keep vendors, outsourcers and cloud providers "honest" remains an ongoing challenge for organisations.

While there were many challenges faced in keeping the in-house skills current and many suggestions to achieve this were offered (e.g. Training, certifications, forums, conferences, third party/vendor engagement). A network thematic showing these challenges and associated mitigations is shown in figure 22.

6.3.1 Challenges

The main challenge faced by many of the organisations was the limited budget common in local government organisations. This leads small team sizes, generalised, rather than specialised skills, an inability to recruit the experience necessary, single points of failure and process neglect (e.g. poor change management).

6.3.2 Mitigations

While the challenges were many and varied, the mitigations offered condensed into three themes:

Succession planning

Training and documentation

Third party engagement

Based on the number of participants offering the mitigation, training, is the single most important activity to engage to keep skills current – all participants mentioned this in one form or another. There was a large variety of training offered including: certifications, conferences, forums, secondments and cross skilling.

Third party engagement was also offered as mitigation for many of the challenges, if budget allowed. One participant stated "*where financially possible, maintenance and support agreements are in place with Vendors*". "*Business owners to provide expertise and support*" is further evidence of third party engagement – business is considered an external party to the IT team.

6.4 Contribution

There is a lot of hype about outsourcing and moving to the cloud, but relatively little advice about how to effectively make the transition for people on the ground. This research is one of the first studies to provide insights as to how to manage the staffing impacts of these moves.

In summary this research:

- Defines the services, roles and skills necessary for effective infrastructure management in small to medium sized local government organisations – no further roles or skills were offered by the participants. This is likely to be generalisable to other comparatively sized organisations.
- Profiles the changing requirements for skill sourcing across different provisioning scenarios. This provides a basis for an 'apples to apples' comparison and studies of staffing levels and organisational change impacts. It is a neglected area academically and is something every practitioner wants to know. A RightScale State of the cloud survey (Weins, 2015) indicates that:

  82% of organisations have a hybrid cloud strategy

  88% of organisations are using public cloud

  93% of respondents indicated a cloud adoption plan

- Skill retention is very complex. There are many scenarios and combinations to accommodate. Overall, a perceived move from 'guru' to 'relationship manager' was a clear trend. This is a change from five years ago where technical skills were more important than personal skills. Now it is the other way round – personal skills are more important than the technical skills. The focus group described this change as:

  "Five years ago I would appoint someone according to his [technical] skills – look to see if he is a guru"

  "Now I would look at the relationship skills then the technical skills"

  "It is a balance though"

  Risks associated with moving the main responsibility for skill provision to the platform provider in a cloud/outsourced arrangement include:

  - Loss of control
  - Hollowing out of skills
  - Dependence on consultants and vendors

On the other hand there are many advantages to moving the main responsibility for skill provision to the platform provider in a cloud/outsourced arrangement include:

- Reduced need to keep skills current – responsibility passed to provider
- Reduced staffing levels – no need to have expertise in all areas within the organisation
- Access to a wider group of experts

Guidelines for keeping organisational skills current, in the form of challenge mitigation, are provided.

6.5 Future Research

There are endless possibilities for further research based on this study. This section describes a few of these possibilities.

This research did not produce the resourcing level framework original proposed. Both this research and the questionnaire could be used as a base to build this framework. The questionnaire should be extended and refined to ensure the intention and questions are clear. Perhaps the research should be undertaken on a per platform basis (i.e. research skill souring in a cloud environment only) instead of trying to gather data for each of the three scenarios at the same time.

The population for this research was limited to local government. The research could be used as a base to determine the similarities/differences between local government, main government and the private sector. In the opinion of the researcher, It is expected that the private sector would be more inclined to let an outsource vendor or cloud provide take more responsibility than local government because the private sector tend to adopt new technologies (and platforms) faster than local government so are therefore more mature in these areas.

Further research to confirm the theory posed by this research that the closeness of partnership between the provider and the organisation will determined the level and importance of skills retained in-house would be interesting.

Additional focus groups using the results from this study to determine why the soft skill (relationship management, governance and assurance) importance rating did not back the skill source responses. Based on the skill sourcing responses, a higher importance rating in this area was expected under the outsourced and cloud scenarios.

