Open Source Software in Irish Government Bodies: A Total Cost of Ownership and Procurement Analysis

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

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Abstract

This study examines the use of open source software within Government Bodies in Ireland. The primary areas of investigation include the advantages and challenges brought about by open source software, the reason for its use, as well as any hidden costs brought about by its use by Government Bodies. A secondary focus of this study is an analysis of the total cost of ownership and public procurement elements of open source software. An interpretive research approach was used throughout this study to explore the factors which affected the success of open source software within Government Bodies in Ireland. Semi-structured interviews were undertaken with nine participants from the ICT functions of Government Bodies. The participants were all at managerial level, with the majority holding overall responsibility for the ICT function within their respective organisation. The findings indicated strong use of open source software among the organisations interviewed with a robust ICT governance framework around the total cost of ownership of software projects, and the expected project benefits. The main advantages of open source software were found to be in the areas of cost and the quality of the software. In contrast, the main challenge was found to be in the area of skills availability and ICT procurement. The findings from this study conclude that while open source software is seen in a positive light by the majority of the organisations interviewed, the choice of software is ultimately driven by business requirements. A number of recommendations are also made.

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1 Introduction

Computers and technology have been an integral part of Irish Government Bodies for many years. The second computer introduced into Ireland, an ICT 1301 model, was installed in the Office of Revenue Commissioners as early as 1963 to assist with the processing of tax records (Donovan 1987). The Minister for Finance noted that this computer was also used by the Department of Education, Department of Transport and Power as well as the Meteorological Service (Haughey 1967). This was a precursor to the shared ICT services that were introduced in later years in the form of Central Data Processing Services.

Over time, computers have evolved from computational aids, to delivery of more efficient business processes, to the provision of online services to citizens. Providing online services to citizens has been a priority for Government, and is now the Government's preferred method of delivering services. This has been outlined by the Public Service ICT Strategy as published by the Department of Public Expenditure and Reform (2015), which defines five key goals:

1. Build to Share
2. Digital First
3. Data as an Enabler
4. Improve Governance
5. Increase Capability

In light of these goals, and the resulting increase in the demand for ICT services that the strategy aims to bring about, it is important to ensure the efficient and effective delivery of these ICT services. Use of ICT within Irish Government Bodies currently varies quite considerably between the various bodies in terms of scale and capability. In terms of scale, this ranges from a small ICT function headed by lower middle management grades (e.g. Higher Executive Officer grade) to a large ICT function headed by senior management grades (e.g. Assistant Secretary grade) in larger bodies. Capability ranges from maintaining office IT equipment right through to building and maintaining systems that provide online services to citizens as well as building and maintaining shared services which are provided to other Government Bodies.

The use of technology used by Government Bodies to provide these services has evolved in line with best practice trends in the wider ICT industry. Early systems were primarily developed in-house and therefore this required a sizeable amount of resources with programing skills at that time. In line with developments in the wider ICT industry, the

Government Bodies evolved and moved towards commercial off the shelf software (COTS) solutions from vendors such as Microsoft, Oracle and IBM. The adoption of COTS was seen as advantageous because of the ability to obtain well-tested software from vendors which was used by other organisations throughout the world. Due to the rather unique nature of Government Bodies, their software requirements are not always aligned to what is available as COTS. Due to this fact, most Government bodies had a need to develop some of their software systems in-house. This requirement led Government Bodies, driven by decreasing or static budgets, to investigate open source software as a method of reducing the costs associated with running their ICT function.

However, according to published research, there are hidden costs and other issues associated with using open source software if managed poorly. While many open source software vendors pitch their products at a price point considerably below the equivalent COTS offering, the cost is rarely free. This misunderstanding is often reinforced due to the fact that the cost model for open source vs COTS offerings are vastly different. Open source software is primarily an annual support-based model, whereas the COTS variants are primarily an upfront licensed-based model. This can have implications for upfront project costs.

Examples of other issues that can arise include software support, total cost of ownership, public procurement, and software licensing issues. It is on these aspects that this study will focus. Cost effectiveness and cost saving are of paramount importance in the context of the current Public Service Reform agenda. It is important to note at this stage that COTS is not immune to these challenges either, and as such, aspects of this work will also be applicable in that context too.

Open source software can be best defined as any software which is released under a license which adheres to the Open Source Definition (OSD) as laid out by the Open Source Initative (2007). The most commonly understood meaning of the OSD is that the source code of the software must be available to users. There are also a number of other requirements laid down by the OSD, and these are described in the literature review chapter.

1.1 What does the term open source mean?

As mentioned in the introduction, failure to understand the term open source can lead to hidden costs. Open source software is sometimes mistaken for *Free Software*. The term *Free Software* is somewhat of a misnomer. In this context, the *free* in *Free Software* refers to freedom, not cost. This concept has been summarised by Richard Stallman, Founder of

the Free Software Foundation as *"Think free as in free speech, not free beer"*. In *Why Open Source misses the point of Free Software*, Stallman (2009) outlines the differences between open source and free software. To a non-expert in this field, these distinctions can appear subtle, but they are important, and they form part of the problem statement in the next section.

Well-known examples of open source software include Apache HTTP Server (web server), Firefox (web browser), PostgreSQL (database), LibreOffice (office suite), Red Hat Enterprise Linux (operating system) and Android (mobile operating system). According to Netcraft Ltd's May 2016 Web Server Survey, Apache powers 45% of the top one million busiest sites on the internet. When this figure is combined with Nginx's (another open source web server) usage figure, open source web servers power 70% of the top one million busiest web sites on the internet. Open source software is particularly prevalent in the cloud computing sector, where the ability to scale rapidly to meet demand is critical. The ability to react to changes in demand without being impeded by licensing costs is a key to the success of cloud computing.

In the Irish Government sector, information regarding the level of usage of open source software is difficult to ascertain. ICT policy has historically been formulated on an organisation by organisation basis. However, with the recent establishment of the Office of the Government Chief Information Officer in July 2013 (Department of Public Expenditure and Reform 2013), this may change. It is possible, however, to establish what an organisation's appetite for open source software is through an examination of their public facing website. This is possible by examining the signalling information (HTTP headers) transmitted and received by the organisation's web server.

A brief examination of seventeen Government websites (comprising the sixteen Government departments at time of writing, together with the largest of the non-departmental civil service offices, the Office of the Revenue Commissioners) showed that six were using an open source software web server; five websites were using the Apache HTTP Server, while one was using NGINX. Of the remaining websites, six were using Microsoft IIS, a commercial off the shelf web server, while a further five did not disclose what web server was used. It is worth pointing out that some of the organisations that do not use an open source web server, (based on the HTTP Headers) may in fact use other open source software internally. Nevertheless, the HTTP Headers are a useful indicator of the prevalence of open source software use within Irish Government Bodies. This will be expanded upon in a later chapter of this work.

1.2 Public Procurement

All Irish Government Bodies are obliged to comply with National and European Union public procurement regulations. These regulations mandate that before the purchase of any goods or services can take place, the purchaser must issue a request for tender, inviting prospective suppliers to submit their best and final offer for the provision of goods and services. While this system is designed to ensure that the best value for money goods or services are always chosen, it does have disadvantages. Procurement rules state that the tender must not be overly prescriptive i.e. describe the type of item required, not a particular brand of item. This can pose challenges for software systems where interoperability with existing software is required. In addition to this, current procurement rules and regulations are typically not well suited to non-commodity items. Certain types of ICT expenditure certainly fit this category. Software in particular is rarely a commodity item. It will usually have large differences at a technical level even from products which perform the same purpose. This is in contrast with other commodity-type office items such as pens, pencils and other items of stationary which simply either fulfil their primary purpose or they do not.

While the benefits of public procurement rules are evident, it appears that the existing procedures are overly focused on the procurement of assets (physical servers, software licenses etc.). In particular, when software is being procured with a view to providing a service in the longer term, the costing models used both for budgeting purposes within the organisation and for the tender evaluation should take account of the long term running costs of the project. Failure to account for this critical issue can lead to situations when a low cost piece of software can be successful in a procurement exercise, but not necessarily be the lowest cost solution over the lifetime of the project. Kirwin (1987) introduced the concept of Total Cost of Ownership which aims to calculate the entire costs of a project over its lifetime. This includes all phases of the project including development stages, maintenance stages and decommissioning stages. Waters (2005) noted that *"These unanticipated high costs can stem from a variety of sources: long and painful implementation, unfactored maintenance and update costs, the inability of the software to adapt to rapidly changing business needs, and/or to the change management, organizational distraction, and internal resource consumption that often comes with a new IT initiative."* Increasingly, organisations are moving away from capital-based expenditure into other more service-based current expenditures such as cloud and subscription based software licensing models, and this is an area that requires investigation.

1.3 Research Question

This work aims to answer the following research question:

What factors must be taken into consideration in order to assess the suitability of open source software for use in software projects within an Irish Government Body?

- *Software quality*
  - *Is open source software of sufficient quality for use within the public sector? How does it compare to equivalent commercial off the shelf products?*
- *Total cost of ownership*
  - *How much does an open source software solution cost versus a similar commercial off-the-shelf equivalent when compared over a five-year product lifecycle? Is total cost of ownership adequately understood within the organisation?*
- *Public procurement*
  - *Is open source software compatible with public procurement rules? Are small open source vendors in a position to respond to a Request for Tender, and all of the necessary paperwork in order to provide support? Is total cost of ownership included in the procurement scoring system? Does it only take account of upfront licensing costs?*
- *Support model*
  - *How is this open source product to be maintained and supported? Is it to be maintained using in-house resources or is open source software with vendor support to be used?*

1.4 Importance of this Research

The research objective of this work is to investigate the use of open source software within Irish Government Bodies. This investigation aims to:

1. Define the various types of software projects in use within Irish Government Bodies and evaluate the suitability of open source software for each type
2. Identify the primary advantages and challenges resulting from the use of open source use in Irish Government Bodies
3. Identify any hidden costs as a result of using open source software
4. Examine the cost model used when deploying new software within Irish Government Bodies
5. Identify challenges in relation to procurement of open source software

It is anticipated that this work will lead to greater awareness of the potential issues in these areas, and will ultimately lead to greater efficiencies across Irish Government Bodies. It is also hoped that a number of recommendations can be made in relation to improvements to the public procurement process, specifically in relation to ICT procurement. This may have

an important outcome for Irish Government Bodies in improving quality and reducing costs in the Public Sector.

1.5 Research Beneficiaries

The primary beneficiaries of this research are expected to be senior ICT management in Government Bodies in Ireland. Secondary beneficiaries are expected to be ICT management in Governmental Bodies in other European countries which are also subject to European procurement directives. Private sector ICT companies who frequently participate or are thinking of participating in public procurement processes are also expected to benefit from this work. The primary goal is to critically access the use of open source software within Irish Government Bodies. This information will assist senior ICT management teams within Irish Government Bodies to critically assess potential open source software projects within their organisations.

1.6 The Scope of the Study

For the purposes of this work, the term Irish Government Bodies shall be defined as any organisation which is comprised of Civil Servants. As per the Civil Service Regulation Act, 1956, this includes both Civil Servants of the Government (the fifteen Government Departments) and Civil Servants of the State (the Office of the Revenue Commissioners and the Office of Public Works are among this category) (Government of Ireland 1956).

Notwithstanding this, from time to time throughout this work it may be appropriate to refer to other agencies within the wider Public Service. As per the Ministers and Secretaries (Amendment) Act, 2011 (Government of Ireland 2011), the term Public Service Body comprises the other remaining agencies which provide Government services. Examples include Local Authorities, an Garda Síochána, the Defence Forces, the Health Service Executive and the Education Sector. Where Public Service Bodies other than Civil Service Bodies are being referred to during the course of this study, this will be clearly indicated throughout.

1.7 Chapter Roadmap

Chapter 1 outlines the research topic and provides the relevant background knowledge required to understand the research area. It describes the problem statement, the research objectives, and the roadmap for the chapters ahead.

Chapter 2 is the literature review. This chapter:

- Defines open source software
- Provides a brief history of open source software

- Sets out a brief history and overview of Government Bodies, an introduction to total cost of ownership and cost benefit analysis
- Provides an overview of public procurement, an overview of the types of software used in the government sector, and finally an overview of open source within the government sector

Chapter 3 describes the research methodology used throughout this work. It details how the research methodology was chosen, and the reasons for its choice. It provides an overview of the method used to obtain the primary data. In this case, face to face interviews with ICT managers within Government Departments were carried out.

Chapter 4 outlines how the data that has been obtained from the face-to-face interviews were collated, analysed and subsequently interpreted. They key findings from the data are presented at the end of this chapter.

Chapter 5 is the conclusion. This chapter identifies the factors which must be taken into consideration when assessing the suitability of open source software during software projects within Irish government bodies. It outlines recommendations based on the information presented, and identifies further areas of related future research possibilities.

2 Literature Review

2.1 Introduction

This chapter aims to examine the relevant literature in the area. It aims to define open source software, provide a brief history of open source software and establish what differentiates it from other types of software. It also sets out a brief history and overview of government bodies, an introduction to total cost of ownership and cost benefit analysis. It also provides an overview of public procurement, outlines the types of software used in the government sector, and finally, delivers an overview of open source within the government sector.

2.2 Background of Open Source Software and Licenses

Open source software can be best defined as any software which is released under a license which adheres to the Open Source Definition (OSD) as laid out by the OSI (Open Source Initative 2007). Feller & Fitzgerald (2000) outlined the key conditions of the OSD as the following:

- The source code must be available to users.
- The software must be redistributable.
- The software must be modifiable, and the creation of derivative works must be permitted.
- The license must not discriminate against any user, group of users, or field of endeavour.
- The license must apply to all parties to whom the software is distributed.
- The license cannot restrict aggregations of software.

Many different software licences exist, each of which impose varying degrees of freedom and restrictions upon the user. As per the OSI, the most popular open source software licenses that exist are the Apache, BSD, MIT, GPL licenses, with the GPL being the most popular of these. The GPL, or the GNU General Public License as it is also known, was first released by Richard Stallman of the GNU Project in 1989.

In addition to these four licenses, there exists different revisions and other derived works of each license as well as other lesser known licenses. These range from permissive licenses through to more protective open source licenses. Permissive licenses allow open source code to be used within proprietary software without the need to release the resulting software as open source. Examples of such permissive licenses include the MIT, BSD and Apache licenses. On the other hand, protective licenses impose restrictions on their use to

maintain their open source status and may prevent the use of the code within proprietary systems due to the requirement to release the overall system under an open source license. Within the family of protective licenses, the MPL (Mozilla Public License), and the LGPL (Lesser GNU General Public License) provides the user with the ability to use open source code within proprietary software, provided that the included open source files are made available to users. This is in contrast to the GPL and the AGPL (Affero General Public License) licenses which are the most protective licenses. These require any software using GPL or AGPL code to be released as open source (Github Inc. 2013).

In Figure 1, Wheeler (2007) gives an overview of the relationships and the compatibilities of the different licenses. He notes that *"an arrow from box A to box B means that you can combine software with these licenses; the combined result effectively has the license of B, possibly with additions from A. To see if software can be combined, just start at their respective licenses, and find a common box you can reach following the arrows. For example, Apache 2.0-licensed software and GPLv2+-licensed software can both reach "GPLv3 or GPLv3+", so they can be combined using GPLv3 or GPLv3+".*

Stallman (2009) stresses the distinctions between free and open source software, and clarifies that not all open source software is free software. He argues that free software is the only way to ensure that the freedoms of the user are respected. He expresses regret that the term *free* creates ambiguity (certainly in the English language), and that the term *libre* is sometimes used in other languages to clarify the meaning of the word.

