Cloud Computing Adoption: An SME Case Study

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Abstract
Cloud Computing is a paradigm shift in IT services delivery. This shift promises large gains in agility, efficiency and flexibility at a time when demands on data centres are growing exponentially. Despite the importance of Cloud Technology there is a dearth of research of Cloud Technology adoption in Small and Medium Enterprises. This paper seeks to address this challenge by conducting Case Study research based on Design Science and Engaged Scholarship on an SME who is in the process of developing a capability in this area. A framework called the IT-CMF was used. The framework enabled a measurement capability that will be an invaluable tool for the company as it ensures that risks are mitigated and the opportunities created by cloud computing are maximized in a planned and controlled way.

Introduction
This paper describes how a highly collaborative research project based on design science principles, involving a start-up company and an innovative research organisation proved to be successful.

Academic Background to Cloud Computing Adoption

In an age of information and globalisation, massive computing power is desired to generate business insights and competitive advantage (Liu and Orban, 2010). Cloud Computing is a paradigm shift in IT services delivery. This shift promises large gains in agility, efficiency and flexibility at a time when demands on data centres are growing exponentially (Iyer and Henderson, 2010). Academic research would suggest that cloud's full potential will exceed IT expectations eventually (Harms and Yamartino, 2010), however cloud critics believe handing data to a third party with unknown levels of control just won't work. The truth lies somewhere between the two extremes and it depends on a variety of factors (Yang and Tate, 2009). From a security perspective, IT professionals making decisions need to accurately assess whether the enterprise can truly secure data or infrastructure better than a potential cloud provider can (Harms and Yamartino, 2010). Moving enterprise email systems to the cloud makes a lot of sense for certain cases. For example, smaller enterprises often lack the expertise in IT and security to manage Microsoft Exchange. Likewise, when you look at infrastructure providers such as Amazon, Rackspace or Google, it is hard to say a small or even midsized organisation will do a better job securing cloud infrastructures. Cost savings are also gained in several other areas, including IT equipment, labour and data centre real estate, not to mention power and cooling savings (Iyer and Henderson, 2010). Cloud Computing demands a deep understanding of business needs coupled with multi-domain expertise that allow companies to design, build and operate highly efficient IT infrastructures that include legacy infrastructures aligned tightly with business priorities (Yang and Tate, 2009). Existing business behaviours and processes will not change just because IT infrastructures do. Implementing cloud infrastructures inside your companies firewall (i.e. Private Cloud) demands a thorough evaluation of the impact on both people and relevant business processes, and can be a difficult lesson to learn. What gets lost is the right service centric IT strategy that ensures alignment of IT decisions with business priorities (Kertesz et al, 2009). Cloud infrastructures must seamlessly integrate with the existing environment as well as leverage rigorous automation to drive value into the enterprise.

Despite the importance of Cloud Technology there is a dearth of research of Cloud Technology adoption in Small and Medium Enterprises such as Mainstream Renewable Power. This paper seeks to address this challenge.

Design Science-based Maturity Models

The research reported in this paper has been developed in the context of the IT-Capability Maturity Framework, which presents a high-level process capability maturity framework for managing the IT function within an organization (Curley 2004). The framework identifies a number of critical IT processes, and describes an approach to designing maturity frameworks for each process. Without any integrating framework and methodology focused on value to help, Chief Information Officers (CIOs) can quickly find themselves feeling pressurized as they are aware that even if they deliver the next CRM or ERP solution exquisitely, it will only keep them or their company in the game. The IT-CMF addresses a continuing structural problem in the IT profession and IT industry around managing the returns from IT investments. The application of IT-CMF to solve real-world problems has been reported elsewhere (Carcary 2011), (Conway et al 2010), (Curry et al 2012a), (Doherty et al 2012) and (Donnellan et al 2011).