7 Conclusion

The services, roles and skills necessary to operate and manage an infrastructure platform were defined and proved.

The research has also provided good insight into the most appropriate source of skills for each platform provisioning option included: in-house, outsourced and cloud. The general trend emerging is that the optimal source of the:

- Soft skills (relationship management and governance) is the organisation
- Specialist skills such as network, database, technical, etc is the platform provider

The organisation does hold some level of all the skills in-house even under the outsourced and cloud provisioning types. It is expected these skills are retained to keep the platform provider honest and effectively manage the service provided.

All skills rate highly to an organisation regardless of the platform provisioning type. A slightly lower importance rating of all skills under the cloud platform could indicate a closer relationship with this provisioning arrangement than with an outsourced arrangement. Further research could prove/disprove this.

While there were many challenges faced in keeping the in-house skills current, many suggestions to achieve this were offered (e.g. Training, certifications, forums, conferences, third party/vendor engagement). Guidelines, in the form of challenge mitigations, have been provided.

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9 Appendix 1: Research Questionnaire

The following is the research questionnaire, showing the purpose, instructions, background and questions that were used.

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

SCHOOL OF INFORMATION MANAGEMENT

Infrastructure Environment

Skill Source by Provisioning Type

QUESTIONNAIRE

This research is being undertaken by
Sue Critchlow
in partial fulfilment of the requirements of a
Master of Information Management

This research is intended to determine the skills an organisation must have to successfully manage an ICT Infrastructure environment under various provisioning models, namely in-house, outsource and cloud.
The outcome of the research will be a framework to assist organisations with determination of optimum skills needed, and from where these should be sourced, based on the infrastructure sourcing model

Please complete and return to Sue Critchlow (email: critchsue@myvuw.ac.nz) by 10th November 2015
Please feel free to phone Sue should you require further clarification - 027 240 6650

DEFINITIONS

For the purposes of this survey terms used have been defined as follows:

Cloud Provider/Vendor	Company/Third party providing Cloud Services
Cloud Service	Building block provided by an external company and managed by the organisation. Pay per use,
In-House	Within an organisation - on the premises
Infrastructure Roles	Infrastructure Management, System Admin/Engineer, Database Administrator, Architect and Security Engineer. *Note:* Service Desk has been deliberately omitted
Infrastructure Source Type	The model used for provision of Infrastructure Services (i.e. In-House, Outsource or Cloud)
Off Shore	Not within the same country as the organisation
Outsource Service	Service provided by an external company, where control of decision making and business processes is transferred to that external company
Third Party	Party external to the organisation (e.g. Consultant, contractor)
Vendor	Company/Third party providing Outsource Services

QUESTIONNAIRE

1 How many people are employed by your organisation?

2 How many people are employed in ICT in your organisation?

3 How many people are employed in your ICT Infrastructure area, as defined previously?

4 How is your infrastructure currently provided?

(*please indicate using X the statement(s) on each row that best describes your organisation's current situation)*

Physically Located	**In my Organisation**	**In New Zealand**	**Off Shore**	**Mixed *(Comment)***
Owned By	**My Organisation**	**Outsource Vendor**	**Cloud Provider**	**Mixed *(Comment)***
Managed By	**My Organisation**	**Outsource Vendor**	**Cloud Provider**	**Mixed *(Comment)***

Comment

5 Are you planning on changing the way infrastructure is provisioned? *(Y/N)*

5a If you are planning to change the way infrastructure is provisioned and managed in your organisation, please describe the proposed change (e.g. In-house to cloud).