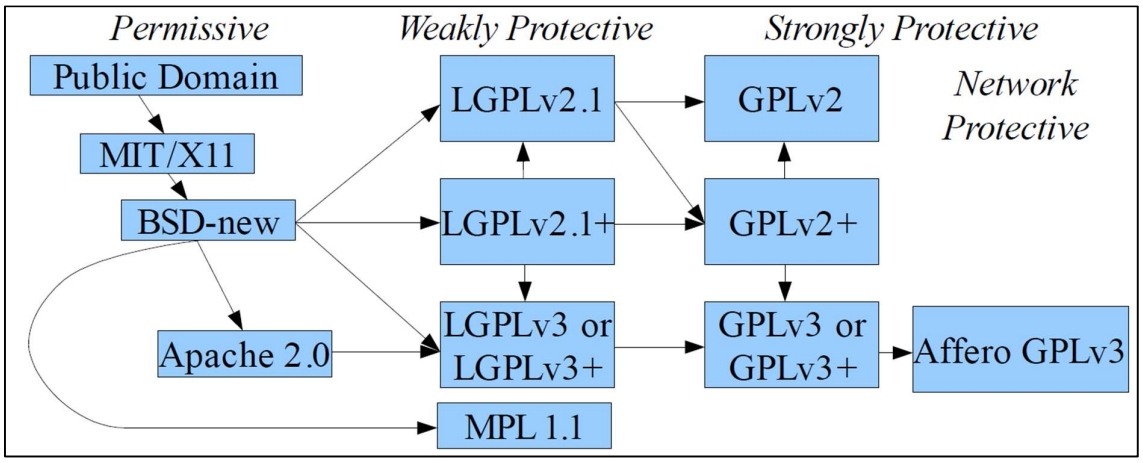

Figure 1: The Free-Libre / Open Source Software (FLOSS) License Slide, Wheeler (2007)

Fitzgerald (2006) notes the manner in which some open source licenses can contaminate or infect other pieces of software. This occurs where software developers (often inadvertently) opt to incorporate code which is licensed under a protective open source

license such as GPL into their own projects or work. Due to the terms of the license, any project which uses GPL code, must make the entire codebase available to others on the same terms as the GPL if they plan to distribute it (as per conditions of GPL license). The implication of this is that a developer who has inadvertently included GPL licensed code in the codebase has contaminated their codebase. This has led to numerous cases of incompatibilities between different open source software, not for technical reasons, but purely for legal reasons. An example of this is the Linux Kernel which is GPL licensed and the ZFS file system which is CDDL licensed. Moglen & Choudhary (2016) note that these two licenses are incompatible with each other and software which includes code from each cannot be distributed in compiled or binary form. Efforts have been made to work around this issue by distributing the affected code in source format and compiling automatically on the end user machine. As such, only source code is being distributed thus defeating the licensing restriction.

Arguably the most well-known open source software available today, is Linux. Linux is an open source clone of AT&T's UNIX operating system. Linux was created by Linux Torvalds, a Finnish computer science student, in 1991 (Garrels 2010). Although Linux was not the first open source Unix-like operating system (Andrew S. Tanenbaum's MINIX held this distinction, however MINIX was for academic use only), its success was derived from the fact that it was the first released under a free software license (Takahashi & Takamatsu (2013). Torvalds openly accepted code contributions from other developers around the world, and included their contributions in future versions of Linux.

2.3 What differentiates Open Source Software from other types of software?

In layman's terms, open source means that the end user has full control over the software, including the ability to inspect and modify the source code. This is in contrast with traditional closed source software which simply provides a functional end product and provides the user with no knowledge of how it is constructed. This does not, however, imply that open source software is available at no cost (GNU Operating System Project 2016). It is perfectly reasonable for open source software to be sold. In reality though, this does not happen as an open source vendor cannot prevent a purchaser from further reselling the source code. They are entitled, by virtue of the GPL open source license, to receive a copy of the source code as part of their purchase, and consequently, they are entitled to resell that same code on to other potential purchasers.

This leads to economic models which are considered non-standard when compared to traditional, closed-source software models. Lerner & Tirole (2002) outlined the economics behind open source software and documents the approaches that companies may take with

regards to monetising open source software. Many companies survive by *"living symbiotically off an open source project"* through the provision of complimentary goods and services which are not adequately supplied by the open source community.

Young (1999) describes how the creation of what is now *Red Hat Inc.* changed the software industry, and created a new, sustainable economic model. This model, based on software subscriptions rather than upfront software licenses enabled *Red Hat Inc.* to provide paid support for their open source operating system. This increases the barriers to entry to the market for other competitors. This is because providing an effective support level agreement is more difficult to successfully implement when compared to simply selling CD-ROMs containing the software.

The primary difference that this brings about for users of open source software is a different economic model for using and paying for open source software. In the case of enterprise users in particular, this can be significant. As there are no upfront software licenses to be purchased in relation to enterprise open source software, the user usually must purchase an annual support or maintenance contract in order to continue to receive updates and support for the open source software. This is more commonly known as Open Core Licensing (Lampitt 2008). This is in contrast with most other forms of commercial off the shelf software products which require a license to be purchased before the software can be used. This is usually accompanied by a recurring annual fee in the region of 20% (this figure varies from vendor to vendor) of the license purchase price. This is an important distinction between open source and commercial off the shelf software.

It should also be noted that enterprise users are under no obligation to purchase annual support for their open source products. Many enterprise users opt to do so in order to have "peace of mind", in the event that an issue arises. However, enterprise users that do not opt to use a commercially supported open source solution, many instead opt to use a *"community edition"* of the software which many vendors now provide. (Chang et al. 2007) note that this "community edition" is often dual licensed (same software released under two difference licenses). This provides no support, and in fact, often offers a lesser feature set than the equivalent paid for edition. The name *"community edition"* derives from the fact that for these versions, the user is dependent on the goodwill of the open source community which has developed around that software to provide support. Due to the low cost nature of this solution, this can be factor in the decision to use open source software.

In this subsection it is worth noting that the advent of cloud computing has resulted in a new trend in the ICT industry. (Marston et al. 2011) notes that traditionally, software sales models

included software license purchased upfront using capital expenditure, followed by purchasing a recurring maintenance contract from current expenditure. The advent of cloud computing heralded a subscription model for software. Within the industry, this aligns closely with the software as a service (SAAS) paradigm used by cloud providers.

The value placed by the users on the availability of the source code should not be underestimated. Depending on the particular requirements of the user, the availability of the source code brings about a number of important abilities which would not be possible if using commercial off the shelf software. In the security industry, the ability to audit the source code to determine exactly what the system does provides additional assurances to security conscious users. This means that it is much more difficult for the users to fall victim of malicious software received from other sources. Equally, in the event that a security issue is discovered, the user can, if sufficiently competent from a technical point of view, resolve the issue themselves (Payne 2002). The same cannot be said about proprietary software purchased from a vendor. In this case, the user is completely dependent on the vendor to provide the user with a solution to the security issue.

2.4 Use of Open Source Software

Open source software has traditionally been associated with Hacker Ethic and Hacker Culture, an ideology summarised by Levy (1984) in the form of five general principles:

- Sharing
- Openness
- Decentralization
- Free access to computers
- World Improvement

Ensmenger (2015) outlined the culture and practices in computer programing over the years and noted the hobbyist nature of hackers; *"At night, however, the computer centres were turned over to the use of undergraduates, either explicitly or with the implied consent of the faculty and administration. It was the after-hours activities of unofficial computer enthusiasts that would establish the distinctive computer 'hacker' identity."* Ensmenger (2015) summarised Brand's (1972) essay in Rolling Stone which described the term hacker as *"a term of derision and also the ultimate compliment"* and noted the link between hackers and open source software; *"Anticipating the Wild West metaphors that continue to be popular within the free software/open source software movements, Brand portrayed computer hackers as the 'outlaws,' 'heretics,' and 'revolutionaries' of the modern era, fighting to bring computer power to the people"*.

It was this ideology that led to many of today's well-known open source software projects being established. It therefore stands that many of the values of these projects have been inherited from the general principles underpinning hacker ethic. This has led to early open source projects being viewed as niche and unsuitable for use in the enterprise environment. In a study commissioned by the European Commission into the use of open source software in the public sector, Schmitz (2001) noted that *"With the exception of education, Open Source Software (OSS) is still not extensively used in most of the European Member States' public administrations"*. Schmitz (2001) also found that 63% of the interviewees used some sort of open source software and compared this to an open source usage figure of 56% among top 2500 US companies in a Forrest survey undertaken in 2000. These figures are similar to those presented by Schindler (2008) in her survey of 328 IT and business executives which found that 53% of respondents were using open source software in their organisations. Both surveys revealed how the majority of open source software use was in the areas of operating systems (Linux), web servers (Apache) and software development tools (Eclipse). In a more recent survey, North Bridge & Black Duck (2015) noted that the percentage of organisations using open source software had increased to 78%. It is clear from these figures that open source software is now considered mainstream.

When compared to public sector organisations, private sector organisations have far greater flexibility in their choice of ICT solutions. This is due to a number of factors, including freedom of procurement and freedom of staff recruitment and retention. Freedom of procurement allows private sector organisations to select and obtain a software solution of their choice. This is in contrast with public sector procurement which requires a tender exercise. Public procurement is covered in more detail in section 2.8. Freedom of staff recruitment and retention allows private sector organisations to compete effectively in the resource market to hire and retain ICT staff. This is in contrast to public sector organisations which must conform to prescribed pay scales and staffing numbers. These restrictions can influence decision making in relation to ICT solutions in each sector. Ryan & Harbison (2009) note that while open source software is highly versatile and adaptable to the *"broad range of unique functions"* carried out by public sector organisations, *"this flexibility comes at the initial cost of developing the applications, together with the ongoing cost of maintaining (and retaining) large IT support groups, with highly skilled personnel."* The recent economic downturn in Ireland, and the resulting pay cuts faced by the public sector, has led to challenges in the areas of staff recruitment and retention. These challenges are particularly acute in skills areas where the private sector has been expanding such as ICT and finance. This may influence an organisation's decision making on whether to use open source software as part of a ICT solution.

In a recent report for the UK Cabinet Office on the total cost of ownership of open source software, Shaikh & Cornford (2011) note that the most common categories of open source software used within enterprise organisations are operating systems, web services, database and networking. In relation to the use of open source software on desktop computers, Shaikh & Cornford (2011) note that; *"Desktops are perhaps the riskiest open source projects with the most stakeholders to consider. Selection in this domain is to be approached with care."* Based on this evidence, it is arguable that open source software is best suited to 'behind-the-scenes' roles in enterprise organisations where reliability is more important than usability.

2.5 Government Structures within Ireland

The current governance structures in Government in Ireland are largely based on the former British structures that existed prior to the foundation of the State in 1922. Bunreacht na hEireann, the Constitution of Ireland, states that the Government is comprised of the Taoiseach, Tánaiste, and between five and thirteen additional members (all of whom must be members of the Oireachtas). Each member of Government is a Minister, and holds collective responsibility for the running of the country. The Ministers and Secretaries Act, 1924 together with the Civil Service Regulation Act, 1924 defines the role of the Minister and the role of the Civil Servants appointed to his/her office. The Government exercises its executive authority through each of the Minister's Departments. The most senior Civil Servant within each Department is the Secretary (later renamed to Secretary General following the Public Service Management Act, 1997), who acts as the Accounting Officer of the Department. The most senior Civil Servant in the country is the Secretary General at the Department of the Taoiseach, who acts also as Secretary to the Government.

While the Government of the day is responsible for setting high level policies and targets, the Government Departments and Civil Servants are responsible for implementing the aforementioned policies.

The Centre for Management and Organisational Development (CMOD) was established as a division of the Department of Finance, with a remit to promote 'eGovernment' across the Public Sector (O'Donnell & Boyle 2004). In 2011, a new Government was elected, and made a number of changes in this area. The Department of Finance was effectively split in two, with the Public Sector Reform areas moving into the Department of Public Expenditure and Reform. As part of this, elements of CMOD were transformed into the Office of the Government Chief Information Officer (OGCIO) in July 2011. The OGCIO has an expanded remit when compared to CMOD, and aims to achieve an "*integrated approach to the*

exploitation of ICT across all Departments and Public Service Bodies" (Department of Public Expenditure and Reform 2013).

Use of ICT within Irish Government Bodies currently varies quite considerably between the various bodies in terms of scale and capability. In terms of scale, this ranges from a small ICT function headed by lower middle management grades (e.g. Higher Executive Officer grade) to a large ICT function headed by senior management grades (e.g. Assistant Secretary grade) in larger bodies. In terms of capability, this ranges from maintaining office IT equipment right through to building and maintaining systems which provide online services to citizens and shared services which are provided to other Government bodies.

The establishment of the OGCIO may lead to changes to how ICT projects are managed in Government departments. Given the wider Public Service Reform agenda and cost-saving measures currently being pursued by the Government, this may lead to potentially cheaper open source solutions being deployed in the sector. Failure to manage these appropriately may lead to higher unforeseen costs further down the line. It should be noted that while the OGCIO aims to achieve a more integrated approach across the Departments, there still exists a large amount of legacy ICT systems currently in place. Interoperability with these legacy systems may act as an impediment to the achievement of this integrated approach. It should be noted however that Circular 02/2016: Arrangements for Digital and ICT-related Expenditure in the Civil and Public Service (Department of Public Expenditure and Reform 2016a) states:

"...organisations must be mindful of the need to achieve optimum value from recurring or ongoing annual expenditure, generally termed non-project expenditure. In addition to determining that the level of expenditure is warranted in respect of current arrangements, organisations should also assess whether an upgrade or replacement initiative would deliver efficiencies when the total cost of ownership for the upgrade or replacement initiative is compared to the total non-project expenditure that will be incurred to maintain the existing level of service for the same period."

Organisations within the Government Sector face a number of unique challenges which are not typically found in organisations in other sectors. Brender & Drazen (2005) summarise the political budgetary cycle and stresses which it faces, particularly in the run up to an election. Organisations within the Government Sector have a broader focus such as social issues, and therefore are not solely reliant on financial figures as a measure of success. It should also be noted that the Government sector provides a large number of services which by their very nature are unique certainly not only across the country, but also across the

world. This limits the amount of commercial off the shelf ICT solutions which can be employed, and Government departments must look to more bespoke solutions, which may incorporate commercial off the shelf or open source products as part of the overall solution. Notwithstanding this, Government organisations may be able to utilise generic ICT solutions for more general business tasks. Examples of these would be Payroll, HR and finance. However, the establishment of the National Shared Services Office in 2011 has aimed to centralise these functions for all government departments (Department of Public Expenditure and Reform 2015b). As Government bodies migrate to shared services, their in-house ICT solutions are being decommissioned. The topic of procurement and how it applies to Government organisations is dealt with in a later section.

The budgetary process within central Government Departments is based upon vote accounting. In this process, Dáil Éireann passes a motion approving a predetermined expenditure for each "vote" or voted budget. Each Government Department, as well as a number of other Offices such as the Office of the Revenue Commissioners and the Office of Public Works have their own voted budget. The Accounting Officer within each organisation is responsible for overseeing the spending of this voted budget (Department of Public Expenditure and Reform 2011). Before any organisation can receive funds from the exchequer, each 'credit' must be authorised by the Comptroller and Auditor General to ensure that the funds are being used for purposes permitted by law (Comptroller and Auditor-General Act, 1923).

In addition to the general budgetary process described above, CMOD, and its successor organisation, the OGCIO have issued a number of circulars in recent years regarding ICT expenditure and governance in public bodies (see Circular 02/16, Circular 02/11, Circular 02/09, and Circular 16/97). The most recent of these, Circular 02/16 outlines the arrangements for all ICT related expenditure from voted funds. The circular instructs organisations to seek approval from OGCIO for any new ICT expenditure above €25,000. This approval is designed to ensure that any new projects are aligned to the Government's strategies and strategic objectives.

2.6 Open Source Software within Government Bodies

Use of open source software has increased in the Government sector in recent years. One reason for this increase, particularly in the Local Authority sector, has been the establishment by the Local Government Management Agency (LGMA), of an Open Source Practice Centre (OSPC) (Achanta 2014). According to the LGMA, the *"OSPC team have been charged with evaluating Open Source Software with the ultimate goal of implementing and managing an in-house Open Source environment. The team is building expertise in*

various open source technologies and is working with interested parties in the local government sector to build a community of knowledge." In a recent Dutch study, van Loon & Toshkov (2015) have shown that successful open source deployments depend on the presence of boundary spanners and political commitment within the local government. This is consistent with the LGMA approach outlined above, where an innovation centre backed by political support acts in an open source evangelist role to bring about an increase in open source software usage.

In the central government sector, the level of open source usage is unclear. There is little publicly available information in this area. The current Public Service ICT Strategy (Department of Public Expenditure and Reform 2015c) makes no reference to open source software.