Despite the growing interest in maturity models, according to Becker et al (Becker et al. 2009), IS research has "rarely endeavored into reflecting and developing theoretically sounds maturity models" and as such there is a lack of evidence of scientifically rigorous methods in their development processes, with some models based on poor theoretical foundations (Mettler and Rohner 2009). Methods, such as Design Science (Hevner et al. 2004) are proposed as a useful means to develop new maturity models in a rigorous manner, using both prior studies and empirical evidence as the basis for the models content development and stages of maturity. Further, (Becker et al. 2009) suggests that there is a lack of validity testing of newly developed models; however to ensure their relevance for practitioners the models need to be piloted and "applicability checks" conducted with practitioners. Closing the gap between current and desired maturity is also problematic, with Mettler suggesting that many models do not describe how to carry out improvements actions.

The model presented here addresses the concerns outlined above through following a rigorous development process based on design science and open innovation principles; empirical piloting, testing and validation of the model; and the development of a series of improvement practices, outcomes and metrics to drive maturity level progression. The objective was to develop the model in a structured, rigorous, and transparent manner, its application in practice is necessary if it is to make a contribution to the field and have wide practical application and acceptance.

The Design Science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artefacts, including constructs, models, methods, and instantiations (Hevner et al. 2004). Maturity models in design-oriented research are regarded as being located between models and methods in the form of state descriptions (e.g. the maturity levels) and guidelines (Mettler and Rohner 2009). In order to transform organizations from one maturity level to another, usually the method component is described by "maturity curves" or "maturity profiles". The IT-CMF represents both model elements in form of assessments as well as method components in form of improvement guidelines. In this regard "method engineering" is central to in our approach and can be seen as elements of Design Science-oriented information systems research (Hevner et al. 2004) (Braun et al. 2005). As (Mettler and Rohner 2009) summarize, methods are systematic, goal-oriented and repeatable. In order to ensure consistency between results and the design process meta-models and a coherent design process are essential.

The IT-CMF follows Design Science principles within a rigorous design process that facilitates the engagement of scholars as well as ensures consistency by providing a meta-model for structuring the maturity model. The design science approach used in the IT-CMF is closely aligned with the three design science research cycles proposed by Hevner. Additional detail on the design process development is available from (Carcary 2011) and (Donnellan and Helfert 2010). In these three closely related cycles of activities: Relevance Cycle, Rigor Cycle and Design Cycle (Hevner 2004).

The Relevance Cycle inputs requirements from the contextual environment into the research and introduces the research artefacts into environmental field- testing. Relevance of the SICT-CMF artefact is driven by the problems of organisations experience in optimizing how they currently manage and measure the business value of their IT investments. Field-testing of the IT-CMF in the application

environment helps determine of further development work is required to ensure its relevance in addressing the business problem.

The Rigor Cycle provides grounding theories and methods along with domain experience and expertise from the foundations knowledge base into the research and adds the new knowledge generated by the research to the growing knowledge base. SICT-CMF development is grounded in existing artefacts, methodologies, foundational theories and expertise and draws from an extensive base of industry and academic literature and existing IT standards and frameworks. Contributions to the knowledge base include a detailed framework and a set of practices that help define innovation and change in how organisations manage and use their IT investments to optimise business value.

The Design Cycle supports a tighter loop of research activity for the construction and evaluation of design artefacts and processes. SICT-CMF development focuses on iterative build and evaluates activities by the working group to address the identified problem, while drawing on existing theoretical foundations and methodologies in the knowledge base. The build process is evolved and refined through evaluation feedback, including committee stage gate reviews to identify further refinements and field-testing of the artefacts within contextually diverse organisations.

The application of IT-CMF in this Case Study

To enable organisation to achieve their sustainability objectives the Innovation Value Institute IVI has developed an integrated and multi-tiered approach, as illustrated in Figure 1, and described in more detail below. The IVI approach allows an organization to decide the appropriate starting level for their organisation, and then to decide to either remain at this level, or to combine with the other available levels in order to satisfy its sustainability requirements. For example an organisation may decide that the Executive level is a good starting point and that once completed they are happy to stay at the level, another organisation may start with the Cloud Assessment and then decide to broaden out to the SICT level. A core function of the IT-CMF is to act as an assessment tool and a management system with associated improvement roadmaps that guide senior IT and business management in selecting strategies to continuously improve, develop, and manage the IT capability in support of optimized business value delivery.

