An Incremental Model for Cloud Adoption: Based on a Study of Regional Organizations

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Abstract – **Many organizations that use cloud computing services intend to increase this commitment. A survey was distributed to organizations in Hawke's Bay, New Zealand to understand their adoption of cloud solutions, in comparison with global trends and practices. The survey also included questions on the benefits and challenges, and which delivery model(s) they have adopted and are planning to adopt. One aim is to contribute to the cloud computing literature and build on the existing adoption models. This study also highlights additional aspects applicable to various organizations (small, medium, large and regional). Finally, recommendations are provided for related future research projects.**

Keywords – **Business Information Systems, Cloud Computing, New Zealand, IT Management.**

1. Introduction

Many organizations in New Zealand which currently use cloud computing solutions intend to increase their cloud related spending in the future. An increasing number of small and medium-sized organizations are also allocating significant amounts of their information technology (IT) budget for cloud based services. There are three major cloud

computing service delivery models (Software as a Service, Platform as a Service, and Infrastructure as a Service). According to the findings of this study, Software as a Service or SaaS for short (including, email, office productivity software and customer relationship management applications) is usually adopted first and accessed in the cloud. This is in line with other studies in the cloud computing literature; for example, Aldarbesti, Goutas, and Sutanto [1] reported SaaS as having the most momentum, by satisfying end user preferences in an economically efficient manner. Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are typically implemented later.

After the introduction, this study provides an explanation of the basic terminology. This is followed by a literature review section on the adoption of cloud computing. As explained in the methodology and the findings sections, the survey in this study includes many questions, for example, how long the local organizations have been using cloud based solutions, their perceived benefits and challenges, and which delivery model(s) they have adopted and which one(s) they are planning to adopt in the future. As a result, the aim of this study has been to contribute to the cloud computing literature, and build on the existing models by synthesizing various factors, and suggesting a draft model that is applicable to a wider range of organizations, including small, medium, and regional ones. Finally, this study makes recommendations for similar and ongoing research projects that analyze the adoption of cloud computing.

2. Terms of Reference

In this section, the essential cloud computing definitions and the historical background are covered. According to NIST [16] the cloud consists of "five essential characteristics (on-demand self-service, ubiquitous network access, location independent resource pooling, rapid elasticity, and measured service); three service delivery models (Software as a Service, Platform as a Service, and Infrastructure as a Service); and four enterprise access models." Of these three service models, PaaS stands for the capability provided to the client to

create and deploy applications using programming tools, libraries, and services supported by the provider [14]. Secondly, IaaS is the provisioning of processing, storage, networks, and other fundamental computing resources to the client [14]. Thirdly, SaaS involves using the provider's applications on the cloud. Cloud based SaaS applications are typically accessed through a web browser or a mobile device [6]. Therefore, the growth in the last ten years in mobile computing has assisted the growth of the SaaS market. The ongoing increase in open source and free software has also allowed many companies to use the SaaS model [9].

3. Literature Review

Creating and using theoretical models for computer science in general and for studying information systems in particular has certain benefits. A model or framework is usually an abstract representation or summarization of certain concepts, trends, or strategies. One of the purposes of a model is to help better understand and visualize the concepts or strategies in question. A model may also guide professionals during the practical application of those business and technology ideas.

One of the recent attempts to describe different businesses and their cloud maturity has been made by the cloud management experts at RightScale as cited in [12]. This particular model is organized according to four categories: cloud watchers, cloud beginners, cloud explorers, and cloud focused. Moreover, the Open Data Center Alliance [18] has released another maturity model with six categories that range from legacy (without any cloud based services or resources) to optimized (with multiple and federated clouds). It is necessary to describe and critique these major two models from the literature in this section before proceeding to suggest new modifications.

Rightscale [23] has continued to use the same maturity model in its most recent reports. First, cloud watchers are organizations that are considering cloud strategies and different plans but have not yet started using cloud services. Second, cloud beginners are relatively new to cloud computing and are working on their initial cloud projects.

Third, cloud explorers have multiple applications or services in the cloud. Those organizations are improving and expanding their use of cloud resources. Fourth, cloud focused businesses are effectively using cloud infrastructures and are working on optimizing their cloud operations. In the RightScale survey, there is also the null option of "no plans" for companies that do not have any cloud plans and do not fit into one of the four categories. Between the 2015 and 2016 surveys, some organizations have moved from the cloud explorer to the cloud focused category; however, organizations

that have no plans or are just watchers make up 15% of RightScale's sample. Interestingly, small and medium-sized businesses are more likely to be on the opposite ends of the scale (rather than in the middle), being either heavy users or abstaining from cloud services.