2.7 Total Cost of Ownership

Total Cost of Ownership (TCO) is defined by Mieritz & Kirwin (2005) as *"Total cost of ownership is the holistic view of costs across enterprise boundaries over time."* In this context, Mieritz & Kirwin understand *"cost"* to mean the allocation of money for hardware and software purchase, staff costs and license fees as well as any costs associated with service unavailability. Cost is further categorised into direct costs and indirect costs (these are harder to identify). *"Ownership"* is understood to mean the *"IT assets"* of an organisation. In this context, the term has a broad meaning and includes both IT and the people using it as, ultimately, both are owned by the organisation. The term *"holistic view"* is used to capture the costs that are not entirely contained in the IT Budget, for example training. Mieritz & Kirwin note that *"over time"* refers to the *"life cycle perspective of TCO, because the cost of assets changes over time."* The term total cost of ownership is commonly understood to mean the total sum of all costs associated with a product or service over its entire lifecycle.

The TCO model was originally proposed as a management accounting concept by Gartner Inc in the 1980s (Kirwin 1987). This model was designed to take account of the direct and indirect costs of a proposed product or system over a period of time. As Kirwin's paper introduced the TCO model during an analysis into the cost of enterprise computing desktops, it is fair to say that this model has been applied and used within the ICT industry since the start. Due to the broad and varied nature of ICT, when calculating TCO, cognisance must be taken of the type of product or system being implemented, as well as current external factors. For example, Kirwin's paper dealt with the TCO of desktop computers within the enterprise. The lifecycle of such desktop hardware is vastly different to the software operating a nuclear power plant. In its guidance paper on Total Cost of

Ownership, the UK Cabinet Office (2011) outlined the factors which must be considered as Cost to Create, Cost to Operate, Cost to Change and Cost to End.

Fitzgerald (2006) argues that calculating the total cost of ownership of software is a "complex, multifaceted issue" and that conventional methods of calculating total cost of ownership may not be suited to open source software. He notes a more cooperative developer-user relationship as a possible reason for this. Notwithstanding this, in their paper, Ellram & Siferd (1993) conducted a study into the prevalence of TCO system use. It was found that when the attendees of the National Association of Purchasing Management Annual Conference, 1991 were surveyed, 18% used a formal TCO system, while 24% did not use any TCO system. The remaining 58% used an informal TCO method when evaluating purchases.

Taudes et al. (2000) argue that one of the criticisms of the total cost of ownership concept is that it does not take account of the *time value of money* or the *net present value*. The time value of money is a key concept used in financial management to compare financial decisions taken over a period of time. In a functioning economy, inflation will erode the value of money over time. It therefore stands that €100 held today is worth more than €100 that due to be received in one year's time. As mentioned in Section 2.3, one of the key differences between open source and proprietary software is the economic model. The concept of net present value is important when considering proprietary software with large upfront license costs. The ability to forgo a large upfront license cost in favour of an ongoing annual support cost may be more beneficial to Government Bodies. It should, however, be noted that the current global economic environment is uncertain. The low interest rate environment that currently exists globally results in a decreased net present value discount rate, and this may decrease the importance of net present value for current projects.

The emergence of cloud technologies, has brought a renewed focus to TCO models. Cloud technologies are funded on a 'pay as you go' basis, and as such, are operational expenditure (OPEX) rather than capital expenditure (CAPEX). This has led to Kirwin (2015) revisiting the concept of TCO, and evolving it. He has developed the concept of Total Cost of Services which is defined as: *"Total Cost of Services refers to full lifecycle cost of the entirety of activities – driven by market forces and directed by policies organized with supporting processes and procedures, as well as any secondary effects – that are performed by an organization or part of an organization to source, plan, provision, operate, control and refresh IT services offered to consumers of those services."*

The migration of Irish Government services to the cloud has not advanced at the same pace as their counterparts in the United States of America. This is partly due to concerns regarding the sensitive nature of the data which the organisations are trusted with when migrated to the cloud. Amazon.com Inc. currently operates GovCloud, a secure and isolated area of their AWS cloud product, designed to meet the US Government's compliance requirements. At present, nothing comparable exists for Irish Government hosting. In December 2015, the Department of Public Expenditure and Reform (2015) issued an advice note on the topic of Cloud Services and Cloud Service Providers (CSPs). This advised that a *"Cloud-first approach"* should be taken for services which provide information already in the public domain, but that *"Cloud is not an appropriate service delivery model information"* for information classified as Top Secret. The document also provides guidance around the decommission element of the total cost of ownership lifecycle; *"Public Bodies need to consider their long-term strategy for the Cloud Service, including future requirements to move to a different CSP, or to deliver the service internally, and the associated costs and constraints."*

In determining the total cost of ownership of open source software, one must give consideration to the method in which the software product was introduced to the organisation. Products may be introduced consciously into organisations or introduced as an integral part of a wider solution. In the latter case, open source software may end up being introduced to the organisation unbeknownst to management. It must be determined if the TCO is evaluated on a per component basis or whether it is evaluated for the solution as a whole. Failure to evaluate the TCO correctly may result in issues further down the road if unforeseen costs associated with the use of open source software emerges.

2.8 Public Procurement

Procurement can be defined as the act of obtaining or buying goods and services. In most instances, this involves a tendering or bidding process. Given the significant value of spends generated annually by Government departments and other Public Sector Bodies (14% of EU GDP), strict rules and regulations must be imposed. These rules are governed by the European Union through Directives and the European Commission's Public Procurement Strategy. This strategy aims to promote transparent, fair and competitive procurement processes.

According the Office of Government Procurement (2015) in their publication, Public Service Spend and Tendering Analysis for 2013, the Irish public services spends approximately €8.5 billion each year on goods and services. In their publication, the OGP was able to categorise approximately €4.3 billion of expenditure. Of the categorised figure,

approximately €212 million related to Information and Communication Technology, and Office Equipment. It is interesting to note that this represents 4.9% of tenders by value, but represents nearly 15% by number of tender notices issued. This suggests that ICT procurement requires a higher number of tenders to be issued than average. It should also be noted that additional ICT related expenditure is included in the Professional Services expenditure category. In 2013, this had a value of €271 million, but it is not categorised by professional services subject area.

In the past, the sheer volume of purchases made each year through the Government sector, together with the lack of rules and procedures meant that it was possible to provide, in effect, state aid. Gordon et al. (1998) outlined the positive impact that EU procurement rules has had on trade around the world. These procurement rules provide strict guidance on what is suitable for inclusion as selection and award criteria during tender evaluation. Inclusion of overly onerous criteria may lead to the exclusion of valid tender responses. Similarly, only criteria advertised during the tender advertisement stage may be used for evaluation purposes.

While the benefits of a functioning public procurement system are evident in terms of value for money, there are open questions about its impact on small and medium enterprises (SMEs). This is an open question in the area of public procurement and the conflict between tender aggregation and tender disaggregation. Therefore, a balance must be found between the need to achieve greater savings and the requirement to increase SME participation. The EU definition of SMEs is defined as having less than 250 employees and either a) annual sales of less than €50 million or b) balance sheet total of less than €43 million (Office of Government Procurement 2015). In April 2014, the Department of Public Expenditure and Reform (2014) published Circular 10/14: Initiatives to assist SMEs in Public Procurement. This circular aims to assist SMEs by directing public service buyers to sub-divide their contracts into smaller Lots, as well as encouraging the use of Prior Information Notices (PINs). PINs are a method of communicating the buyer's long term purchasing plans to suppliers. By communicating this information early, SMEs have longer to react and form bidding consortia if required. The current Public Sector ICT Strategy (Department of Public Expenditure and Reform 2015c) provides direction in the area of tender aggregation vs disaggregation specifically in relation to ICT procurement; *"Office of Government Procurement (OGP) will deliver the commercial implementation of the Public Service ICT Strategy through the development and delivery of sourcing strategies aimed to reduce the current fixed ICT cost base. These strategies will leverage the considerable buying power of the Public Service and will include, where possible, aggregation of spend"*

The Department of Public Expenditure and Reform has recently published Progress Report: High Level Group on SME Access to Public Procurement (2016). This document outlines the initiatives taken by the Government to increase SME participation in Public Procurement. One of these initiatives, is to increase the number of SMEs registering on eTenders (www.etenders.gov.ie). eTenders is the Government's national procurement portal and is designed *"to be a central facility for all public sector contracting authorities to advertise procurement opportunities and publish award notices."* All active Irish public procurement opportunities are displayed on eTenders as well as information regarding Irish tenders which are published in the Official Journal of the European Union (OJEU).

When compared to public sector procurement, private sector procurement is quite different in a number of ways. The primary difference is the restrictive regulations imposed on public procurement exercises which are not applicable to private sector procurement exercises. Other, more minor, differences, include greater interaction and negotiation between buyers and sellers in the private sector, as well as the value placed on items other than cost in public procurement exercises, for example, societal or social benefits (McCrudden 2004).

Herbert (2013) conducted a survey of attendees at the eWorld Procurement & Supply Conference 2013 on the differences between Public and Private Sector Procurement. One of the attendees noted that *"Because of the Public Contracts Regulations most of the public sector is too risk averse to procure effectively"* while another attendee noted that *"One significant difference is that the public sector seems frightened to talk to suppliers, relying too much on the use of formal processes & arm's length negotiations."* One attendee said; *"Public sector procurement is too rules based (for very understandable reasons) to allow for much innovative procurement and to take advantage of shifts in the market."* Another said; *"Public sector procurers have to put up with more - adverse headlines, constant government interference, competing priorities (aggregation for savings v disaggregation for SME involvement), more legal uncertainty, the constant pressure of challenges etc."* Clinton (2014) argues that the regulations associated with public procurement cannot be blamed for the perceived slowness associated with public sector procurement, and notes that *"much of the public sector bureaucracy and lack of speed that we do often see is* ***not*** *inevitable. It can be avoided if we have the right approach to public procurement, the right skills (in procurement staff but also in other stakeholders) and the right processes and tools."*

2.9 Conclusion

This chapter has reviewed and analysed the literature available in the areas of open source software, Irish Government, total cost of ownership and public procurement. It has defined open source software and has identified what are the characteristics which makes open

source software different to other types of software, and has identified the usage trends of open source software. It has provided a comprehensive overview of government structures within Ireland as well as providing an overview of open source software usage within Irish Government Bodies. The final two sections of this chapter dealt with the concept of total cost of ownership as well as public procurement.

3 Methodology

3.1 Introduction

This chapter outlines the research methodology used during the course of this research. It provides an overview of the research methods adopted during this work, and the rationale behind the selection of each. This chapter also contains a description of the research strategy, details each method of data collection, and data analysis. A section outlining the lessons learnt and details of any ethical considerations arising from the data collection is also included.

3.1.1 Purpose of the Research

The research project is intended to investigate the use of open source software within Government Bodies within Ireland. Open source software is frequently purported to deliver large savings when compared to commercial-off-the-shelf equivalent products. This project aims to examine both the total cost of ownership and public procurement aspects of open source software use within Irish Government Bodies. This examination aims to determine if these purported benefits are being realised within Irish Government Bodies. In addition, non-monetary benefits of open source software such as increased interoperability and reduced vendor lock-in are also examined.

3.2 Research Process

The purpose of this chapter is to identify and select a research process which is appropriate to the research being undertaken as part of this study. One such research process is the often-cited ‘research onion’ approach which was first described by Saunders et al. (2009). In this methodology, Saunders attempts to describe the stages involved in the formulation of a research methodology by a researcher. This involves a number of distinct stages. The outermost layer of the onion refers to the research philosophy to be defined. This is the starting point, and is followed by the research approach in the second outermost layer. The third layer encompasses the research strategy, while the fourth layer identifies the research choices. The fifth layer considers the time horizon. The sixth and final layer represents the point at which the data collection methodology is identified.

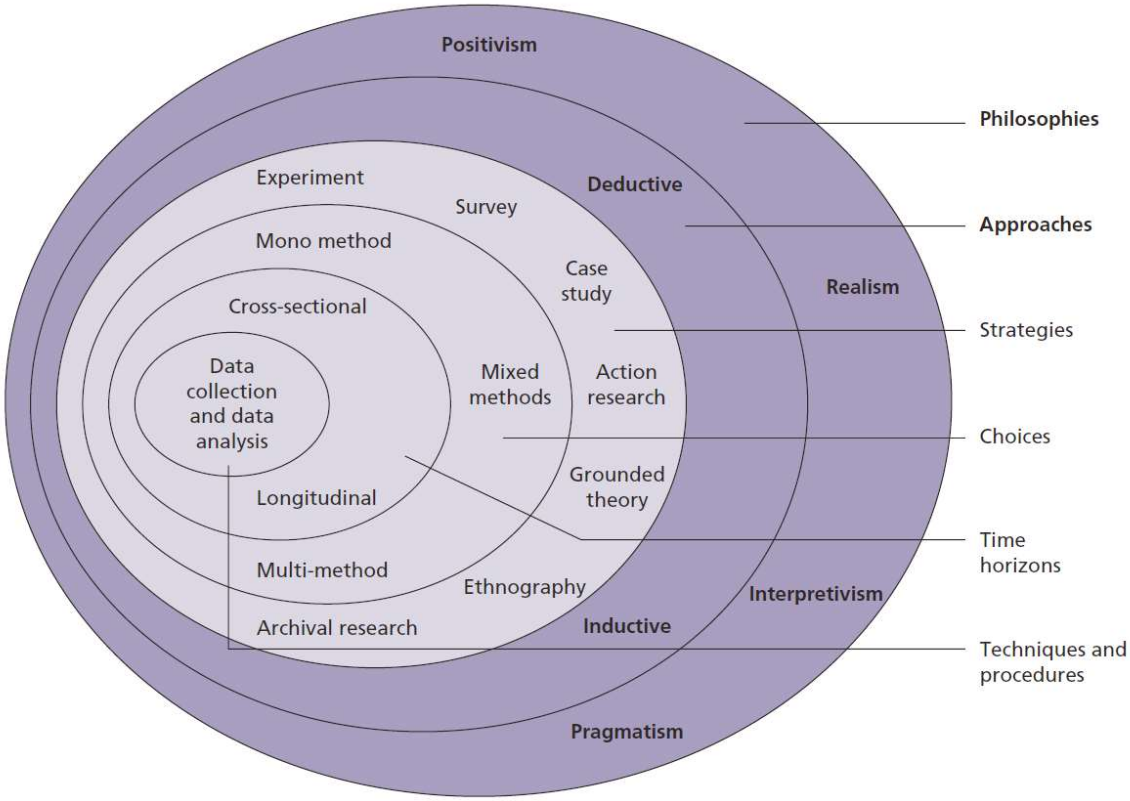

Figure 2: The Research Onion, Saunders et al. (2009)

3.2.1 Research philosophies

There are a number of different research philosophies which can be selected within this outer layer of the 'research onion'. Saunders identifies these as Positivism, Realism, Interpretivism and Pragmatism. Positivism aims to generate objective research questions which can be replicated by other researchers to verify the results. Realism builds on Positivism by incorporating the views of the researcher into the research question. This is in contrast to Interpretivism which focuses on devising research questions by observing the subject's social interactions in their natural environment. Pragmatism takes the approach that no single viewpoint can give the full picture. Many data collection techniques may be required.

In terms of the context of this research, it was felt that an interpretive and qualitative approach was the best fit. This was due to the fact that a pragmatist approach would have been rather limited and infeasible due to the time constraints involved. As the purpose of the research was not to create a hypothesis to be proven or disproven by other researchers through statistical analysis, the positivist and realist approaches were also ruled out.

3.2.2 Research approaches

Deductive research approaches aim to develop a theory, derive a hypothesis, make observations and subsequently confirm or reject the hypothesis. An inductive research approach takes the opposite approach i.e. make observations, find patterns, create a hypothesis and validate it, and create a theory from the hypothesis. Put another way, a deductive approach works from the more general to the particular, while an inductive approach works from a particular to more generalised. It was decided that given the topic of Open Source use within Irish Government Bodies, an inductive approach was most suitable. This is due to the relatively unique nature of this research topic.

3.2.3 Research strategies

There are a number of varying and different research strategies within the context of Saunders' model. These include Experiment, Survey, Case Study, Action Research, Grounded Theory, Ethnography and Archival research. The primary goal of experiments is to formulate and test a hypothesis. Case studies aim to study the characteristics of a real-life instance to understand the reasons for these characteristics. Action research aims to solve a problem iteratively through consultation with a community of subject practitioners. Grounded theory aims to systematically create theories through thorough analysis of data. Ethnography aims to study the characteristics of people and cultures from the point of view of the study subject. Archival research aims to identify and extract evidence from original archival records. The researcher felt that given the narrow focused topic being researched, a survey based approach was the most suitable research strategy. This was chosen in order to maximise the amount of primary data available to the researcher.