A Capability Maturity Framework for Sustainable ICT (SICT)

Organizations face many challenges in developing and driving their overall sustainability strategies and programs (Seidel et al. 2010). IVI has developed a capability maturity framework for managing SICT. The SICT-CMF (Donnellan et al. 2011) complements existing approaches for measuring SICT maturity, such as the G-readiness framework (which provides a benchmark score against SICT best practices) (Molla et al. 2008) and (Molla et al. 2011) or the Gartner Green IT Score Card (which measures corporate social responsibility compliance). It offers a comprehensive value-based model for organizing, evaluating, planning, and managing SICT capabilities, and it fits within IVI's IT-Capability Maturity Framework (IT-CMF). The SICT-CMF assessment methodology determines how SICT capabilities are contributing to the business organizations overall sustainability goals and objectives. This gap analysis between what the business wants and what SICT is actually achieving positions the SICT-CMF as a management tool for aligning SICT capabilities with business sustainability objectives (Curry et al. 2012a), (Curry et al. 2012b).

The framework focuses on the execution of four key actions for increasing SICT's business value: (1) Define the scope and goal of SICT, (2) Understand the current SICT capability maturity level, (3) Systematically develop and manage the SICT capability building blocks and (4) Assess and manage SICT progress over time

A Cloud Capability Maturity Framework using a Life Cycle approach

The Cloud maturity framework (Conway and Curry 2012) provides a mechanism for organisations to assess and control the migration and on-going management of cloud-based services. It uses a systematic approach to measure an organisation's capability to migrate and manage cloud services, and enables the generation of a practical capability improvement roadmap.

The life cycle approach provides organizations with a management structure to rapidly understand and assesses their IT capability maturity to position, evaluate, introduce and manage cloud based services.

The Cloud life cycle covers the following: (1)Strategic positioning, business benefits and financial model, (2) Governance, (3) Enterprise Architecture, (4) The sourcing and selection of cloud service provider(s), (4) Solution delivery, (5) Service provisioning, (6) On-going supplier management and (7) Risk Management/Compliance. The approach is shown in Figure 1 below.

Research Method

Since this research seeks to answer "how" and exploratory "what" questions on an emerging phenomenon, qualitative case study methodology was selected (Benbasat et al, 1987, Eisenhardt 1989, Yin 2003). Furthermore, because of the emerging nature of Cloud Computing it was felt that the case is ideal for revelatory cases where an observer may have access to a phenomenon that was previously inaccessible (Yin 1984). The reason why a Case Study approach was selected for this study was it excels at bringing an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research (Flyvbjerg, 2011). Case studies emphasise detailed contextual analysis of a limited number of events or conditions and their relationships. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1984). Through the work of researchers such as Benbasat et al. (1987) and (Yin 1984) case studies, particularly those designed to be consistent with positivist criteria, are accepted as a legitimate and useful method of IS research (Klein and Myers, 1999). Their purpose is to try to understand, interpret, phenomena in terms of the subjective meanings people bring to them (Denzin, 1994). However, as (Walsham 1995) suggests "the most appropriate method for conducting empirical research in the interpretative tradition is the in-depth case study". There are important factors and considerations for the decision to adopt Cloud Computing and the current studies and research in this field can be summarised as focussing around questions why adoption of Cloud Computing would occur, how much adoption would take place or how it would be adopted (Luoma and Nyberg, 2011, Nuseibeh, 2011).