The Cloud Maturity Model (CMM) released by the Open Data Center Alliance [18] has the following six levels:

CMM 0 – Legacy: No cloud approach or solutions used.

CMM 1 – Initial, Ad hoc: Basic awareness and some usage of cloud solutions.

CMM 2 – Repeatable, Opportunistic: Although cloud solutions are used, this implementation is lacking consistency across the organization and includes shelf-ware (underutilized applications or subscriptions)

CMM 3 – Defined, Systematic: Includes a high level of integration, automation, and documentation

CMM 4 – Measured, Measurable: There are significant quantitative and qualitative gains.

CMM 5 – Optimized: The organization uses federated clouds and optimizes its operations.

Another approach is to look at a company's overall swiftness and scope in terms of adopting cloud services. With a revolutionary approach, an organization may adopt cloud based resources and applications quickly and on a whole scale [11]. In contrast, the evolutionary approach involves a gradual evaluation and implementation, with the option of possibly stopping at any time in the future. Small businesses that typically do not have large scale legacy systems or large investments in their own IT infrastructure may be tempted to take a revolutionary approach. However, the evolutionary approach may seem safer as taking the time may allow the technologies and the end users' own basic technical knowledge to mature. In the meantime, a portion of their information systems may still remain hosted on-site or offline if the business feels more comfortable about the safety as well as the general maintenance of such an IT environment.

Another outcome of an evolutionary approach may be a hybrid cloud model, as opposed to just using public clouds. According to Gartner [8], a hybrid cloud is a mixture of internal and external cloud services, or a combination of dedicated (private) as well as shared public resources. This type of mixture can also involve multiple service models (SaaS, IaaS, and PaaS). A potential challenge with the hybrid model is the complexity of design and integration [10]. However, because of the current popularity of the hybrid cloud concept, it is appropriate to include a question in this survey of this study around public, private, and hybrid cloud models.

4. Methodology

According to the New Zealand Ministry of Business, Innovation and Employment [17], while cloud computing has good potential to reduce the costs of IT services, local companies need encouragement to adopt cloud services. As a result, this paper investigates and addresses the issues, trends, and strategies for transitioning to cloud based and virtualized IT resources and services.

A general-purpose survey was distributed in 2016 to local organizations to understand their adoption and use of cloud solutions. The survey questions were based on an initial literature review and conversations with local IT experts. The goals of the survey are to document the state of organizations in the Hawke's Bay region of New Zealand, and to better understand local IT developments, in comparison with global trends and best practices.

The rationale behind using an online questionnaire was to reach out quickly to a larger number of organizations than would have been possible through individual interviews. The list of questions can be found in the Appendix. The questions are essentially in the multiple-choice format. Therefore, the results can be analysed and summarized in terms of general descriptive statistics. This type of quantitative survey can also serve an exploratory purpose. As a result of the summary findings, more issues or ideas can be raised for future research; and those can be investigated by site visits, qualitative interviews, and through practical and in-depth company case studies.

5. Findings

Figures 1. through 11. summarize the quantitative results of the survey and help to illustrate the findings. For the reader's convenience and to keep the manuscript's form orderly, these figures have been all put together after the text.

Figure 1. shows that more than one half of these respondents represent small companies (with fewer than 50 employees), which is in line with a provincial economy. On the other hand, the remaining 45% of the sample belongs to relatively more sizeable companies similar to those found in larger metropolitan areas.

As seen in Figure 2., a great majority of the respondents is made up of non-IT companies, i.e. companies whose core business is in other industries. As opposed to primary (natural resources) and secondary industries (manufacturing), the majority of this sample represents a wide range of services while the distribution is quite heterogenous.

Figure 3. above shows that 72% of respondents are using cloud based services, which rises to 86% when those that implementing and trialing are also counted. This regional figure is very close to the most recent global trends. The results are comparable, for example, with the results obtained by the USA based research firm North Bridge [25], and the recent results obtained by the UK based Cloud Industry Forum [3].