3.2.4 Research time horizon

A cross-sectional study aims to conduct the research at a particular point in time or snapshot view. This is in contrast with a longitudinal study which aims to identify trends and evolution in the research area over a period of time. Given the limited amount of historical information on this topic and the time constraints involved it was felt by the researcher that a cross sectional study was the most appropriate time horizon for this work. A longitudinal study may be suitable for a future follow-on research project on this subject area.

3.2.5 Sample Selection and Data collection

The target subjects for the research were identified based on contacts acquired by the researcher through current and former employers. This was a group of ICT managers and enterprise architects within Irish Government Bodies. With the exception of one subject, all were at either Assistant Principal, Principal or Assistant Secretary or equivalent grades within the Civil Service. The exception to this, was one subject who was not within the Civil

Service, but rather a Local Authority in the Local Government sector. With the exception of two subjects, none were previously known to the researcher. Each subject was sent an introductory email containing background information regarding the project and a participant information sheet inviting them to participate in the research. A total of nine subjects agreed to participate in the study. This was considered to be a good representation of Government Bodies in Ireland and included organisations which comprise the largest three largest ICT functions, by number of staff employed, in the Central Government Departments/Offices.

It was decided that given the research aims of developing an understanding of participant's personal experiences and understandings of the subject area, it would be best to conduct semi-structured interviews. It was felt that semi-structured interviews would allow the research participants to contribute additional information, and the researcher to focus on particular areas which he feels pertinent.(Qu & Dumay 2011) note that the "*semi-structured interview enjoys its popularity because it is flexible, accessible and intelligible and, more important, capable of disclosing important and often hidden facets of human and organizational behaviour in order to obtain the necessary information*". The researcher felt that these hidden facets would be invaluable to the research. For this reason, other interview-based methods such as an internet based surveys were not considered.

3.3 Methodology Limitations

3.3.1 Ethics Approval

Prior to the commencement of this study, ethics approval was sought for this work from the Ethics Committee of the School of Computer Science and Statistics, Trinity College Dublin. No ethical issues were identified by either the researcher or the ethics committee. The informed consent process ensured that the participants were aware of the purpose of the study and that their participation was entirely voluntary. It also informed them that they could terminate their participation at any point during the study. Participants were assured that any information provided to the researcher for the purposes of the study were fully anonymous and confidential. The Ethics Approval documentation is attached in Appendix 2: Ethics Approval.

3.3.2 Lessons learnt

Two test interviews were conducted prior to the finalisation of the interview questions. As a result of the feedback received, a number of questions were modified to improve clarity. Having taken account of the niche research area, the researcher would reconsider the sole use of a semi-structured interview. While the quality of the data received is deemed to be of higher quality than other approaches such as internet-based surveys, the response rate

to the researcher's introductory email on the whole was poor. This required further emails to encourage further participation among those selected. The use of an internet-based survey may be perceived by the participants to require less of their time, and hence they may be more willing to participate. It must be noted however, that there was a marked increase in the number of subjects willing to participate following the circulation of a reminder email. Following the first reminder email, no additional reminder emails were sent. A combination of semi-structured interviews together with internet based surveys should be considered for further studies in this area as this may lead to a greater participation rate. In particular, it is felt that the inclusion of a survey link in a follow up email only to those who did not agree to participate in the semi-structured interview process or did not respond would help to increase the overall participation levels without the risk of affecting the number of semi-structured interviews conducted.

The researcher underestimated the time required to transcribe the digital recordings of the semi-structured interviews. The researcher had estimated that the transcription process would take approximately one and a half times the real-time duration of each interview. In reality this was an overly optimistic estimate. The actual time taken to transcribe the digital audio recordings was closer to three times the real-time duration of each interview. As each of the nine interviews took an average duration of 45 minutes, their transcription proved to be a significant body of unforeseen work.

4 Findings and Analysis

4.1 Introduction

The primary purpose of this chapter is to present the results of the qualitative data collection process and to provide an analysis of these findings. The analysis process is also described in this chapter. The chapter concludes with an overview of the research findings collected during the semi-structured interviews.

4.2 Background and Context

This project aims to examine both the total cost of ownership and public procurement elements of open source software used in Irish Government Bodies to determine if these purported benefits are being realised. In addition, non-monetary benefits of open source software such as increased interoperability and reduced vendor-lock-in are also examined in order to determine if these benefits are being delivered.

4.3 Analysing and Interpreting the Research Data

As alluded to in the introduction section above, semi-structured interviews were used to gather the information required for this research. In support of this research, a total of twelve candidates were invited to partake in the research. Nine of those candidates were willing to participate, and consequently a total of nine semi-structured interviews were conducted. These were conducted with senior ICT managers within central Government and Local Authority bodies.

The questions focused on three key areas, namely; open source software, total cost of ownership, and procurement. In addition to this, there was an introductory section which contained a number of questions relating to the interviewee and to the interviewee's organisation. This was to establish the interviewee's ICT experience, and to ascertain information about the interviewee's organisation and the scale of the ICT function contained therein. Once the interviews were completed, the digital recordings were transcribed by the researcher. These formed the basis of the qualitative data used for the research and the results of each answer provided by the interviewees were analysed and classified. The list of semi-structured interview questions that were provided to interviewees in advance of the interview is attached to this document at Appendix 1.

The three topic areas of the semi-structured interview, together with the background information area are expanded on in the subsections below. These subsections are aligned with the areas covered in the literature review chapter. These category headings are as a follows:

4.3.1 Background information

This subsection contains basic information about the interviewee and their organisation. In relation to interviewees, information such as job title and number of years ICT experience was captured. In relation to organisations, information such as the size of both the organisation and the ICT function, along with ICT budget and a brief description of the capabilities of the ICT function was captured.

4.3.2 Open Source Software

This subsection contains information in relation to the organisation's use and experiences in relation to open source software. Information regarding the reasons for/against the use of open source software, the advantages, challenges and support of open source software are discussed in this section.

4.3.3 Total Cost of Ownership

This subsection aims to understand the organisation's use of total cost of ownership techniques and expected benefits. The final two questions in this subsection relate specifically to total cost of ownership and its application to open source software

4.3.4 Procurement

This subsection deals primarily with the area of procurement, its application to the interviewee's organisation and challenges that are facing the interviewee's organisation.

4.4 Semi-Structured Interview Analysis and Findings

This section aims to present the information gathered from the semi-structured interviews conducted with the interview participants. A total of nine interviews were conducted. Due to the large differences in size and scale of the interview participant's organisations, a number of logarithmic scale graphs have been used in addition to the more frequently used linear scale graphs. The use of logarithmic scale graphs is intended to increase the accuracy of the graphs and remove the apparent bunching of smaller values when compared with a smaller number of much larger 'outlier' values.

4.4.1 Background information – General

All nine of the participants in the study were considered to be very knowledgeable in the area of ICT and their responses were found to be credible. Every respondent was found to be operating at management level within the ICT function of their organisation. Seven of the participants were the CIO, overall ICT manager, or an equivalent title within their organisation. The average number of years ICT experience among the participants was 26.8 years, with 31 and 20 years being the highest and lowest number of years ICT experience respectively. Eight of the respondents were civil servants working in central

Government organisations, while one was a public servant working within a Local Government organisation. In terms of the organisations themselves, it was found that they varied greatly in terms of workforce size. Figure 3 shows an overview of the number of full time equivalent employees in each organisation.

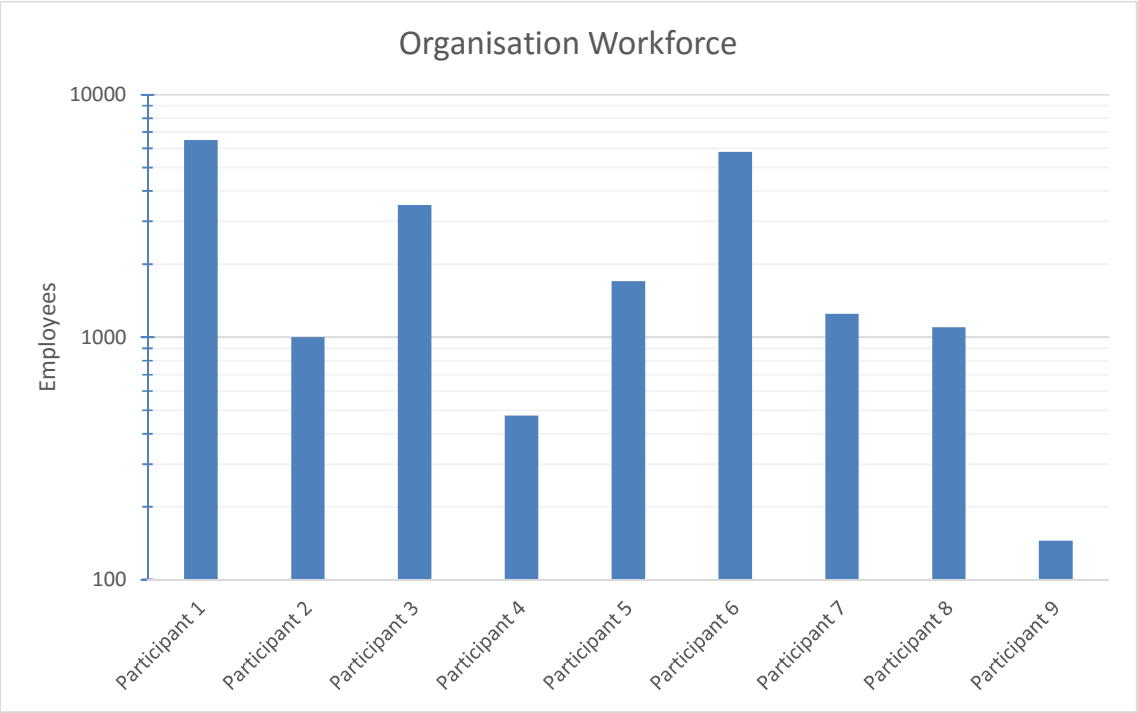

Figure 3: Number of employees working within each organisation

4.4.2 Background information – ICT Function

In terms of ICT function, it was found that, similar to the wide range of number of employees discussed in the previous section, an almost identical disparity was found when comparing the ICT function in each organisation. Figure 4 shows the annual ICT expenditure of each organisation. As can been seen from the graph, the highest ICT expenditure, €60 million, was more than 100 times greater than that of the lowest ICT expenditure, € ½ million. The average annual ICT expenditure across the organisations was €17.76 million, though it should be noted that when the three largest organisations were excluded, the average fell substantially to €2.98 million.

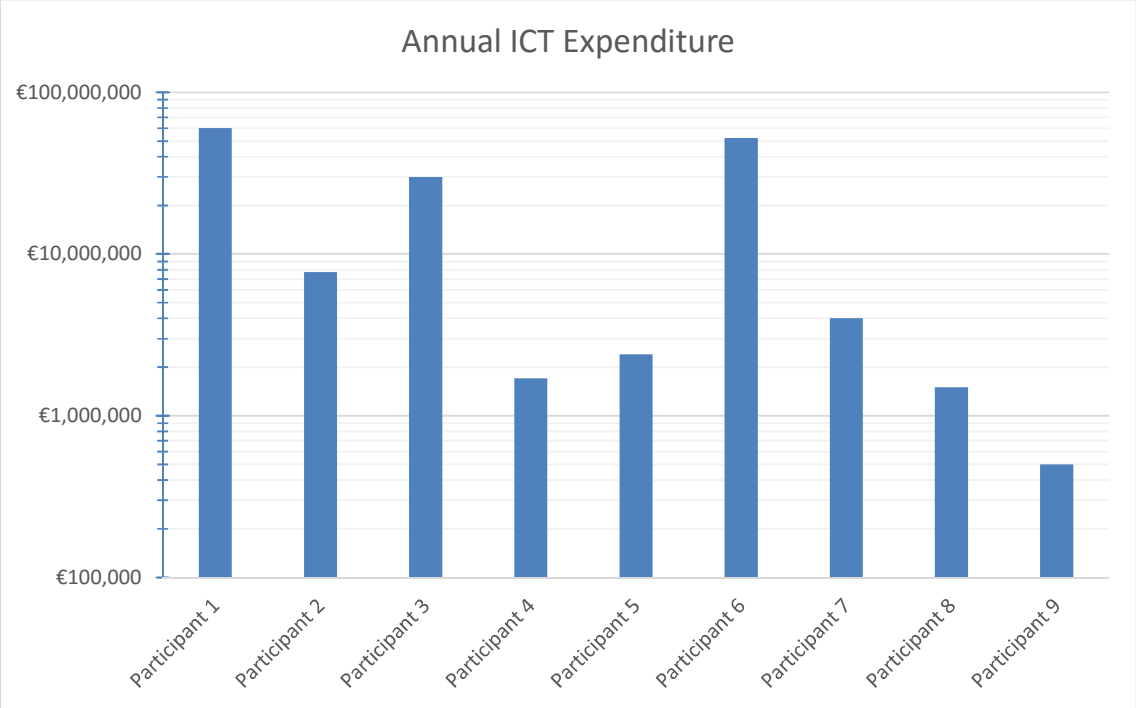

Figure 4: Annual ICT Expenditure

The information received from the participants revealed a similar disparity in terms of the number of staff working within the ICT function. Figure 5 shows the number of Internal and external staff working within each organisation, while Figure 6 shows the number of ICT staff as a percentage of the total workforce in each organisation. Participant 6 had the largest amount of staff working within the ICT function at approximately 495 staff. This was a combination of both internal and external staff. At the other end of the spectrum, participant 9 only had three members of staff working within the ICT function. When these figures, which include both internal and external ICT staff, were considered in the context of the number of staff working within the whole organisation, participant 3 was found to have the highest proportion of the organisation working within the ICT function at 9.1%, while participant 5 had the lowest proportion of the organisation working within the ICT function at 1.5%.