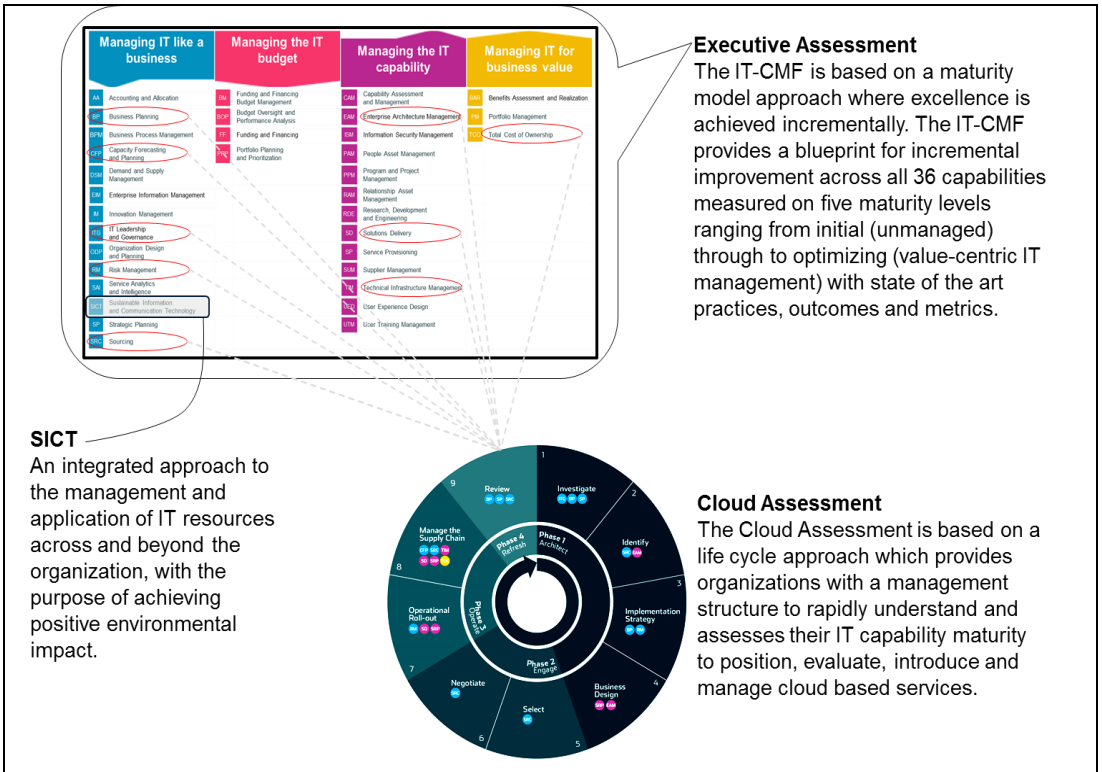

Figure 1. IVI's integrated and multi-tiered approach to improve sustainability

Sustainable Cloud at Mainstream Renewable Power

Mainstream Renewable Power (**http://www.mainstreamrp.com/**) was established in 2008 with a clear vision for the future, "where thriving economies and communities are liberated from the restrictions of fossil fuels, and using renewable energy as their mainstream source of power". Their core business is to develop, build and operate large-scale wind and solar power plants. As a start-up company in the renewable energy sector Mainstream wanted to put this vision into practice within their own company, so they required that their IT systems, should not alone be based on sound sustainability principals, but that the IT department should be a show cases and a enabled for sustainability across the entire company. Based on the core values CIO John Shaw established the following IT Principals:

- Buy rather than build IT services and solutions.
- Build IT systems that are fully integrated and that allow future systems to be seamlessly integrated into the existing infrastructure.
- Sustainability - the greening of and by IT.
- Position IT to be on the leading edge, not the bleeding edge.

To realize this vision Mainstream decided at an early stage to base its IT infrastructure on a sustainable cloud model. As this was a relatively risky and unproven strategy they engaged with the Innovation Value Institute who provided their expertise and assistance to help Mainstream realize their vision. The following section describes how Mainstream utilized the management tools provide by IVI at each stage of their development.