The most significant years when cloud based solutions were adopted in this regional context are 2010, 2012, and 2015. Figure 4. also shows relatively smaller rates of adoption during 2013 and 2014. A reason for this slowdown may be related to the public perception of digital data in the cloud being vulnerable as more security and privacy incidents were reported in the media during those years in comparison with previous years [13].

Respondents could pick multiple items (types of cloud computing), as can be seen in Figure 5. Software as a Service (SaaS) is the most popular, followed by Infrastructure as a Service (IaaS), suggesting that most organizations will try and use SaaS prior to trusting and using IaaS. This can also be because, while all organizations need software, many of them do not need extensive computing capacity and therefore do not use IaaS. PaaS (cloud based development) is the least popular since most organizations outside of the information technology and media industries do not need to develop new software.

Although close to 90% of these organizations are either using or discussing cloud based IT solutions, Figure 6. shows only 66% of them explicitly covering the Cloud in their strategic plan. One possibility is that cloud based options are now considered to be normal, and therefore do not need to be especially highlighted.

Two barriers to cloud adoption stand out the most in Figure 7. The first one is overall risk; any new project or new technology involves general and sometimes intangible risks, not specific to that technology. Data sovereignty and privacy has been voted by these respondents as the greatest barrier or concern among the given choices. Similarly, Scholtz, Govender, and Gomez [24] found data privacy to be the second most important technical barrier to cloud adoption.

As shown in Figure 8. above, IT efficiency has been picked by the greatest number of respondents (where they were allowed to select multiple items). This shows that these local organizations are still interested in running their own IT operations (to one extent or another) but are using cloud based resources to do it in a more agile or effective way.

Many of the respondents are either from small and medium organizations (or have worked in them before), or their large organizations work and interact with small and medium organizations in the region. Figure 9. shows that they find the hybrid cloud model relatively more appropriate for small to medium sized organizations. According to the Cloud

Standards Customer Council [2], businesses need not only to be innovative and try new services, but also to maintain and leverage internal systems that cannot be replaced easily. Thus, the hybrid approach can be attractive.

A majority of the local organizations using cloud based solutions are willing to use multiple providers. This makes sense, for example, they may need to use different vendors for different types of cloud computing (SaaS, IaaS, and PaaS), or their business different functions may benefit from different SaaS applications. The findings reflected in Figure 10. indicate that the respondents are prepared for this reality. They trust the Cloud sufficiently, and are willing to work with multiple external IT companies.

Figure 11. shows that most of these local organizations will continue and expand their use of SaaS (keeping in mind that most of them are already using it). Interest in using IaaS for the future is also noteworthy, as this type of cloud has currently not been implemented as widely as SaaS. Therefore, a growth in IaaS adoption can be expected during the ongoing evolution and adoption of the Cloud.

Among the functional and business processes that these organizations would like to migrate to the cloud, financial services and collaboration have been selected by the respondents as the most popular areas, although other services have also been picked such as human resource management and planning, but without an overwhelming trend or details as to the specific use in those general areas.
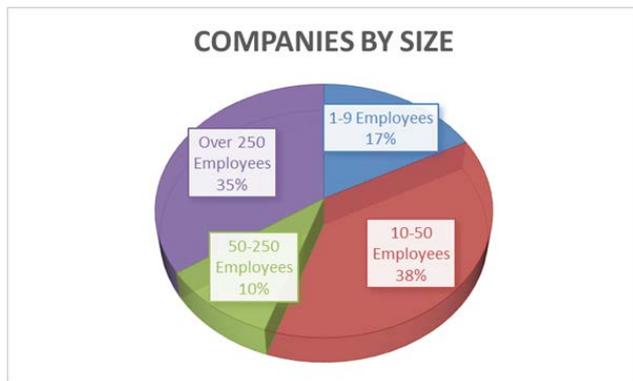

Figure 1. Distribution of respondents by company size

Industrial Classification (Australian & NZ Categories – Grouped for Convenience)	Percentage (Rounded)
Services (Repair, Maintenance, Personal Care)	21%
Information, Media & Telecommunications	17%
Professional, Financial and Admin Services	17%
Health Care and Social Assistance	14%
Manufacturing	14%
Education and Training	7%
Wholesale and Retail	4%
Agriculture, Forestry, and Fishing	3%
Transportation	3%