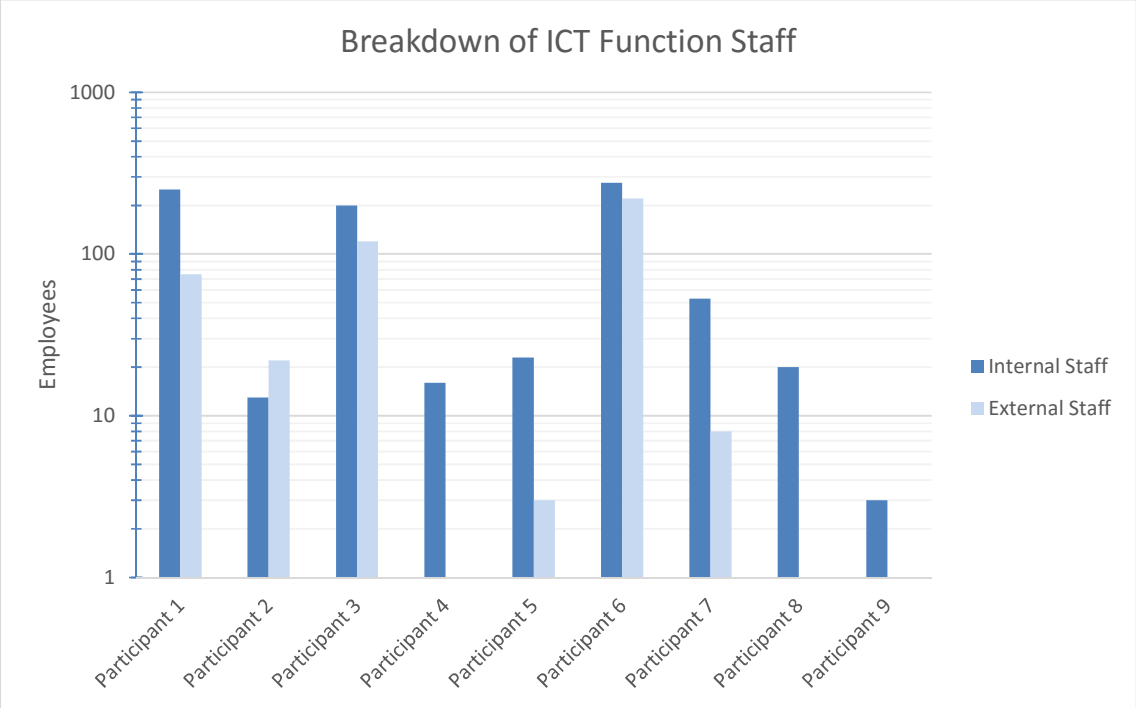

Figure 5: Breakdown of ICT Function Staff

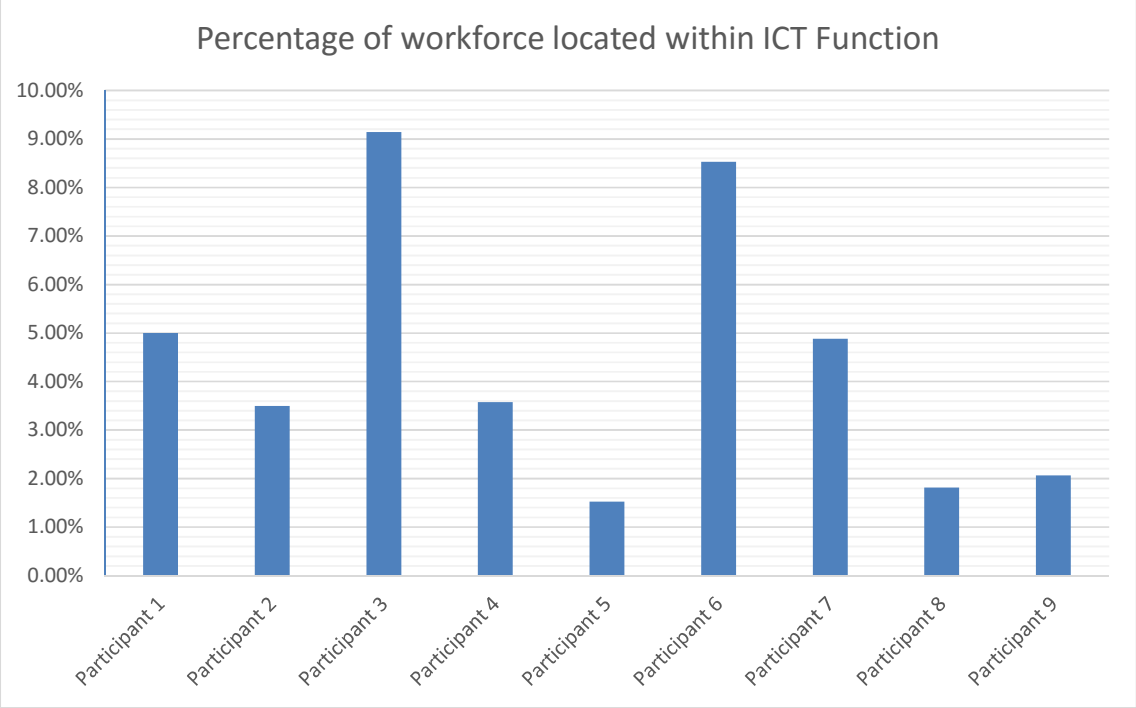

Figure 6: Percentage of workforce located within ICT Function

Eight of the participants have an ICT Strategy Statement, while one is in the process of preparing one. Figure 7 demonstrates the scale of the ICT function within the participant organisations. The ICT function in each of the participating organisations was involved in the provision or maintenance of office equipment or software. In terms of development and maintenance of business software, all were involved in the development or maintenance of business software for use by in-house staff as well as for interacting with other organisations. Only seven of the participating organisations were involved in the development or maintenance of software for interacting with members of the public. It should be noted that the lack of a provision of services to the public should not be taken as an indication of lesser ICT capability. It certain circumstances, the organisation may not have any role in providing services directly to the public. The researcher did however note, that all of the participating organisations did have a website. In a sense, all were providing, albeit limited in some cases, services to the public.

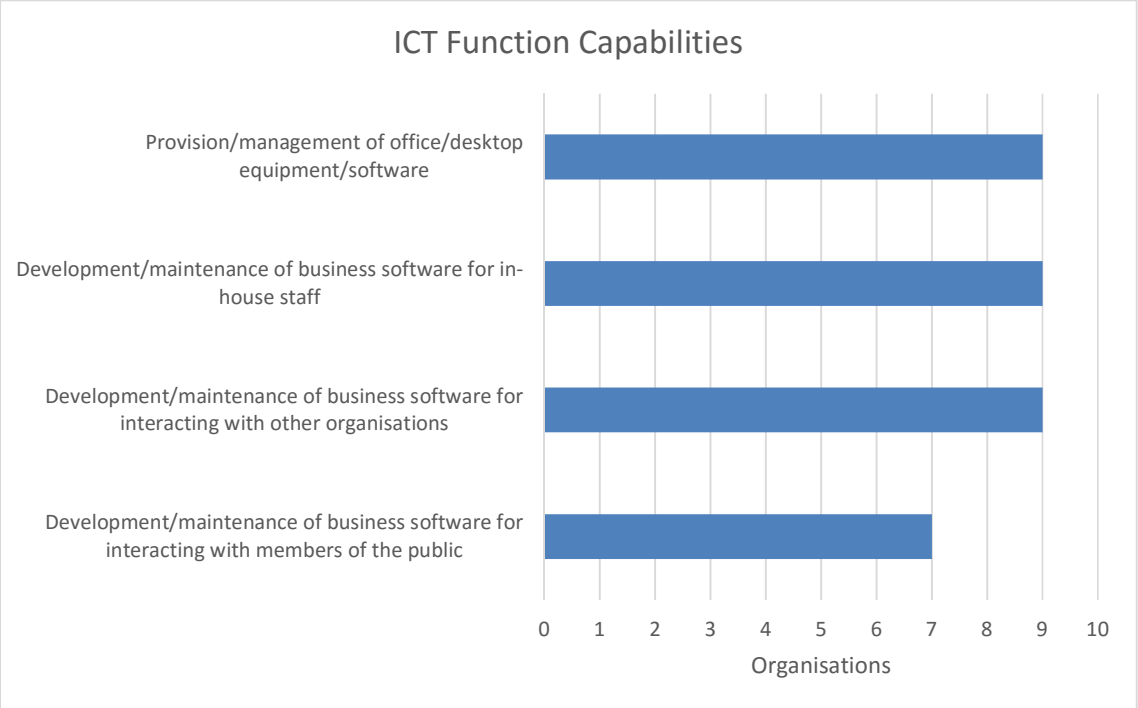

Figure 7: Capability of the ICT Functions

Figure 8 and Figure 9 outlines the views held by the organisations on the subject of ICT software and infrastructure policy. Only one organisation used a build their own approach in relation to ICT software solutions. Two organisations favoured a buy approach, while the majority of the organisations (six organisations) used a mixed or hybrid approach to their

ICT software solutions. These six organisations found that their approach varied between build vs buy depending on the individual circumstances of the project. A number of participants pointed out that due to the specialised nature of their organisation, often buying an off the shelf ICT software solution is not an option, and the solution must instead be built.

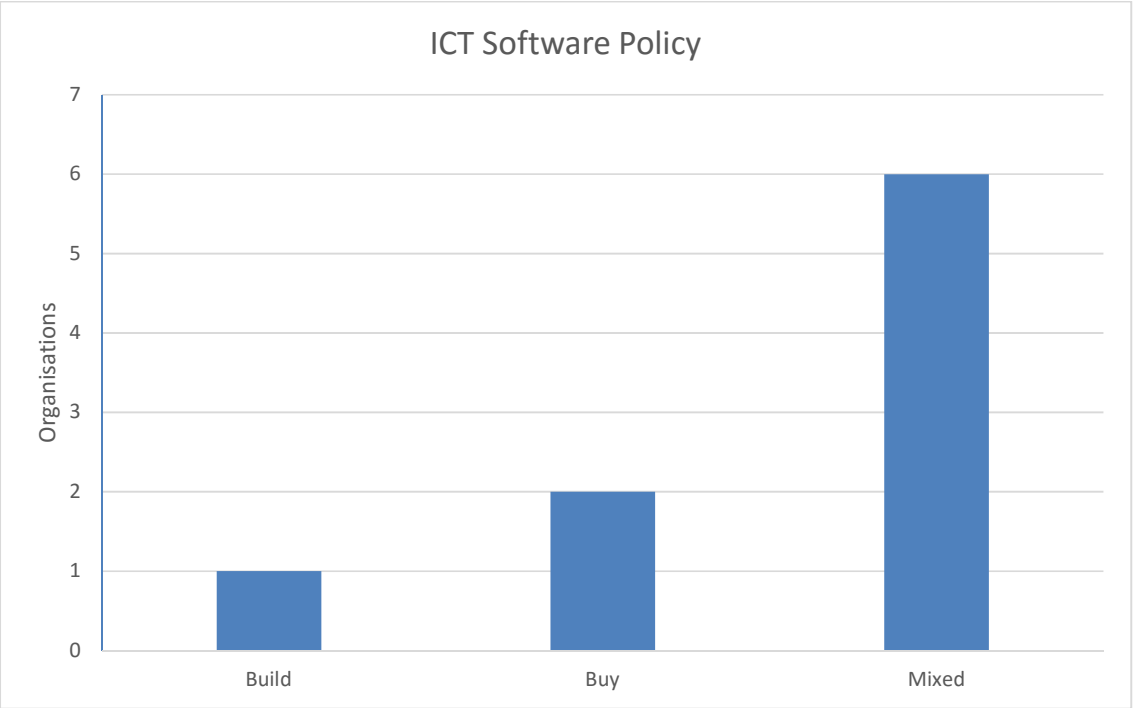

Figure 8: ICT Software Policy

In the area of ICT infrastructure, none of the organisations used cloud as their only ICT infrastructure strategy. All of the organisations used on-premise hosting, while a number of the organisations used a hybrid on-premise/cloud approach depending on the individual characteristics of the project. Also of interest is that three of the organisations availed of a shared-service hosting facility provided by a third-party organisation (who, coincidentally, also participated in this study). This shared service facility was used by organisations for either their primary or disaster recovery hosting capabilities. In relation to cloud, one participant surmised that one of the reasons for the slow uptake within Government Bodies was the lack of a clear direction or policy in relation to the use of cloud. The same participant noted a recent Government publication regarding cloud services (Department of Public Expenditure and Reform 2015a) and felt that this may provide clarity in this area.

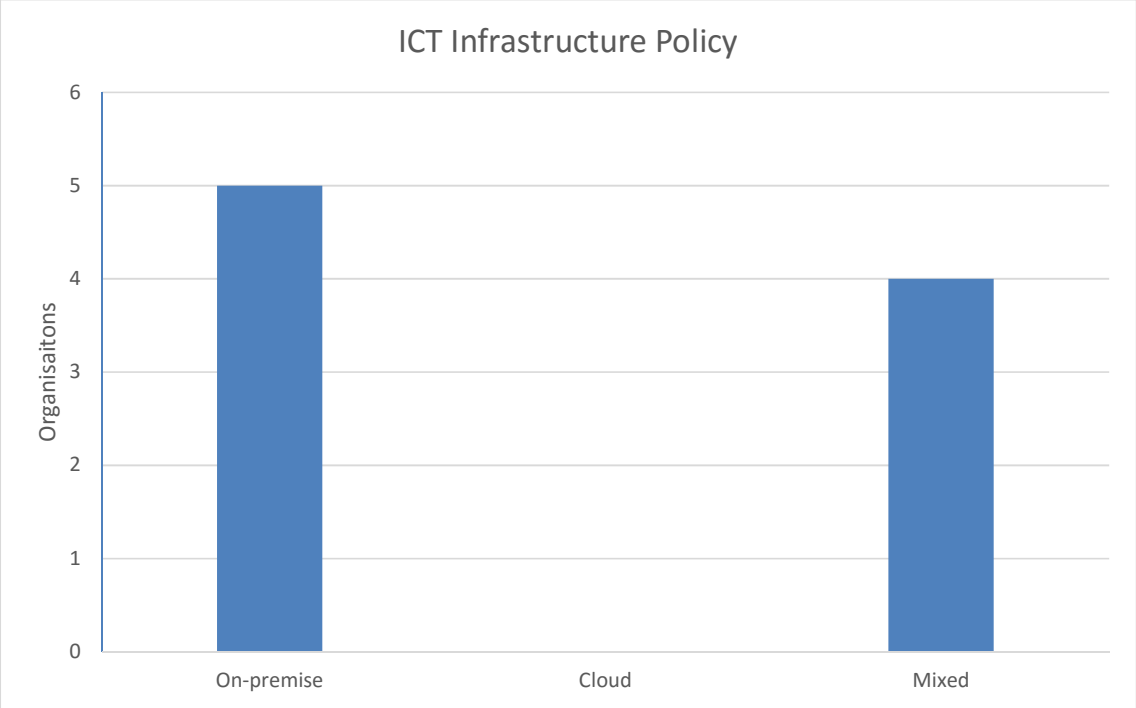

Figure 9: ICT Infrastructure Policy

4.4.3 Open Source Software

Of the nine participant organisations, eight used open source software in some capacity across their organisation. While this figure of 88% appears quite high, this figure should be considered in the context of the voluntary participation in the interview. Organisations who both use and advocate open source software are more likely to respond to and be willing to participate in a research project on the topic.

It was found that the organisations had varying policies on the use of open source in their organisation. Three of the organisations had no policy in relation the use of open source software. Four of the organisation had a clear policy in relation to open source software. This policy was to use open source software where it is the 'correct solution' to the problem at hand. This demonstrates that the organisations are open to using open source software, but have also considered the other solutions, including commercial off the shelf products and building their own solutions. One organisation had *"not strictly a policy, but the general strategy of going for tried and tested off the shelf products."*

The eight organisations which use open source software were asked their reasons for using it. As can be seen in Figure 10, cost was a factor for five of these organisations. Other popular reasons were freedom and flexibility, ability to easily perform proof of concepts, and

simply that an open source solution was part of a successful tender application. One of the organisations which did not feel cost was a reason for using open source pointed to the leading edge nature of the technologies used in open source software and noted *"One of the main reasons for using open source is, often times it tends to be leading edge, but not quite bleeding edge. So it tends to be more modern stuff. It gives you that level of, we want to do something innovative, we want to do something now with new technologies. And often those new technologies arrive as open source."*

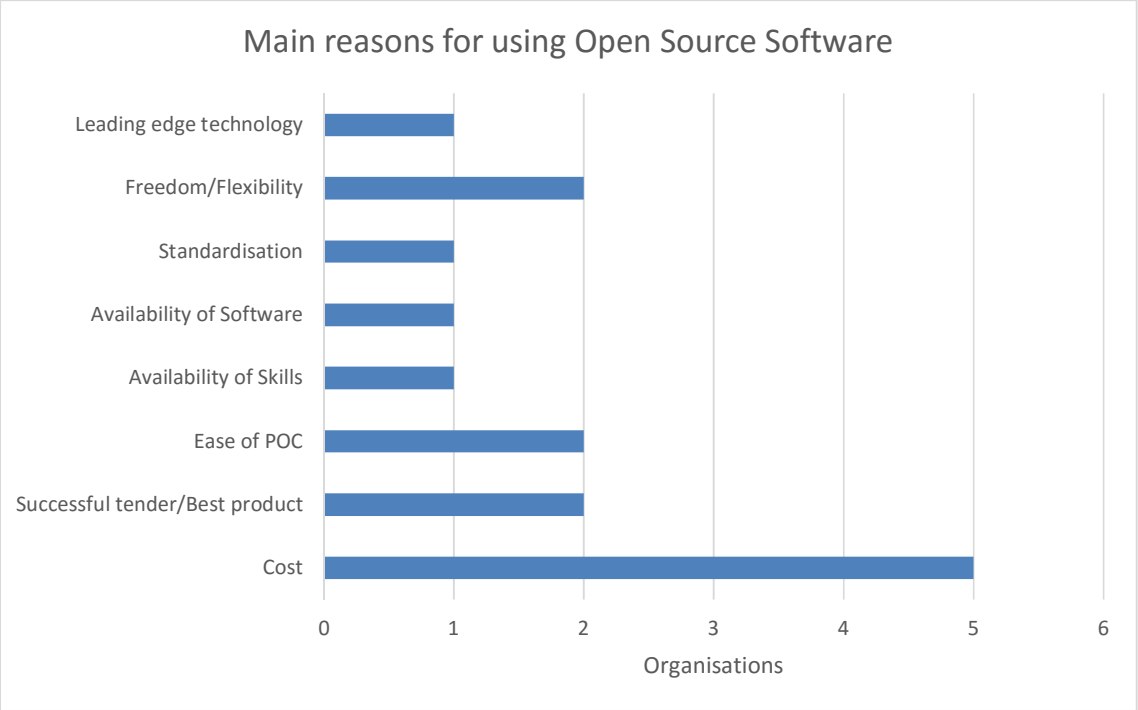

Figure 10: Main reasons for using Open Source Software

It was interesting to note that all of the organisations which use open source software made a conscious decision to do so. A follow up question asked about the process for approving the use of open source software within their organisations. It was found that in all of the organisations, the decision to use open source software was approved by the ICT manager or CTO/CIO within their organisation Three organisations made reference to an architecture group or council which evaluated open source solutions and made recommendations to the CIO on whether to approve any new software or technologies within their organisations.