6 Apart from Service Desk roles which have been deliberately omitted, are there any other roles that should be considered part of an infrastructure team (please list)

7 Please describe the challenges you currently have managing and maintaining skill levels in the infrastructure area and how you overcome these challenges

For questions 8 - 33 please indicate the following using percentages (adding to 100) against each Infrastructure Source Type:

** How your organisation currently provisions the skill listed*

** In an ideal world, do **you think** the organisation needs to retain that skill under each infrastructure sourcing type, and, if so, how should this be resourced*

Note:

** If you feel the skill is not required by the organisation under a particular sourcing scenario, enter 100 in the "Not Required" column.*

** The second part of each question is what you believe to be the correct provisioning model, not what your organisation intend to do.*

** Each row needs to add to 100%*

Example Skill

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?		100				
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House		50	50			
Outsource		25		75		
Cloud	100					

In this example

** the organisation currently has in-house staff that provide the skill*

** In the opinion of the participant, in an ideal world, this skill should be provided by:*

In-House - 50% In-House staff and 50% third party
(Partial in-house and partial third party to ensure backup and fresh ideas)

Outsource - 25% In-House and 75% Outsource Vendor
(Sufficient skill held in house to keep the vendor honest)

Cloud - 100% Not required
(The organisation would not be required to retain this skill in an cloud environment)

8 **Infrastructure Management** - General IT *(e.g. Contract Management, Resource Management, Planning)*

		Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?	%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%							
In House	%						
Outsource	%						
Cloud	%						

9 **Infrastructure Management -** Programme Management (Infrastructure Programmes)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

10 **Infrastructure Management** - Project Management (Infrastructure Projects)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

11 **Relationship Management - Vendor**

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

12 **Relationship Management - Stakeholder**

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

13 **Technical** - Specialist (product specific knowledge e.g. Active Directory)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

14 **Technical** - Programming (e.g. SQL Scripting, Stored Procedures)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

15 **Technical** - Installation/Decommission (Servers, hardware)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

16 **Architecture** - Enterprise

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

17 **Architecture** - Solution

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

18 **System** - Integration (e.g. Active Directory, Email)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

19 **System** - Design (non business application systems e.g. Email)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

20 **Network** - Support

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

21 **Network** - Design

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

22 **Network** - Planning (e.g. Capacity)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

23 **Security** - Information (e.g. Security policy, rules, best practice)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

24 **Security** - Administration (e.g. security software configuration)

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

25 **Database** - Design

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

26 **Database** - Administration

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

27 **Database** - Management

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

28 **Miscellaneous** - Consultancy

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation?						
%						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

29 **Miscellaneous** - Assurance

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

30 **Miscellaneous -** Governance

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

Please add and rate any skills not listed above that you consider necessary for an organisation to retain in order to run an effective infrastructure service

31 *<Skill Name>*

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

32 *<Skill Name>*

	Not Required	In House	Third Party	Outsource Vendor	Cloud Provider	Don't Know
How is this skill currently provisioned within your organisation? %						
Ideal world - should this skill be retained by an organisation under each of the infrastructure sourcing types below and, if so, how should it be provisioned? Note: Each row must add to 100%						
In House %						
Outsource %						
Cloud %						

33 Please describe how would you keep the organisational required skills current

34 Please provide any additional comments you think are relevant to this survey

35 *Please indicate on a scale of 0 - 5 how important, in your opinion, each skill would be to the organisation under each sourcing scenario.*
Scale: 0 - Not Required, 1 - Very Low, 2 - Low, 3 - Moderate, 4 - High, 5 - Very High.

	In-House	Outsource	Cloud
Infrastructure Management - General IT			
Infrastructure Management - Programme			
Infrastructure Management - Project			
Relationship Management - Vendor			
Relationship Management - Stakeholder			
Technical - Specialist			
Technical - Programming			
Technical - Installation/Decommission			
Architecture - Enterprise			
Architecture - Solution			
System - Integration			
System - Design			
Network - Support			
Network - Design			
Network - Planning			
Security - Information			
Security - Administration			
Database - Design			
Database - Administration			
Database - Management			
Miscellaneous - Consultancy			
Miscellaneous - Assurance			
Miscellaneous - Governance			
<Additional Skill>			
<Additional Skill>			

Please provide your email address if you would like to receive a copy of the report produced in relation to this research

Should time allow focus groups will be held to discuss the findings. Please provide your name if you would like to participate in a 1 hour focus group.