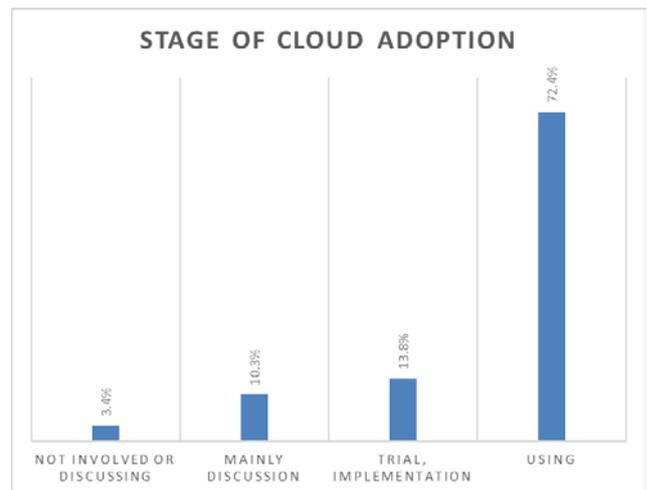*Figure 2. Distribution of respondents by industry*

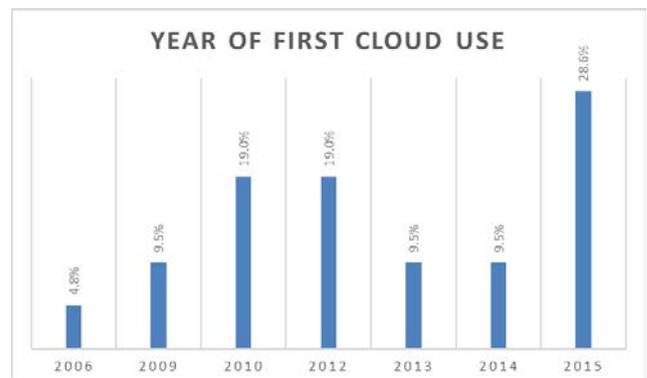*Figure 3. Distribution according to their adoption level*

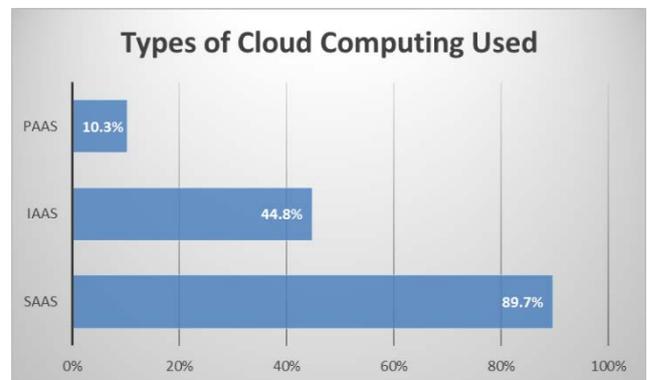*Figure 4. Distribution of respondents according to years*

Figure 5. Distribution across SaaS, IaaS, and PaaS

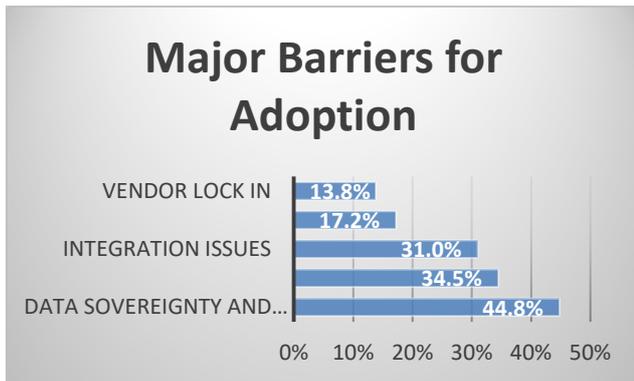*Figure 6. Does your ICT strategic plan include a migration to the Cloud?*

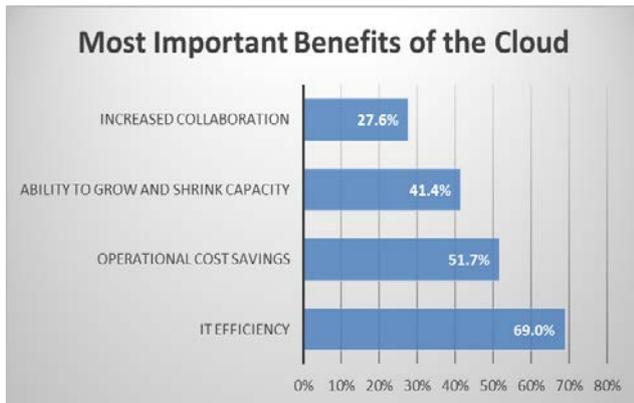*Figure 7. Top five barriers selected from nine choices*