Regarding the impact of open source licences such as the GNU General Public License on the organisations, none of the organisations had experienced any legal or license issues as a result of using open source software. It should be noted however that none of the

organisations were in the business of distributing software, and therefore were, in most part, immune to the redistributions clauses of the various open source licenses.

When asked what are the main advantages that open source software brings to the organisation, the participants provided a broad range of answers. These are outlined in Figure 11. As per the answers received, the greatest single advantage is cost. The second greatest advantage provided by open source was noted as the high quality of the software. Other advantages included favourable software licensing costs/models as well as flexibility of software and an active user community. Of particular interest is one participant who felt that a key advantage of open source software was the procurement element, in that a procurement wasn't required if using a self-supported version.

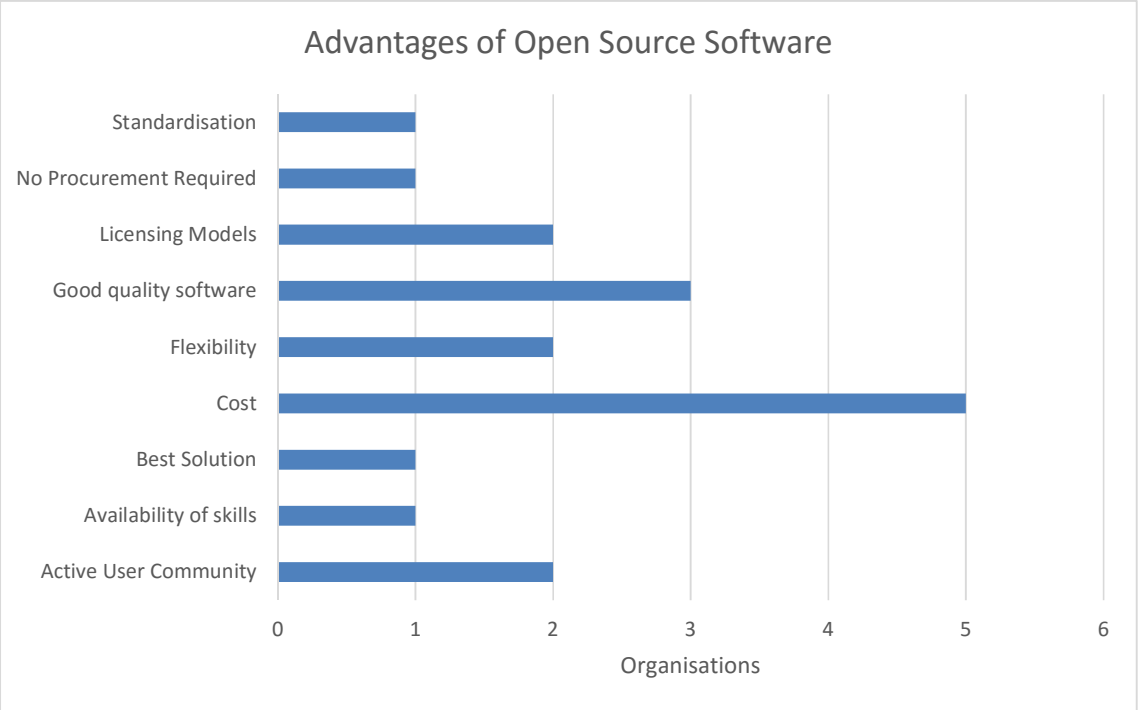

Figure 11: Advantages of Open Source Software

In contrast, the challenges relating to open source are predominately related to support. In this regard, obtaining external vendor support and obtaining people with the right skill sets to support the software were the issues. In this context, participants experienced skill set challenges in both in-house and external staff. Many noted the rather unique skill set required. One participant noted in relation to open source skills that *"across the organisation you need to have people who have those types of skills. And they are not common in the public service."* The challenges are outlined in further detail in Figure 12.

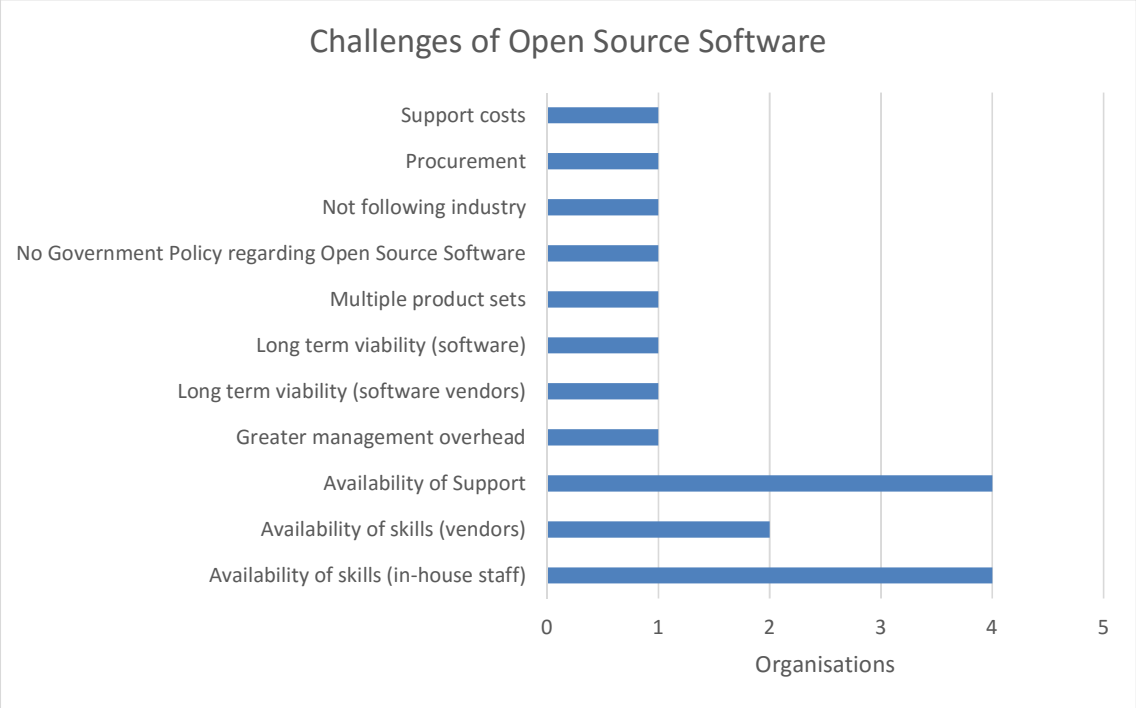

Figure 12: Challenges of Open Source Software

The results of the open source challenges question were consistent with an explicit question further down the interview which asked *"Have you had difficulty in obtaining support for open source software?"* Figure 13 shows the responses to this question, and this corresponds to the support challenges listed in the previous question. One participant who made extensive use of open source software felt that they did not have any difficulty obtaining software, but that *"we are being careful in what we use. We aren't just going to go out and buy some obscure piece of software and start trying to become an open source development house."* A similar view was held by another participant who only used open source software provided by a major open source vendor. This viewpoint was not shared by all participants however, as two participants felt that while the support provided by companies is very good, there were not enough companies out there providing support. One participant felt that a lack of Government policy in relation to open source software was a problem, and that a clear policy in relation to open source software may lead to new support companies being established. One participant held a different view, in that they felt that the challenges associated with support for open source software were in many ways no different to using niche proprietary software.

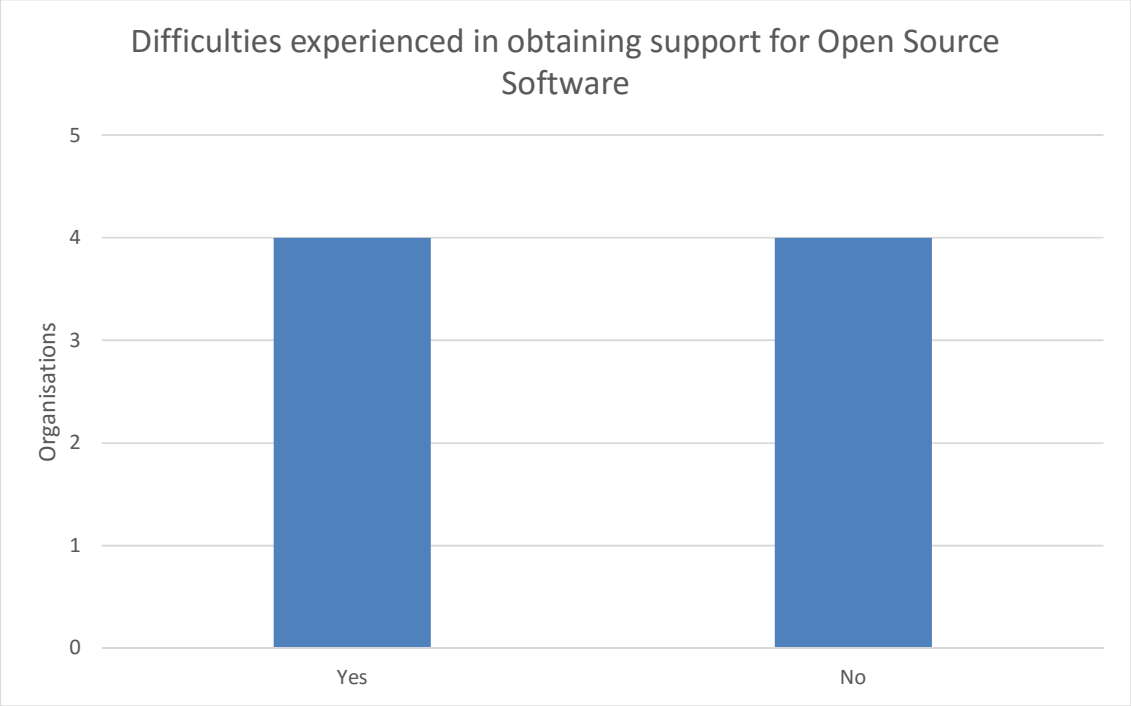

Figure 13: Difficulties experienced in obtaining support for Open Source Software

Eight of the participants felt that the level of support required by their open source software solutions was in line with what they had anticipated, although one participant felt that in the early days of the solution, the level of required support was greater than anticipated. One participant felt that the support required was less than anticipated, and that this was due, in part, to the greater community support element associated with open source software.

On the subject of unexpected costs arising out of their use of open source software, all of the participants expressed a view that they have not incurred any unexpected costs, but one participant noted that *"I think when we started out, there were unexpected costs. We hadn't quite got the model in our heads as to what it actually meant. As you know the ICT industry is dreadful for over marketing things and not quite selling things the right way. The concept of open source, people were confusing with free."* Another participant quipped that they have had plenty of unexpected costs from proprietary software, far more than with open source software.

Figure 14 shows the mission critical status of open source software within the organisation. Five organisations are using open source software for mission critical systems, while a further two organisations will be in the near future. One organisation does not use open source software in any mission critical systems.

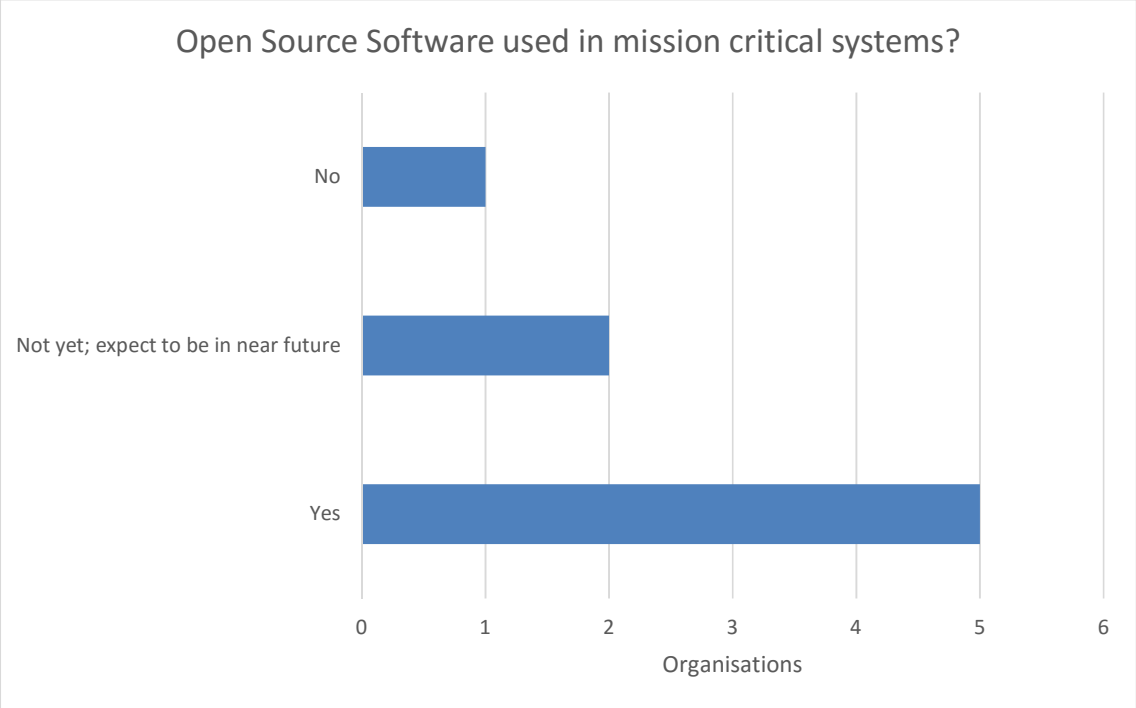

Figure 14: Open Source Software used in mission critical systems?

The open source software products used by each organisation was noted during the interview and is presented in Figure 15. The most common single piece of open source software used by organisations was Linux, which was used by five organisations. The participants used a number of different Linux distributions including Red Hat Enterprise Linux, Ubuntu Server and SUSE Linux Enterprise Server. The most common software category, database, which includes MySQL, PostgreSQL, Ingres and Hadoop, was used seven times across the organisations. Other popular open source products among participants included Alfresco (enterprise content management), SugarCRM (customer relationship management) and Java application servers such as JBoss and Tomcat. It is interesting to note that there was no open source desktop software mentioned by the participants during the interviews. The researcher is of the opinion that open source web browsers such as Mozilla Firefox are used within some the organisations. Due to its widespread usage, the open source lineage of Mozilla Firefox may have been overlooked by participants.

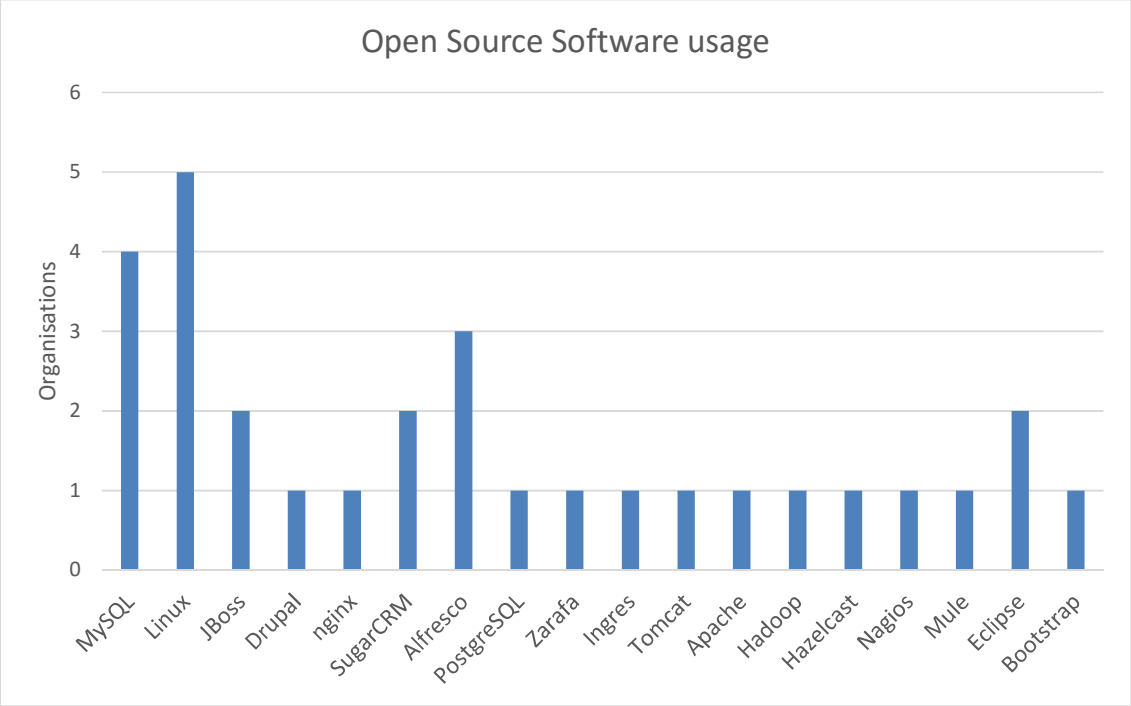

Figure 15: Open Source Software usage

The final analysis in this section relates to the one organisation that does not use any open source software. The participant felt that the main reason for not using open source software revolved around the risks involved in migration, the costs of a significant staff reskilling exercise and potential incompatibilities with third-party software used by the organisation. Asked whether the organisation envisaged using open source software in the future, the organisation felt that it *"is not going to be an IT based decision. That is going to be driven by the business needs of the organisation."* The participant was not aware of any open source software that would potentially be of benefit to the organisation.