Executive Assessment:

In 2009 Mainstream underwent an executive level IT-CMF maturity assessment to establish a baseline of IT management maturity. The results overall was a basic, level 2 maturity. A comprehensive roadmap was then designed and implemented to achieve a higher level of maturity across various IT management capabilities within a 24 month period. The results are show below:

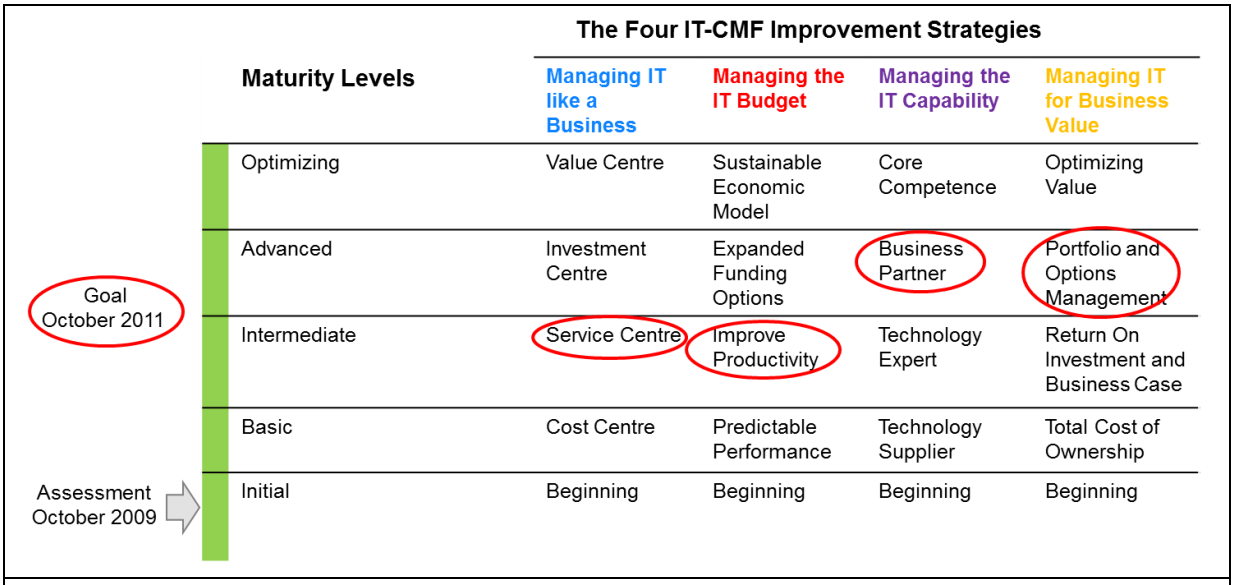

Figure 2. Executive Assessment results and goals for Mainstream

SICT Assessment:

Following on the success on the initial assessment and the development of an improvement roadmap, Mainstream decided to undertake an SICT assessment. The assessment used a survey of IT and business leaders to understand their individual assessments of the maturity and importance of these capabilities. A series of interviews with key stakeholders augmented the survey to understand key business priorities and

SICT drivers, successes achieved, and initiatives either planned or completed. In addition to helping Mainstream understand their current maturity level, the assessment provided insight into the value placed on each capability, which varied according to each department's strategy and objectives. The assessment also provided valuable insight into the similarities and differences in how key stakeholders view the importance and maturity of individual capabilities, as well as the overall vision for success. As a new and rapidly evolving business Mainstream faced many challenges in achieving their sustainability objectives. .

Cloud Assessment:

The next phase in Mainstream's journey was to assess their ability to manage a sustainable cloud infrastructure. This followed a similar approach as for the Executive level and SICT assessments i.e. by running on-line assessments followed by targeted interviews with key personnel. The results of that assessment were as follows:

Key Assessment Results

Overall there was a positive consensus of opinion across the enterprise about the current state of maturity (2.5 basic) and the importance of Cloud to the organizations' strategic objectives (4.4 advanced). The assessment showed strong business and IT leadership with a closely-aligned business and IT strategy. There was a clear business and IT vision of the future i.e. to move from a private internal cloud to a hybrid public/private cloud and to do so in a controlled and planned manner whilst simultaneously minimizing risk.

Importantly, the assessment pinpointed the most important critical IT management capabilities at each stage of the cloud computing life cycle, thereby enabling creation of definitive roadmaps to improved maturity.

What was achieved?