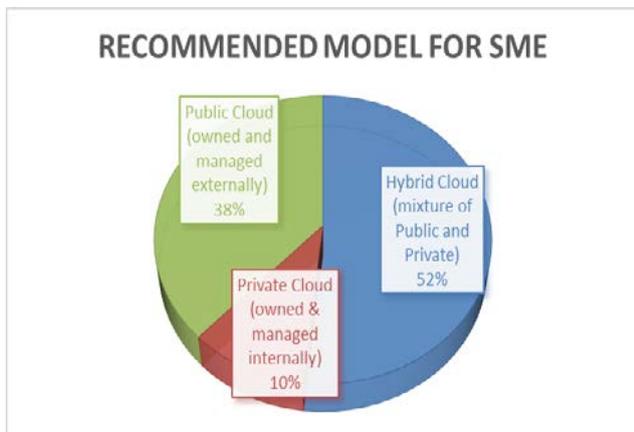*Figure 8. Top four benefits selected from eleven choices*

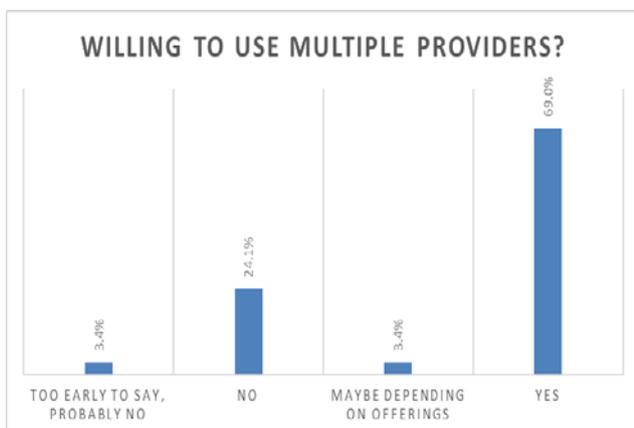*Figure 9. Suitable solutions for small/medium enterprises*

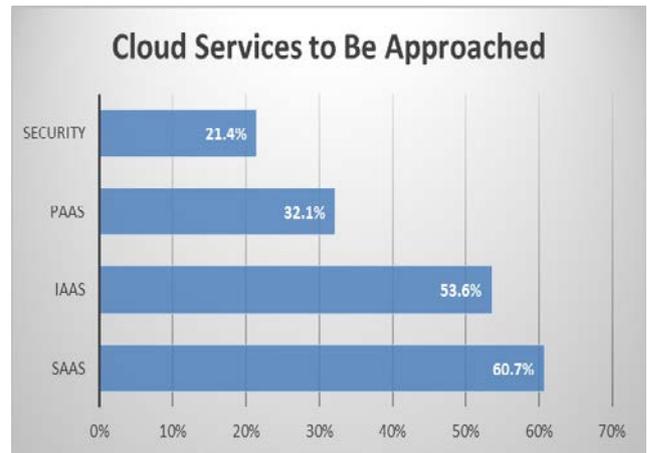*Figure 10. Are these companies willing to (or already) outsource to more than one provider?*

Figure 11. Distribution of respondents by the services they are likely to approach in the future

The correlation coefficients were measured between the following variables: the size of the enterprise, the stage of cloud computing, and the inclusion of cloud computing within the strategic plan. However, none of the results were indicative; as the coefficients were only 0.25 or lower. A challenge here is that most of the variables are categorical and ordinal (suggesting other statistical calculations such as ANOVA and ANCOVA). However, the current results at least indicate that an enterprise's ability to adopt cloud technology is not affected by its either small or large size.

Primary among the perceived challenges were highlighted in the Cloud Watchers and null option groups. The first challenge was the reliability of the local and national network supporting the technology. Cloud computing requires a robust and reliable infrastructure. The roll-out of Ultra-Fast Fibre (UFB), considered by many in the region to be a minimum standard for cloud solutions, began in late 2011 [19]. The Internet in New Zealand is connected to the world via the undersea cables. A break in the cable or another technical issue with the infrastructure or power could isolate New Zealand from the rest of the world. Even recently, the demand for services has impacted major providers resulting in delays, cost overages and damages [22].