4.4.4 Total Cost of Ownership

On the subject of total cost of ownership (TCO), all of the participants noted that they used a formal methodology to calculate TCO before commencing ICT projects, though three participants mentioned that TCO is not calculated for smaller ICT projects within their organisation as it is not deemed feasible to do so. Five of the respondents calculated TCO over a period of five years, while three other respondents used either three years or five years depending on the project. The final respondent stated that TCO was typically

calculated over a period of five years, but in certain circumstances, that TCO could be calculated over ten years or beyond depending on the size and scale of the project.

When asked about the calculation of benefits before commencing ICT projects, eight of the nine participants indicated that the benefits were calculated. The ninth participant indicated that benefits were calculated only sometimes. Six of these participants noted that these benefits were mainly business benefits rather than IT benefits. One participant noted a difficulty when trying to quantify the benefits that the project delivers for the organisation in terms of staff time.

When asked whether the lower upfront costs associated with open source software were a consideration when evaluating project costings, five participants felt that they were, while four participants felt that it was not an issue. One participant who felt that it was a consideration noted *"We don't have to find a huge amount of capital expenditure before we can start using the tool or understanding the tool."* On the other hand, a participant who felt that it was not an issue noted that *"the TCO is the TCO, irrespective of actually how the expenditure is profiled over the five years."* The researcher notes that due to the way in which Government organisations are funded, both approaches may be valid depending on the circumstances, and which area of the annual ICT budget the funds for a project may reside in.

The final area of this section of the interview dealt with the topic of TCO evaluations between open source software and equivalent commercial off the shelf solutions. Seven of the participants stated that they had evaluated it and had based their decision to use or not to use open source software around that. One participant who had previously evaluated the costs felt that in the future, "the focus should be on the business solution, the business project that you are trying to address" and in doing so, the best solution for the problem should be chosen, be that, open source software, commercial off the shelf software, or a mix of both.

4.4.5 Procurement

In this section of the interview, participants were invited to give their thoughts on the procurement element of their work. Each of the participants explained how their organisation purchases or acquires software. Due to the public sector nature of all of the participants, the response was unanimous; *"through tendering or procurement."* Five of the organisations had a centralised procurement ICT procurement unit, while the other four organisations did not. One participant noted that due to size, the organisation *"can't afford to have a centralised ICT procurement unit, we just can't afford it."*

In relation to whether the organisation conducts its own procurement or outsources to an agency such as the Office of Government Procurement (OGP), the common theme across the responses was one of a mixed approach. Organisations felt that while the OGP was a relatively new organisation, they would be engaging with them increasingly in the future. Some participants held the view that the OGP, and in particular the tender frameworks which have been established, would be beneficial. Notwithstanding that, all of the participants were of the view that their organisation would still have to run procurement exercises themselves in the future. This is due to a sizeable proportion of ICT-related procurement in each organisation which is unique to that organisation. As such, there is no justification for establishing a framework in this case.

Other participants felt that the OGP was still in the early stages and that it would take time to establish the relevant frameworks in order for the OGP to be a benefit to their organisation. One participant saw merit in the OGP providing a *"procurement/tender helpdesk service"* which would provide assistance to organisations in relation to upcoming procurement exercises that the organisation plans to run. They saw particular value in receiving assistance with the legal aspects of the tender process.

When asked about the procurement approaches used within their organisation, all used competitive tendering in the general case, while a number of organisations have used other procurement approaches where required. These included frameworks, competitive dialogue, selection and open procedures.

On the subject of the organisation's approach to acquiring support for ICT software, five participants said that support was generally something that was included as part of the original tender document. One participant made explicit reference to the difficulties faced by their organisation when attempting to renew ICT support agreements beyond the period agreed upon in the original tender. The participant mentioned how it was often not feasible to run a new tender for support services due to the limited responses that they would get. This is particularly true of ICT software where the only provider of support services is the original vendor. In this case, it could be argued that conducting a tender for this would only push up the cost of the new support agreement. It was noted that a different participant had moved away from a fixed annual support contract, to one which was based on a limited number of drawdown support hours each year. The participant felt that this gave better value for money, particularly for software which was very reliable, and therefore unlikely to give rise to many, if any, problems throughout the year.

When asked whether the organisations had recently faced, or are currently facing any challenges or difficulties in relation to ICT procurement, it was found that all of the participants had experienced difficulties in relation to ICT procurement. Common themes across the participants were found to be the complexity around the procurement process, the rate of change of procurement rules and regulations, and challenges in maintaining and retaining staff with the requisite mix of ICT and procurement skill sets.

One participant highlighted the procurement challenges brought about by the advent of cloud computing. It was their opinion that the current rules governing procurement were *"totally based around capital procurement"*. This created challenges in relation to procurement of cloud services which were, by their very nature, subscription based. Challenges were also noted in relation to the evaluation of tenders where a variety of solution types (cloud services and traditional on-premise) were proposed by bidders particularly the time period required to evaluate the cost model. They had also observed challenges within their organisation in relation to the cost management of cloud services, and the overhead of managing cloud service accounts within their organisation. They noted the potential risk of an employee failing to deprovision previously provisioned services, and how that can lead to an unexpectedly large cost at the end of the billing cycle. They felt that the ICT asset management team within their organisation were best placed to tackle this issue through expanding their role to become a *"software rental management"* team. This team would *"have a live view of expenditure on cloud resources and see spikes as they happen and react to them."*

One participant noted the challenges of operating within public sector procurement guidelines while implementing technical strategies. They noted how it can be difficult to manage and maintain a plethora of different software products, often from different vendors as a result of various tender exercises. Often there can be benefits to obtaining additional software from a single vendor due to enhanced interoperability between the products as well as a single point of contact for account management and support issues.

Two participants noted the challenge of having to specify generic rather than specific terms in tender documentation. One participant noted *"There are public procurement procedures in place, and they are in place for a good reason. One of the principles behind it, one of the reasons is it is taxpayer's money, and you need to make sure that what you're doing is spending it in an efficient and value for money way. Also, public procurement procedures are there to give the business community an opportunity to pitch. So you want a level playing field where everyone can pitch in. When you put the two of those together sometimes it means you have to go out and procure and you can't procure specific things. So you have*

to go out and procure generic stuff. […] that is a challenge, and especially if you're talking in relation to open source." In this example the participant felt that they were being directed by the market on what they should and should not be using, rather than being demand led. Similarly, a second participant noted a challenge in relation to procurement of items which have become *de facto* or industry standards, and an example of Microsoft Office and OpenOffice was provided. The participant felt that there was always the risk when procuring an office productivity suite that someone could pitch in OpenOffice. It could win the tender on cost grounds, but still be an inferior product in terms of desktop interoperability, user experience and 3rd party compatibility.

As mentioned above, a common theme across the participants was the complexity of the procurement process. While the participants could see the benefits of the procurement process for large procurements, two participants felt that the process did not scale well for smaller procurements. It was felt that the tender process required a lot of staff time and added significant costs, relative to the value of the item being procured. It was felt that the tender process added unnecessary delays when purchasing items of relatively small value. It was also felt that the documentation required significant legal expertise which was often not available in the smaller organisations, and that this was precluding smaller suppliers from competing. One participant also noted challenges in relation to the quantity of reading material to sift through during the evaluation phase; *"The main challenge we have is the tortuous effort required to evaluate tenders, particularly when you get a heap of material back to have to go and weed through."*

One participant spoke about the pace at which the procurement environment is changing. They mentioned how they recently had gone back out to the market after three years to retender for an existing service and found that they had to completely redesign their tender and the evaluation model as a result of new procurement rules and regulations which had come into force in the intervening period for the same product.

Three participants noted how they felt that the current procurement environment was weighted heavily towards the larger vendors in the market. They felt that the amount of documentation required of the vendors meant that smaller companies were now being effectively excluded from competing by virtue of not having the resources to dedicate to completing the procurement documentation. Two of these participants felt that this was detrimental to the procurement process as a whole and that in their experience the smaller vendors can provide a much more personalised and better value service. They could understand the reluctance of the smaller vendors to submit a tender document given that it would be a significant body of work to undertake when they have no guarantee of success.

On the subject of whether the organisation set minimum bidder requirements during tender exercises, four participants mentioned how their organisation did set minimum bid requirements. In most cases, these were set in order to ensure that the organisation was attracting bids from suppliers who were of a sufficient size to remain viable over the course of the contract or that the organisation was advised or mandated to do so from a legal perspective. On the other hand, five participants did not set minimum bidder requirements during tender exercises, with all conscious of the need to support smaller vendors. One of these participants noted how the organisation set minimum requirements in the past but has since stopped because *"they were the practices in the past and the recommendations coming to us from agencies, but now we are trying to remove that."* The participant felt that it was only right to support vendors in the local community as these were *"the people who actually are paying our bills."* Another participant felt that the move towards procurement framework agreements established by the Office of Government Procurement was problematic as it was difficult for small firms to get onto the framework; *"We would have no problems dealing with small firms. With some of the new framework stuff, the small firms have long since been ruled out before it would come next or near us and that is a pity."*

When asked if the heavy emphasis on cost as a public sector procurement evaluation marking category provided open source software providers with an advantage over proprietary software, none of the participants felt that it had. Three participants noted that license costs comprised only a portion of the total cost element of tenders. Two of these participants expanded further on this idea and made reference to the costs of commercially supported open source software. They felt that in order for the costs to affect the outcome of a tender, the supplier would need to be proposing the use of the community edition and offer little additional support services around this.

4.5 Limitations of the Study

This research is based on the responses provided by the participants who agreed to partake in a semi-structured interview. The research is not intended to be a comprehensive study of open source software in all Irish Government Bodies, but rather a representative sample. The researcher is satisfied that the sample of responses obtained during the course of this work is a broadly accurate illustration of the other organisations who did not, or were not willing to participate. Attention must be drawn, however, to the element of the survey which queried whether the organisation used open source software. The researcher is of the opinion that the interview candidates were more likely to participate if the organisation was already using open source. A possible reason for this is that the participant may feel that they would have little to contribute to the study if either their organisation did not use open

source software or that they were personally unfamiliar with open source software. The semi-structured interviews gave an on-the-ground perspective from within the participant organisations, and this may conflict or contradict with the outward public facing view provided by the organisations on the topic.

4.6 Summary

As can be seen from the responses received, the size and the scale of the organisations who participated varied greatly. It was clear, however, that the majority of them shared a similar point of view in relation to open source software. They were open to using open source software where it was the best solution. This is both a pragmatic point of view and encouraging to see. It was clear from the interviews that open source software is no longer viewed as a niche, and that it is used as part of mission critical systems in the majority of the organisations that participated in the semi-structured interviews. The biggest advantage that the use of open source software brought to the organisations was the lower costs associated with it, while the greatest challenge was the difficulty in obtaining resources with the requisite open source skills.

The interviewee organisations demonstrated strong levels of ICT governance, with all organisations using a formal methodology to calculate the total cost of ownership of projects. In addition to this, the majority of the organisations calculated the expected benefits of each project prior to commencement.

The interviews clearly identified ICT procurement as an area which has created difficulties in the past, and continues to create challenges for Irish Government Bodies. The primary drivers for this include the complexity of the tender documents, the rate of change in tender guidelines and legislation as well as retaining staff with a suitable mix of procurement and ICT skills.

5 Conclusion

5.1 Introduction

This chapter aims to provide a summary of the key findings and conclusions of this research project. These findings are discussed in the context of their impact on open source software in Irish Government Bodies. A number of recommendations were identified as a result of this research. These recommendations are presented, along with a brief overview of the background and proposed benefits of each. The chapter also outlines the limitations of the research work. The chapter concludes with possible areas of further research that could be undertaken in the future, and a final summary of the work undertaken.

5.2 Addressing the Research Question

This research was concerned with three key areas; open source software in Irish Government Bodies, total cost of ownership, and public procurement. Throughout this work, these key areas have been analysed from four perspectives:

1. Small Government Bodies in Ireland
2. Large Government Bodies in Ireland
3. Software vendors
4. Government ICT Policy

Based on the research to date, it was found that public sector organisations had a good understanding of the term total cost of ownership and that it was used to assess the costs of software projects prior to project approval. It was discovered that within the public sector, open source software provides a lower total cost of ownership when compared to standard commercial off the shelf software products. This was in line with the findings of the reviewed literature. The organisations that participated in this study felt that, in their experience, open source software was of comparable or better quality than that of equivalent commercial off the shelf software. A number of challenges were identified in relation to the availability of vendor support and staff with the requite skillset to support open source software solutions.

Public sector procurement was also examined and it was determined that all of the organisations that participated in this research had experienced difficulties in relation to ICT procurement recently. A number of participants felt that the public procurement process was overly cumbersome and that it was difficult for small and medium enterprises (SMEs) to gain a foothold in the public sector market. They felt that the number of SMEs participating in public procurement processes had decreased in recent years. This was not consistent with the reviewed literature in this area which found that significant efforts to encourage SMEs to participate in public procurement processes were successful.

It was found that larger public sector organisations were more likely to use open source software based on its high technical quality and leading edge design. Organisations were of the view that that it was common for vendors of new emerging software technologies to base their business model on open source software. Cost, while still a driver, was not as important a factor in their decision to use open source software. In contrast, smaller public sector organisations broadly fell into two categories of users. The first category were organisations which made a conscious decision to use open source software to reduce their ICT costs. The second category were organisations which felt that they were too small an organisation and did not possess resources with the appropriate skillset to use a large amount of open source software. This resulted in little or no open source software usage in these smaller organisations.

All of the participant organisations were using server-based open source software only. No desktop-based open source software was identified by the participants. The most popular categories of software used by the participants were operating systems, database and application servers. This is broadly consistent with the reviewed literature in this area.

5.3 Recommendations

Based on the research findings, the researcher proposes a number of recommendations. These are designed to promote and ease the use of open source software as a credible component of ICT solutions within Irish Government Bodies. These are outlined in a number of recommendations below.

1. Enhance the role of the Office of the Government Chief Information Officer

It is not clear whether the Office of the Government Chief Information Officer (OGCIO) currently provides sufficient guidance to public sector organisations as to what software they should or should not use. As a result, smaller public sector organisations currently look to larger organisations for guidance and to identify successful solutions which may work in their own organisations. This is not a sustainable model in the long term. The promulgation of ICT best practice across the public sector should be one of the key functions of the OGCIO.

In order to implement this, every public sector organisation should maintain a software asset register. This should be submitted to the OGICO on a quarterly basis. Based on this information, the OGCIO should identify best practice ICT software solutions for the public sector. This would help to consolidate the support and maintenance requirements of ICT systems in the public sector. In the longer term, this could lead to the creation of an *"ICT shared services centre"* for the public sector within the OGCIO. This would allow smaller

public sector agencies to take advantage of the benefit that open source software can deliver for their organisation, without having to significantly enlarge their existing ICT capability. The creation of an *"ICT shared services centre"* for the public sector would provide in-house ICT staff with a career path and allow greater levels of ICT specialisation to be achieved. This would bring benefits in terms of enhanced maintenance and support of ICT solutions compared to what is currently available.

