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Abstract
Irish e-Government has long endured a myriad of issues associated with traditional enterprise resource planning (ERP) implementation, hampering their ability for fiscal accountability, to control budgets and adhere to compliance regulations. Cloud ERP is positioned as a revolutionary approach to deploy an ERP solution. The main benefits associated with deploying a cloud ERP in comparison to traditional ERP deployment include low implementation, continuing, licencing and support costs, faster implementation of IT projects and increased agility. While the recent transition of Irish e-Government to cloud computing is laden with opportunities and risks it is imperative to identify public sector mission critical applications that would derive substantial benefits from moving to a cloud based solution. In this paper, we explore the ERP innovation potential of cloud computing for Irish e-Government as a viable mechanism for replacing the traditional implementation process of enterprise resource planning.

Keywords: Cloud Computing, Enterprise Resource Planning, ERP Implementation

1 Introduction
There is evidence to suggest that cloud computing has become a strategic direction for many government agencies, and has the capability to be employed in critical areas of the government's IT infrastructure (West, 2010, Bailey et al., 2011). On-going economic downturns and associated governmental cuts have the potential to drive radical innovations in information technology across public sectors. It has been argued that “the real strength of cloud computing is that it is a catalyst for innovation, and in keeping with Moore’s Law, as
cloud computing becomes more cheaper and ubiquitous further opportunities for innovation will manifest” (Brynjolfsson et al., 2010). Further, a report by the Brookings institution in Washington, ‘Building a Long-Term Strategy for Growth through Innovation’, proclaims that all levels of government should “move aggressively to cloud computing in order to achieve service improvements and cost efficiencies … savings of 25% to 50% in costs” (Bailey et al, 2011).

November 2011 marked the launch of the Irish government’s public service reform plans which contained commitments to cloud computing and shared services. Specifically, the reform plans outline a commitment to maximise new and innovative service delivery channels such as piloting the use of cloud computing services across the public sector. There is also a commitment to the establishment of consistent baseline performance information across a number of functional areas e.g. finance, human resources, ICT.

In February 2012, the Irish government unveiled its first cloud computing initiative Cloud4Gov. The Cloud4Gov programme, a synergetic partnership between IDA Ireland and the EMC Corporation, involves the construction of a cloud centre with hubs in government networks. The Cloud4Gov programme has been lionised not only as a vehicle for driving the smart economy but also as a means of putting Irish e-government on the map as a ‘first mover’ in its attempts to leverage the innovation capabilities afforded by cloud computing.

The motivation for this paper is to explore the ERP innovation potential of cloud computing for Irish e-Government as a viable mechanism for replacing the traditional implementation process of enterprise resource planning (ERP). To this end, we first discuss traditional ERP implementation, we then focus on public sector ERP, and examine how cloud computing can provide mechanisms for improved ERP in the public sector context.

2 Traditional ERP Implementation

“ERP (enterprise resource planning systems) comprises of a commercial software package that promises the seamless integration of all the information flowing through the company—financial, accounting, human resources, supply chain and customer information” (Davenport, 1998). According to Rowe (1999) as cited in Adam & O’Doherty (2000), “ERP systems represent the implementation of the old managerial dream of unifying and centralizing all the information systems (IS) required by the firm in one single system”. ERP solutions have been designed to remedy the issue of fragmented information contained within multiple legacy systems in a business setting. Traditional ERP vendors include companies such as Oracle and SAP who provide ERP systems as standardised software packages. ERP offers a multitude of benefits including: removing the need for often disparate and unreliable end-user applications; standardizing operating/reporting procedures and optimizing the key processes of an organisation (e.g. order acquisition and processing or inventory control (Adam & O’Doherty, 2000). According to Escalle et al. (1999) potential benefits include “drastic declines in inventory, breakthrough reductions in working capital, abundant information about customer wants and needs, along with the ability to view and manage the extended enterprise of suppliers, alliances and customers as an integrated whole”.

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2.1 ERP Implementation Challenges
According to Sumner (2000), ERP implementation projects can “often represent the single largest investment in an information system (IS) in the histories of implementing companies”. Davenport (1998) cautions that “the growing number of horror stories about failed or out of control projects should certainly give managers pause”. According to Davenport (1998), “an enterprise system imposes its own logic on a company’s strategy, culture and organisation”. Further, FitzGerald and Carroll (2002) affirm “successful ERP implementations are defined as those that deliver full functionality on time and within budget; failed ERP implementations are abandoned prior to, or during, implementation and so are never implemented. Challenged implementations may have gone over time or over budget or are operational but not delivering full functionality”. An organisation’s business processes must often be modified, business process reengineering (BPR), in order to align with provider recommended ‘vanilla’ ERP software packages (Chen, 2001). A study by Trunick (1999) identified that 40% of all ERP installations only achieve partial completion, and 20% of ERP adoptions are scrapped as total failures. Ptak and Schragenheim (1999) reported that between 60% and 90% of ERP implementations failed to attain the return on investment (ROI) identified during project approval phase. As such, it is clear that organisational ERP implementation is both complex and challenging, with significant risk.