Another initial concern was cost. Fibre installation and monthly service fees are costly compared to other services such as VDSL. The cost of hardware (new equipment and upgrades) to support it across an organization could have impacted heavily against the IT budget, especially for small businesses.

Finally, another issue is that most cloud services are hosted primarily offshore. This raises several concerns namely: the security of data, access to long distance services, and the legal and jurisdictional ownership of data. With cybersecurity threats a continuous risk, businesses are reluctant to store data in a way which could leave them more vulnerable. The idea that data is more than an arm's length away

leaves them open to more breaches. Overseas cloud providers are not bound to the Privacy Act of 1993, which involves electronic data access, storage, and modification principles and regulations [15].

One of the major perceived benefits was raised by the businesses in the cloud explorer and cloud focused categories. Many of the researched businesses conduct themselves in a global market. Access to services previously unavailable put businesses into a more competitive position. Services such as Office365, VoIP, and Video Conferencing tend to be considered crucial. Remote access to data, email, user collaboration and other SaaS processes appeal particularly to businesses with the budget to support the exploration of fibre internet services [4]. Similarly, business telephone and call center functions are also increasingly being delivered more cost-effectively and maintenance free through vendor hosted and cloud-based systems [5].

6. Proposed Model

The first concept in consideration for the model is the sequence of activities that an organization may perform, for any given service: Discussion, Trial, Regular Use, and Evaluation. Next, it is more often the case that organizations adopt the different types of cloud computing in the following order: SaaS first, IaaS afterwards, and possibly PaaS later. A way to combine these two concepts is to use a cyclical model as organizations will repeatedly perform the activities over multiple iterations.

The combination discussed above is relevant to the so-called "Cloud Beginners" and "Cloud Explorers." Cloud Focused organizations, however, are defined by more advanced characteristics and will perform a different list of activities. The depictions in this paper include only the Cloud Beginners, Explorers, and Cloud Focused categories from Rightscale [22] (leaving out the Cloud Watchers, which are becoming very few in numbers).

One particular characteristic of a cloud focused enterprise is to having a designated employee in the organization, who can articulate the cloud strategy and practices across different departments [20]. The other highlights of the cloud focused organizations are: setting metrics so that progress and efficiency can be tracked, increasing synergy and transparency among the different cloud products and users, identifying and realizing (not only financial but also) intangible benefits, automation of management procedures and data analysis, and (lastly) maintaining best practices and pursuing optimization. However, these types of tasks are suited only to companies of greater size, which also have employees with advanced IT and Cloud related skills.
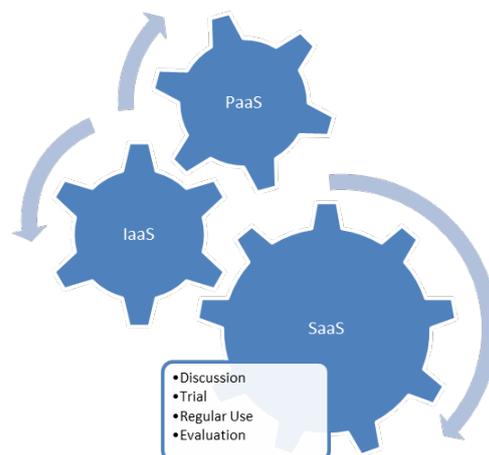

Figure 12. Cyclical Implementation Activities

Although SaaS is the easiest and most popular form of cloud computing used, the same four activities apply to the adoption of all three service models. The second activity (trial) may be brief. As organizations continue to adopt more cloud based software and other services, the trial phase in Figure 12. may be skipped, thereby moving from discussion or analysis directly to regular use. The outcome of iterative evaluations (positive user feedback, return on investment, and functional benefits) will determine how far the organization will go, in terms of adopting new cloud service models and products.
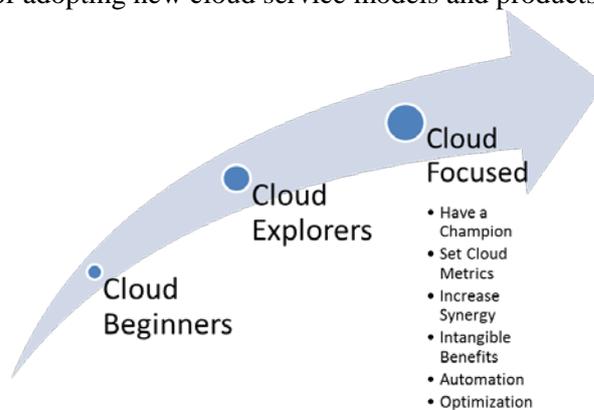