It is clear that this new shared service model would require cooperation from the ICT functions within the existing Government Bodies. This would provide opportunities for staff from the larger organisations to take a lead role in the direction of these new services. Similarly, advantages for smaller organisations include upskilling of existing ICT staff through knowledge transfer programmes involving staff from larger organisations who have had broader ICT exposure and knowledge.

2. Maintain a public register of ICT skillsets required by the public sector

One of the key challenges faced by interview participants was in the area of support and maintenance of open source software. Participants felt that there were not enough vendors providing support for open source software solutions. An increase in the number of vendors providing support would allow the public sector to increase its usage of open source software. Unfortunately, this is currently a chicken-and-egg problem. New vendors are not emerging as there is uncertainty as to whether a market exists for the provision of open source support. Public sector organisations are cautious about expanding their use of open source unless they are able to obtain support.

A possible solution to this issue would be to build on recommendation 1, by publishing the information gathered from each organisation in the form of a publicly available list of ICT software used by public sector organisations in the previous quarter, along with the number of organisations using each. This, together with forward-looking information regarding upcoming ICT projects, would allow software and support vendors to identify where there is likely to be business opportunities in the future. It is anticipated that this information would contain all types of software, making no distinction between open source and commercial off the shelf software.

As vendors become more aware of the public sector's increasing requirement for open source support, it is hoped that they will react to market demand and increase supply in this area. In turn, the increased availability of support will encourage more public sector organisations to use open source software as part of new ICT software solutions within their organisations

3. Promulgation of Public Sector Procurement Best Practices

It is clear from the interviews that were conducted that public procurement rules and regulations were a source of frustration for the participant organisations. While all of the participant organisations understood the reasoning behind public procurement rules and regulations, there was an acknowledgement that tender processes did not always lead to the best solution emerging as the winner. This can be attributed to two factors; 1) misinterpretation or lack of familiarity of public sector procurement rules and regulations; 2) poor communication between sellers and public sector buyers, imposed by public sector procurement rules and regulations. While it is unlikely that these rules can be changed in the short term, there are a number of methods to address these issues through a combination of enhanced guidance and exploiting relatively unused areas of the existing regulations. It is envisaged that this recommendation would be administered by the Office of Government Procurement (OGP).

The establishment of a *"procurement/tender helpdesk service"* by the OGP for public service buyers would help to increase procurement knowledge across Irish public sector bodies, and ultimately increase familiarity with the required rules and regulations. It was felt by interview participants that procurement was a specialised area in which skills were difficult to obtain, and that those skills required constant upskilling to keep abreast of developments in tender rules and regulations. It is noted that the OGP currently provide a Tender Advisory Service for suppliers, and it is envisaged that a similar service should be provided for buyers where necessary. This buyer helpdesk service is designed to assist with tenders which are being run in-house within public sector bodies (i.e. those which are not suitable for inclusion on a national procurement frameworks)

To address the issue of communication, Prior Information Notices (PINs) and Request for Information (RFI) notices should be used more frequently. These instruments allow public sector buyers to announce their intention to buy and to signal their thinking to market.

The first of these, Prior Information Notices, should be used where possible by organisations on an annual basis where they expect purchases to take place to notify sellers within the market. This allows the market to react and prepare themselves to expect a Request for Information (RFI) or Request for Tender (RFT) document or both to follow in the medium term. These are a one-way form of communication from buyer to sellers.

The second of these, Request for Information documents allow two-way communication between buyer and seller and can be used by the buyer to signal their proposed intent to the market. The sellers can then respond to the buyer with specific information on their

requirements, and can also provide information on a new approach that the buyer may not have considered.

By encouraging the use of both PINs and RFIs prior to issuance of RFT documents, it is felt that both buyers and sellers will be more firm on the requirements of the other party. This is particularly true in the case of open source software. During the interviews, one participant felt that while they would have liked to see open source solutions being proposed in recent tenders, none were proposed. Increased communication between buyers and sellers through PINs and RFIs could have signalled to sellers that the organisation was open to, and looking to use open source solutions.

4. Review of Total Cost of Ownership Calculation Periods used in the Public Sector

Based on the findings of the interviews, it is apparent that the total cost of ownership costing model is widely used across the public sector when calculating the cost of ICT projects and services. The majority of participants calculated TCO on a three-year basis, but for certain projects a five-year costing model was used. This is in line with Circular 02/16 (Department of Public Expenditure and Reform 2016a), which states *"Costs should be calculated and evaluated over the lifetime of the proposed contract or five years if the contract is not for a specified term."* Only one participant noted that their organisation calculated TCO over a period greater than five years in certain circumstances. This was the case where the organisation expected the lifecycle of the project or service being provided to extend beyond five years.

It is unclear whether a TCO calculation period of five years is sufficient, particularly in the case of public sector ICT projects. A large number of public sector ICT projects are designed to modernise and replace existing paper based processes with modern digital alternatives. Therefore, it stands that the expected lifecycle of these projects will be greater in duration than five years. Indeed, this has been the case with the Revenue Online Service (ROS) and Motor Tax Online systems. These were initially launched in 2003 (by the Office of the Revenue Commissioners) and 2004 (by the Department of Transport, Tourism and Sport) respectively, and continue to operate today.

It is recommended that the TCO calculation period be increased to ten years in the case of ICT projects and services where the anticipated life of the project or service is greater than five years. This would provide public sector organisations with more accurate costing models. This is increasingly important given the growth of cloud computing and ICT subscription models, to which open source software is closely related.

5.4 Limitations of the research

This research is based on the responses provided by the participants who agreed to partake in a semi-structured interview. The research is not intended to be a comprehensive study of open source software in all Irish Government Bodies, but rather a representative sample which included all of the key players. The researcher is satisfied that the sample of responses obtained during the course of this work is a broadly accurate illustration of the other organisations that did not, or were not willing to participate. Attention must be drawn, however, to the element of the survey which queried whether the organisation used open source software. The researcher is of the opinion that the interview candidates were more likely to participate if the organisation was already using open source. A possible reason for this is that the participant may feel that they would have little to contribute to the study if either their organisation did not use open source software or that they were personally unfamiliar with open source software. The semi-structured interviews gave a real-world perspective from within the participant organisations, and this may conflict or contradict with the outward public facing view presented by the organisations on the topic.

5.5 Future Research

As demonstrated in the literary review chapter of this work, the topic of open source software is constantly evolving. It is clear that open source software has progressed from a hobbyist platform into one that is capable of underpinning large enterprise organisations. The findings and analysis chapter has identified that open source software provides a number of key advantages for public sector organisations. These advantages are mainly in the areas of low total cost of ownership and high software quality. Given these advantages, it is clear that the increase in open source software usage by public sector organisations will continue into the future. Based on this, a pertinent future research question would be to investigate the key skillset required by employees to make effective use of open source software. This is particularly applicable to public sector organisations where many employees spend their entire careers working within a single organisation. It is important that these employees are able to adapt to new developments in ICT as they arise.

Another topic for further research in the future would be to compare and contrast the use of open source software in public service organisations in a number of countries. This work would include comparisons from countries from across Europe as well as North America. This work would contribute to the research area by investigating the effect that different government policies in relation to open source software can have on its use within the country.

An alternative area for further research would be to study the use of open source software in different sectors of the economy and the total cost of ownership in each. For example, are start-up companies more likely to use open source software in an effort to save costs and will those cost savings continue as the company expands?

5.6 Summary

This research sought to better understand the use of open source software in Irish Government Bodies. The areas of total cost of ownership and public procurement were examined in the context of open source software. An interpretive research approach was used throughout this study to explore the factors which affected the success of open source software within Government Bodies in Ireland. Semi-structured interviews were undertaken with nine participants from the ICT functions of Government Bodies.

The main advantages of open source software were found to be in the areas of cost and the quality of the software, whilst the main challenges were found to be in the areas of skills availability and ICT procurement. The findings from this study conclude that while open source software is seen in a positive light by the majority of the organisations interviewed, the choice of software is ultimately driven by business requirements. Based on this findings, a number of recommendations are made. These recommendations, while developed in the context of open source software, are also applicable to commercial off the shelf software solutions.

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Appendix 1: Semi Structured Interview Questions

INTERVIEWEE

a. Organisation Name:
b. Job Title/Grade:
c. Number of direct reports:
d. Number of years ICT experience:

ORGANISATION

e. What is the primary function/output of the organisation?
f. How many staff (FTE) work within the organisation:
g. How much autonomy does the organisation have? Is it subject to direction from a parent department, OGCIO etc?

ICT FUNCTION

h. What is the organisation's annual ICT budget?
i. How many staff (FTE) work within the ICT function (include both internal and external resources):
j. Does the organisation have an ICT strategy (or a corporate strategy which includes ICT goals)?
k. How mature is the organisation from an ICT perspective?
l. What is the scale of the organisation's ICT function?
    i. Provision/management of office/desktop equipment/software
    ii. Development/maintenance of business software for in-house staff
    iii. Development/maintenance of business software for interacting with other organisations
    iv. Development/maintenance of business software for interacting with members of the public
m. What is the organisation's policy in relation to:
    i. ICT software solutions - Build vs buy?
    ii. ICT infrastructure - hosted vs cloud?

OPEN SOURCE SOFTWARE

n. Does the organisation have a policy regarding use of open source software?
o. Does the organisation use open source software?
p. If answer to Q 4(b) is YES:
    i. What are the main reasons for using open source software?
    ii. Has the organisation made a conscious decision to use open source software or has it acquired open source software as an integral part of a software product?
    iii. What advantages does open source software bring?
    iv. What challenges does it bring?
    v. Who generally decides to use and approves the use of open source software? (Technical Architects? CTO? CIO?)
    vi. Has the organisation experienced any legal/license issues through use of open source software?
    vii. Is vendor support required for all open source software used within your organisation?
    viii. How much support is required for open source software? Is such support greater than, less than or equivalent to the anticipated support?
    ix. Is open source software used for mission critical functions?
    x. Approximately what percentage of the software used in your organisation is utilising open source software?
    xi. Did you have unexpected costs arising from the use of open source software?
    xii. Did you have difficulty in obtaining support for open source software?
    xiii. Is it possible for an organisation to use open source software without the backing of a vendor?
q. If answer to Q 4(b) is NO:
    i. What are the main reasons for not using open source software?
    ii. Do you aim to source most of your software from a single vendor?
    iii. Do you envisage the organisation using open source software in the future (1-2 years)?
    iv. Are you aware of any open source software projects that would potentially be of benefit to your organisation?

TOTAL COST OF OWNERSHIP

r. Does the organisation use a formal methodology to calculate TCO before commencing ICT projects?
s. Over what period of time is TCO calculated in relation to ICT projects?
t. Does the organisation calculate expected benefits before commencing ICT projects?
u. Are the lower upfront costs associated with open source software a consideration when evaluating total cost of ownership proposals?
v. Has the organisation evaluated the TCO of open source software solutions and equivalent commercial off the shelf solutions?

PROCUREMENT

w. How does your organisation purchase/acquire software?
x. Is there a centralised ICT procurement unit within the organisation? Is software procurement carried out on an ad-hoc basis by staff throughout the ICT function as needed?
y. Does the organisation conduct its own procurement or outsource to a shared agency (e.g. Office of Government Procurement)?
z. What type of procurement approach is used within the organisation? e.g. competitive tendering or selection.
aa. How did the organisation set out to acquire support for its ICT software? Has this approach changed over time?
bb. Do you re-approach the market on an ongoing basis for support?
cc. Is the organisation currently facing (or has recently faced) challenges in relation to ICT procurement? If so, can you please elaborate on what these challenges were?
dd. Does the organisation set any minimum bidder requirements during tender exercises (either turnover or number of staff)? If yes, does this may disqualify OSS consultancy firms (which by their very nature are small)?
ee. Does the heavy emphasis on cost as a public sector procurement evaluation marking category give an unfair advantage to open source products as opposed to proprietary products?

Appendix 2: Ethics Approval

School of Computer Science and Statistics
Research Ethical Application Form

Part A

Project Title: Open Source Software in Irish Government Bodies: A Total Cost of Ownership and Procurement Analysis

Name of Lead Researcher (student in case of project work): Jonathan McCrohan

Name of Supervisor: Noel Faughnan

TCD E-mail: @tcd.ie Contact Tel No.: 086

Course Name and Code (if applicable): Management of Information Systems (M.Sc.)

Estimated start date of survey/research: 16th May 2016

I confirm that I will (where relevant):

- Familiarize myself with the Data Protection Act and the College Good Research Practice guidelines http://www.tcd.ie/info_compliance/dp/legislation.php;
- Tell participants that any recordings, e.g. audio/video/photographs, will not be identifiable unless prior written permission has been given. I will obtain permission for specific reuse (in papers, talks, etc.)
- Provide participants with an information sheet (or web-page for web-based experiments) that describes the main procedures (a copy of the information sheet must be included with this application)
- Obtain informed consent for participation (a copy of the informed consent form must be included with this application)
- Should the research be observational, ask participants for their consent to be observed
- Tell participants that their participation is voluntary
- Tell participants that they may withdraw at any time and for any reason without penalty
- Give participants the option of omitting questions they do not wish to answer if a questionnaire is used
- Tell participants that their data will be treated with full confidentiality and that, if published, it will not be identified as theirs
- On request, debrief participants at the end of their participation (i.e. give them a brief explanation of the study)
- Verify that participants are 18 years or older and competent to supply consent.
- If the study involves participants viewing video displays then I will verify that they understand that if they or anyone in their family has a history of epilepsy then the participant is proceeding at their own risk
- Declare any potential conflict of interest to participants.
- Inform participants that in the extremely unlikely event that illicit activity is reported to me during the study I will be obliged to report it to appropriate authorities.
- Act in accordance with the information provided (i.e. if I tell participants I will not do something, then I will not do it).

Signed:  Date: 5th May 2016

Part B

Please answer the following questions.		*Yes/No*
Has this research application or any application of a similar nature connected to this research project been refused ethical approval by another review committee of the College (or at the institutions of any collaborators)?		No
Will your project involve photographing participants or electronic audio or video recordings?		Yes
Will your project deliberately involve misleading participants in any way?		No
Does this study contain commercially sensitive material?		No
Is there a risk of participants experiencing either physical or psychological distress or discomfort? If yes, give details on a separate sheet and state what you will tell them to do if they should experience any such problems (e.g. who they can contact for help).		No
Does your study involve any of the following?	Children (under 18 years of age)	No
	People with intellectual or communication difficulties	No

	Patients	No

School of Computer Science and Statistics
Research Ethical Application Form

Details of the Research Project Proposal must be submitted as a separate document to include the following information:

1. Title of project
2. Purpose of project including academic rationale
3. Brief description of methods and measurements to be used
4. Participants - recruitment methods, number, age, gender, exclusion/inclusion criteria, including statistical justification for numbers of participants
5. Debriefing arrangements
6. A clear concise statement of the ethical considerations raised by the project and how you intend to deal with them
7. Cite any relevant legislation relevant to the project with the method of compliance e.g. Data Protection Act etc.

Part C

I confirm that the materials I have submitted provided a complete and accurate account of the research I propose to conduct in this context, including my assessment of the ethical ramifications.

Signed:  Date: 5th May 2016

There is an obligation on the lead researcher to bring to the attention of the SCSS Research Ethics Committee any issues with ethical implications not clearly covered above.

Part D

If external or other TCD Ethics Committee approval has been received, please complete below.

External/TCD ethical approval has been received and no further ethical approval is required from the School's Research Ethical Committee. I have attached a copy of the external ethical approval for the School's Research Unit.

Signed: ..... Date: .....
Lead Researcher/student in case of project work

Part E

If the research is proposed by an undergraduate or postgraduate student, please have the below section completed.

I confirm, as an academic supervisor of this proposed research that the documents at hand are complete (i.e. each item on the submission checklist is accounted for) and are in a form that is suitable for review by the SCSS Research Ethics Committee

Signed:  Date: .....08/05/2016.....
Supervisor

Completed application forms together with supporting documentation should be submitted electronically to research-ethics@scss.tcd.ie Please use TCD e-mail addresses only. When your application has been reviewed and approved by the Ethics committee hardcopies with original signatures should be submitted to the School of Computer Science & Statistics, Room F37, O'Reilly Institute, Trinity College, Dublin 2.