2.2 Public Sector ERP
ERP systems had initially been designed for private sector organisations; however governments and public bodies soon began to envisage the potential benefits that they too could derive. According to Sawhney (2001), “organisations are now realising the pressing need to link ‘islands of applications’ that have emerged as a consequence of divisional or functional silos”. Raymond et al. (2005) identified a number of studies which have focused on the IT management process in the public and private sectors in an attempt to identify the differences between the sectors. Heinze and Bretschneider (2000) highlight how at an environmental level, public organisations are influenced far greater by the political rather than the economic environment which enforces a short term vision, strong measures of accountability and tasks performed under the scrutiny of the public. At an organisational level, public organisations have more rigid hierarchies and structures. Newcomer and Caudle (1991) argue that information system development strategies in the public sector should put greater emphasis on middle management who may be more inclined toward the development of new information technology (IT) applications in comparison to top level managers who are less enthusiastic.

Bannister (2001) argues that issues such as “Weberian” bureaucracy, political control, internal politics, the uninfluential position of information system managers and fragmented authority, have resulted in information systems in the Irish public service having “developed as a series of isolated islands of processing without much commonality”.

ERP has been glorified as a means with which to demolish these public sector silos in order to align legacy systems and processes. However, the Irish public sector has had a “chequered” history with regards to information system implementation projects (Bannister, 2001). The Personnel, Payroll and Related Systems (PPARS) case study by Sammon and Adam (2007) exposes the damning failure of the Irish Health Service (HSE) in their attempts to implement SAP ERP during a 9 year period from 1997 – 2006. The original estimate for implementing SAP projected implementation costs at €8.8 million with an implementation schedule of 3
years. As of 2012, the PPARS implementation, now referred to as the SAP/PR System, is still on going and the project has cost a total of €201 million (Lynch, 2012).

3 Cloud ERP Implementation

Cloud computing affords organisations the opportunity to deploy innovative technologies such as cloud ERP. According to Raihana (2012) “cloud ERP is positioned as a revolutionary approach to deploy an ERP solution” and provides a fantastic opportunity to capitalise on an ERP investment. The main benefits associated with deploying a cloud ERP in comparison to the traditional deployment of ERP include: low implementation, continuing, licencing and support costs; faster implementation of IT projects and increased agility which enables organisations to adjust to changing market environments (Motalab & Shohag, 2011). A study conducted by Iyer and Henderson (2012) demonstrate how a firm with over 10,000 global employees reaped a manifold of benefits when switching from a traditional ERP provider to a cloud ERP provider to meet its human resource payroll needs. Prior to the transition to the cloud provider, the firm experienced common problems associated with traditional ERP such as application limitations, increased costs and disruptions caused as a result of lengthy upgrades. The firm chose a cloud provider who had extensive experience dealing with human resource services and opted for applications that the vendor has already developed for other clients. As a result, the firm avoided the substantial costs associated with customization. It is estimated that the cost of implementing cloud ERP were 15% lower than the traditional approach and that opting for a SaaS solution reduced implementation time by 50% to 70%. The costs savings experienced by the private sector companies has also manifested in public sector organisations that have transitioned to cloud based technology solutions (See West, 2010, Bailey et al., 2011). The U.S. city of Washington D.C. experienced cost savings of 48% following their transition to cloud computing. In 2008, the city of Los Angeles experienced cost savings of 23.6 % by moving its email system to a cloud platform. The transition to the cloud platform permitted the city to “reduce its technology staff, save money on file servers and economize in software purchases” (Bailey et al. 2011). As the cloud computing paradigm continues to evolve the benefits and risks associated with selecting a cloud solution become more understood and accepted by potential adopting organisations. In Australia, the New South Wales Government’s trade and investments department have selected SAP’s By Design Software-as-a-Service (SaaS) ERP cloud solution for mission critical applications for a cluster of 15 agencies. Microsoft has recently released their cloud ERP offering, DYNAMICS AX 2012, which contains functionality that has been tailored specifically for use in the public sector. In the U.K., two local government authorities serving a total of 214,000 combined residents selected DYNAMICS AX 2012 as part of a procurement process to be the cornerstone of their ERP infrastructure.

The scalable infrastructure allowed the two local authorities to streamline their operations, reduce staff by two thirds and collate average savings of £3 million per year. In order to fully comprehend the capabilities afforded by cloud computing it is necessary to explore the innovation potential across the cloud computing layers capable of offering value to public sector organisations. In the following section we identify and detail these capabilities in the public sector context.
3.1 Cloud Computing 5-4-3 Stack Model

According to Mell and Grance (2010), as proposed by the American National Institute of Standards and Technology (NIST), cloud computing may be defined as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” This description is specific in detailing cloud computing as comprising five essential characteristics, four deployment models, and three service models. It is this definition and delineation that we employ in this paper, in particular, what we term the 5-4-3 stack model consisting of the essential characteristics layer, the deployment model layer and the service model layer (Clohessy, Acton and Coughlan, 2013).