Figure 13. Progressive Implementation Activities

Cloud Explorers will perform the activities in Figure 12. while Cloud Focused businesses will additionally perform the activities shown in Figure 13. The movement from Cloud Beginners to Cloud Explorers is incremental, i.e. this involves a set of activities and decisions while each cloud based solution can be implemented both in isolation, one-at-a-time, or in parallel with the implementation of another solution. For example, even when two solutions may be discussed at the same time, standard activities such as user requirements gathering and documentation can be done incrementally over a period of time. The advanced activities of a Cloud Focused business can also be performed in a sequence or carried out incrementally.

For example, designating a cloud solutions champion will lead to that person formulating the cloud related performance metrics for the business. The same person can also help the individual departments to collect the data for the metrics and measure them. Good business practices towards automation and optimization can also be tested and adopted incrementally.

7. Conclusions

One of the important aspects of the user experience with any product or service is dependability and the users' ability to control that product, as a result of how predictable and reliable the product is. While most businesses have been using off-shore (hosted) services without knowing it (i.e. Google Mail and Google Drive), many of them were initially reluctant to make a full commitment to the cloud. Some of these tools were used by employees themselves as part of Shadow IT (without official corporate or IT department support or approval). A greater commitment to the cloud involves going beyond basic communication and storage services and, for example, using cloud based resources to support daily business processes and work tasks. This research paper has outlined a draft model to describe the typical course of cloud adoption for many companies. An important step for evaluation is to discuss this model in the future with companies in a voluntary consulting context. As a result, the primary author of this paper will be available in the future for any questions on cloud based IT solutions and for individual business guidance and assistance.

Very recently, the Cloud Industry Forum [3] reported that organizations migrating to a cloud solution experience a list of difficulties, and are affected by similar concerns mentioned in this paper, for example, data privacy. Another common finding is the significant and strategic value of cloud based collaboration, within the organization and with other organizations and external stakeholders. Training the new IT workforce to collaborate effectively in the cloud begins during university and tertiary studies [7].

The technical skills needed in cloud computing may not always be complicated; however, successful collaboration requires a certain mindset and teamwork, which take time to mature.

Even for companies that may refrain from cloud services or those that may move to somewhat different computing paradigms such as edge computing or direct peer-to-peer, the cloud will still probably be the place where business data is offloaded or archived in the long term. The adoption of cloud computing (versus client based or local based computing) is not a black and white issue. There is room for more future research as the interconnectivity of people and devices continues to grow, and the spectrum of adoption gets broader with new levels or technologies. Further research on the adoption of Cloud Computing and the Internet of Things, for example, in the education realm, will also contribute to the wider body of research about the acceptance of new technologies and their impact on society.

Some of the key findings in this paper were similar to studies done overseas and in large countries i.e., widespread adoption that is expected to continue to increase in the future. An important question for reflection is the influence of globalization and standardization on regional organizations. As a result of these two important forces, provincial organizations use the same technologies as urban or international companies [21]. As a result, a potential area for research is a comprehensive investigation of the emergence and convergence of cloud computing standards (for example, ones related to management, security, and storage) in the last five years, in order to come up with a prognosis for the near future, along with practical implications for IT professionals.

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Appendix: Survey Questions:

What is the size of your enterprise you represent?

Which of the following industry types is your company in?

What does your organization view as the most important benefits of the cloud?

At what stage is your organization with regards to cloud computing?

What are the greatest barriers for adoption of the cloud in your organization?

Which of these types of cloud computing is your organization currently using?

Please indicate the year when you started using the above cloud services (if any)?

Which solution do you see as the most suitable for an SME, according to the following Cloud Computing taxonomy?

Which "layer" of Cloud would you be most likely to approach in the future?

Would you be willing to outsource to multiple providers?

Does your ICT strategic plan include a migration to Cloud Computing?

Enterprises that migrate to cloud computing tend to do on a service by service basis. In your enterprise, which of the services is most likely to get migrated to cloud computing?