- Successfully implemented a vision which kept the carbon foot print of IT to a minimum.
- A technology roadmap that is future proof. This was done by partnering with hardware and software vendors that were likely to survive into the future and that had sustainability as part of their core values e.g. companies such as HP, Cisco and Microsoft.
- Worked with a cloud service provider (Eircom) to achieve the lowest possible energy footprint. Eircom were early adopters of sustainability principles such as passive heating, efficient data centre layout etc.
- Provide systems that improved the sustainability of the company e.g. the implementation of an electronic workflow and managed print system, reducing both printing and paper usage.

Key Practitioner insights

- Need to have a clear picture of what will be the end point i.e. visualizes what will be required from IT in 3-5 years' time, so "begin with the end in mind".
- Keep the internal IT organisation to a minimum by developing partnerships with suppliers so that the correct IT services can be delivered at the cost, time-scale and quality required.
- To counteract the tendency of some suppliers to over-sell what they can deliver, use a mechanism such as project toll gates which applies strict sign-off to allow one phase of a project to close before another can start.
- Membership of an independent organisation such as the Innovation Value Institute (IVI) is recommended, as it allows the sharing of problems, facilitating the correct discussions and sharing of expertise to decide on the optimum solutions that can be benchmarked against peer organisations.

Theoretical Reflection on Progress To-Date

As Cloud Technology diffusion proceeds, it is useful to consider Rogers' (2003) seminal work that defined diffusion as the process by which "an *innovation* is *communicated* through certain *channels* over *time* among the members of a *social system*". Furthermore, he classified adopters of innovation, developed during his doctoral research and first published in the Rural Sociology journal in 1958, into five major categories; Innovators, Early Adopters, Early Majority, Late Majority and Laggards. It is important to note that, as pointed out in the work, the term "laggard" is used as a classification and not pejoratively. Thus we see the approach by Mainstream Renewable Power to be a thoughtful, considered, approach to an emerging IT innovation that requires careful consideration of all the potential risks associated with emergent technology.

(Swanson 1994) argued that current innovation theory had done little to explain IT innovation and where it stood within the general debate on organisational innovation. To address this situation he posited the following three types of IT innovation to provide a new theoretical impetus - Type I: innovations confined to the IT task, Type II: innovations supporting administration of the business and Type III: innovations imbedded in the core technology of the business. A subsequent empirical testing of the model resulted in "cautious optimism" but suggested a need for further theoretical work to refine, elaborate and extend the system (Grover et al. 1997). In a more recent and influential paper, (Swanson and Ramiller 2004) start by defining IT innovation as the process by which "IT comes to be applied in novel ways" and conclude that the literature on bandwagon phenomena indicate that much supposedly innovative behaviour is actually "me too" activities . In his study we will see that Mainstream Renewable Power sees Cloud Adoption as residing within Swanson's "Type III" typology: i.e. innovations imbedded in the core technology of the business.

Conclusion and Future Directions

Sustainable Cloud is a vitally important strategy for Mainstream's continued growth in a complex and rapidly-changing environment. Mistakes can be very costly while success will help gain competitive advantage. The IT-CMF provided Mainstream with a means to assess their capability and plan for each phase of their growth and development by assessing their critical capabilities across the key areas of the business, developing improvement roadmaps and reassessing their maturity.

Mainstream now have a baseline across the entire IT organization with a clear understanding of its strengths and weaknesses in relation to sustainable cloud. Their development of a comprehensive roadmap enables a 'managed' transition to a hybrid solution that ensures sustainability. Performance can be measured on an annual basis to ensure that targets are reached or exceeded. This measurement capability will be an invaluable tool for Mainstream as the organization plans its continued growth. It will ensure that risks are mitigated and the opportunities created by cloud computing are maximized in a planned and controlled way.

IVI are currently working on a more in-depth assessments that can be tailored to suit different businesses so they can tailored the assessment to target specific industry segments and /or to where there are in their journey to sustainability. As organisations or in the process of moving or have already moved services to the cloud, IVI as are piloting a framework that can be used to objectively rate the maturity of a Cloud Service Provider (CSP). To simplify the selection process, the assessment considers the many factors that need to be used when selecting a cloud service provider so that the client organisation can easily distinguish between similar offerings from a range of companies. The assessment can quickly rate how different CSPs compare and it can be customised to suit different business requirements and sectors.

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