![Cloud Computing 5-4-3 Stack Model](image)

Figure 1: Cloud Computing 5-4-3 Stack Model

3.1.1 Essential Characteristics Layer

This base layer contains 5 well-described components that underpin the mantra of cloud computing. Numerous aspects buttress this layer, such as user-friendly user interfaces to cloud services and applications, network optimisation, security, resource sharing techniques, system virtualisation and leverage of existing best standards in distributed computing (See Vouk, 2008, Vaquero et al., 2009, Buyya et al., 2009). Certain components such as elasticity provision and resource pooling are provision-dependent, meaning that it is the role of the cloud provider to provide their functionality. Deficiencies in any of these 5 components can negatively impact the potential for innovation. All components would be present in an ERP solution, but the manifestation of these 5 characteristics in an organisation or public sector is largely dependent on the deployment model implemented.

3.1.2 Deployment Model Layer

There are primarily four cloud deployment models, public cloud, private cloud, hybrid cloud and community cloud. According to Garrison et al., (2012) organisations may fail to capitalise on the benefits associated with cloud computing “if cloud deployment is ineffective”. The innovation value rests with the cloud deployment model that best fosters an innovation process that promotes a greater focus on increasing core competencies while balancing this
focus with the cost of cloud-based services. Take for example, a hybrid cloud which constitutes a combination of both public and private cloud deployment models. An organisation may choose a hybrid cloud model in order to achieve the extra capacity afforded by a public cloud whilst also capitalising on the benefits afforded by an ‘isolated’ private cloud environment (Garrison et al., 2012). Recently, traditional ERP vendors such as SAP have developed cloud-based ERP systems which offer the choice of running ERP applications on private or public clouds. The manifestation of innovation potential is largely dependent on the choices made in the upper service model layer. However, in the public service context, and considering pressure on e-Government initiatives to facilitate easily-accessible systems for the public, and with value a stakeholder concept, an increased value may be gained through leveraging public and community-based cloud deployment.

3.1.3 Service Model Layer
This layer comprises the 3 well-established cloud computing service models commonly referred to as the SPI (Software, Platform, Infrastructure) model describing each as a service (Mell and Grance, 2010, Vaquero et al., 2009). The innovation value of this layer is dependent on the choices made in the immediate sub deployment model layer. Innovation can be facilitated by channelling various outbound services through one of the SPI components, and is dependent on the business focus of organisations or bodies. The Infrastructure-as-a-Service (IaaS) model permits the implementer to solely acquire the computing utilities and resources from a cloud computing vendor. This option permits the separate choice of ERP vendor and ERP system. According to Schubert and Adisa (2011) the Platform-as-a-Service (PaaS) model is not suited for the operation of an ERP system. However, the recent emergence of solutions such as JustEnough, which enables manufacturers to integrate a third party add-on to their cloud ERP solution, highlights the potential of PaaS. SaaS benefits to both service providers and end users are well-documented (see Armbrust et al., 2010). The SaaS model entails ERP applications being provisioned via the synergistic partnering of a cloud and ERP vendor. The SaaS model is seen as a viable option to reduce the acquisition and maintenance costs associated with traditional ERP implementations. In the public service context, service layer choices reflect those in organisational and other private contexts, with provision needs indicating the appropriateness of choice. However, considering the relative strengths of public or community deployment models, public service bodies and agencies have an increased emphasis on ensuring a secure overall architecture. While security is an ongoing and relatively well-discussed issue in relation to cloud computing (Subashini and Kavitha, 2011, Kumar et al., 2011), its importance becomes exacerbated for public sector bodies with responsibility for citizen data, and becomes elevated to a primary focus particularly in the case of public cloud models.

4 Conclusion
While the recent transition of Irish e-Government to cloud computing is laden with opportunities and risks, it is imperative to identify public sector mission critical applications that would derive substantial benefits from moving to a cloud based solution. In this paper, we explored the ERP potential of cloud computing for Irish e-Government as a viable mechanism for replacing the traditional implementation process of enterprise resource planning (ERP), and identified particular aspects of the cloud computing 5-4-3 stack model of

direct relevance to public sector cloud-based ERP. The 5-4-3 stack model is combinatorial, in that choices are made at each layer, with higher layer choices dependent upon those made in others. However, with the Irish public sector as a lens, in this paper we outlined particular emphases for public sector implementations of ERP that have a resonance in the context of e-Government provision.

In terms of a recommendation to public service bodies, one possible avenue for Irish e-Government to leverage the capabilities afforded by cloud computing would be, on a trial project basis, to transition and consolidate the disparate departmental systems of a number of public sector agencies into a single ERP project in the cloud. This “cluster” of agencies could perhaps implement a ‘vanilla’ ERP cloud SaaS solution on a hosted platform to support finance, payroll, procurement, and human resources functions. The benefits of implementing a ‘vanilla’ solution include rapid deployment, minimal configuration and the capability to support standard processes. The overall aim of this trial project would be to deliver prerequisite minimum capability and depending on the results of the trial could provide the foundation for aligning public sector legacy systems on a mass scale.

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