Please email your completed survey to critchsue@myvuw.ac.nz or hand to Sue Critchlow on or before 10th November 2015

Thank you for participating in this research

10 Appendix 2: Participant Information Sheet

SCHOOL OF INFORMATION MANAGEMENT
TE KURA TIAKI, WHAKAWHITI KŌRERO
LEVEL 5, RUTHERFORD HOUSE, PIPITEA CAMPUS, 23 LAMBTON QUAY, WELLINGTON
PO Box 600, Wellington 6140, New Zealand
Phone + 64-4-463 5103 Fax +64-4-463 5446 Email sim@vuw.ac.nz Website www.victoria.ac.nz/sim

Participant Information Sheet

Research Project Title: Infrastructure Environment – Organisational Skills Levels by Provisioning Type

Researcher: Sue Critchlow, School of Information Management, Victoria University of Wellington

As part of the completion of my Master of Information Management, I am undertaking a research study to determine the skills an organisation must retain under for various forms of infrastructure provisioning, namely in-house, outsource and cloud, as well as from where these skills would be sourced (in-house, vendor, third party contractors, etc) in an ideal world. The result of this research is intended to be a framework to assist IT Managers with resourcing decisions when changing infrastructure provision types, as well as determine the optimum mix of resources for their current environment.

Victoria University requires, and has granted, approval from the School's Human Ethics Committee.

I am inviting you as the CIO/IT Manager of to participate in this research. Participants will be asked to take part in a non-anonymous survey that should take 15 – 30 minutes to complete and, if time allows, a one hour focus group to discuss the survey results. Permission will be asked to record the focus group sessions, and a transcript of these sessions sent to participants if required.

Participation is voluntary, and you and your organisation will not be identified personally in any written report produced as a result of this study, including possible publication in academic conferences and journals. All material collected will be kept confidential, and will be viewed only by myself and my supervisor, Dr Mary Tate, Senior Lecturer, Victoria University of Wellington. The research report will be submitted for marking to the School of Information Management, and subsequently deposited in the University Library. Should any participant wish to withdraw from the project, they may do so within three days of the survey return date, and the data collected up to that point will be destroyed. Although you may withdraw at any time after this point, the data provided up to the time of withdrawal cannot be withdrawn. All data collected from participants will be destroyed within 2 years after the completion of the project.

If you have any questions or would like to receive further information about the project, please contact me at critchsue@myvuw.ac.nz or telephone 027 240 6650, or you may contact my supervisor Dr Mary Tate, Senior Lecturer, Victoria University of Wellington at mary.tate@vuw.ac.nz or telephone (04) 463 5265. If you have any ethics queries please contact the Victoria University of Wellington HEC Convenor, AProf Susan Corbett at susan.corbett@vuw.ac.nz or phone (04) 463 5840.

Sue Critchlow

11 Appendix 3: Participant Consent Form

SCHOOL OF INFORMATION MANAGEMENT
TE KURA TIAKI, WHAKAWHITI KŌRERO
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Participant Consent Form

Research Project Title: Infrastructure Environment – Organisational Skills Levels by Provisioning Type

Researcher: Sue Critchlow, School of Information Management, Victoria University of Wellington

I have been given and have understood an explanation of this research project. I have had an opportunity to ask questions and have them answered to my satisfaction.

I understand that I may withdraw myself (or any information I have provided) from this project, without having to give reasons, by contacting Sue Critchlow via email (critchsue@myvuw.ac.nz) within three days of the survey return date.

I understand that any information I provide will be kept confidential to the researcher and their supervisor, the published results will not use my name, and that no opinions will be attributed to me in any way that will identify me or the organisation I work for.

I understand that the data I provide will not be used for any other purpose or released to others.

I understand that, if the focus group discussions go ahead and are audio recorded, the recording and transcripts of the discussions will be erased within 2 years after the conclusion of the project. Furthermore, I will have an opportunity to check the transcripts of the focus group discussion.

Please indicate (by ticking the boxes below) which, if any, of the following apply:

- ☐ I would like to receive a summary of the results of this research when it is completed.
- ☐ I agree, should the focus group discussions proceed, to these being audio recorded.

Signed:

Name of participant:

Date:

Please either hand completed form to Sue Critchlow or scan and email it to critchsue@myvuw.ac.nz

End of Report