Masters en Gestión de Empresas, Productos y Servicios

Fostering Innovation with Cloud Computing

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Abstract

The study of innovation is of the most important discussions of modern times. As will be illustrated, growth is highly dependent on the ability of organizations to innovate processes, products, positions, and paradigms. A disruptive new technology, known as cloud computing, has demonstrated a connection with helping organizations foster innovation. This research explores this relationship by combining decades of innovation research with an analysis of a large sample of cloud computing case studies.

I. Objective

This thesis was elaborated in the pursuit of a Master's Degree in the Management of Business, Products and Services (*Gestión de Empresas, Productos y Servicios*) in the Polytechnic University of Valencia, Spain (*Universitat Politècnica de València*), under the guidance of Dr. José Albors Garrigós.

The objective of this thesis is the examination of the cloud computing model, in its ability to foster organizational innovation. In particular, in cloud computing's ability to foster innovation that is neither serendipitous nor pushed, but rather a purposeful response to an identified need. There are two reasons to focus on this type of innovation. First, the majority of all innovations are created through a purposeful response to a need, instead of pushed (Myers, Marquis, & others, 1969). Second, while serendipitous innovation may result in profound outcomes, it unlikely to contribute to maintained innovation in the long term (Liyanage, 2006).

The articulation of this objective will be structured around the purpose of creating a resource for decision makers and academics which serves as guidance as how to leverage cloud computing for innovative purposes. This is in contrast to general observations on the topic which provide insight, but little value or guidance. Also, the context of innovation will be of those innovations happening within organizations, as opposed to by individuals. The purpose of this is to coincide with the management field of study.

Furthermore, this research will not be technology specific. Instead, specific cases will be drawn upon in order to link cloud computing with innovative theory. It is my contention that this approach will provide more value to the reader, as it conforms more appropriately to a modern practice of innovation. The logic being that looking at available solutions to find where they can best be used is more congruent with a technology push approach to innovation, where a technology pull model is more desirable. This owes to the fact that cloud computing is not a specific technology, per se, but rather a model under which technology is created (Mell & Grance, 2011). Therefore, creating a model based on longstanding innovative research, one can capitulate innovation needs for which the model of cloud computing should strive to satisfy. With this method, a more timeless research is possible which can continue providing value to researchers and practitioners despite technological changes in cloud computing.

II. Methodology

This research will first frame an explanation of innovation using innovation research that has been developed for many decades. Innovation will be defined first on the nature of innovation, which gives an understanding for what is and is not considered innovation, providing a focus for this research. This will be followed by describing the aim of innovation, answering why firms innovate, and giving a direction or end to this research. Finally, the description of innovation will end with the different types of innovation. This will create an important explanatory framework which will allow the distinguishing between the similarities and differences of various types of innovations later in the research.

Once a general definition of innovation is established, the research will then begin the most significant stage, which is how to foster innovation. This chapter will also be based on longstanding innovation research which has been developed over previous decades. This research generally yields scattered explanations for different practices which foster innovation. Therefore, innovation is broken into four stages, and these explanations will be organized according to what part of the innovation process they fall under. With this method, we can inductively establish a theory for the underlying goals in each stage of the innovation process. By doing this, we then create a model to which we can apply cloud computing in order to determine how cloud computing can be used in pursuit of those underlying goals found in each stage of the innovation process. The four stages of innovation include: need recognition, coalition building, implementation, and diffusion.

Thereafter, we will begin with the topic of cloud computing, giving an explanation of what cloud computing is, utilizing a 5-4-3 model by Clohessy and Acton, as well as the NIST definition of cloud computing (Clohessy & Acton, 2013)(Mell & Grance, 2011). This will provide a general understanding of cloud computing.

From here, this research will attempt to link the fields of cloud computing and innovation, using our model on how to foster innovation. We will validate this model using cloud computing case studies found both in academic research, industry analyses, as well as publications made by cloud providers. Overall, over two-hundred case studies were examined. Of these, fifty one were selected on the basis of relevance to the topic. The criteria of relevance used is in regards to the company which adopted the cloud, and includes: 1) the company used cloud computing for purposes of innovation, or in an innovative way that deviates from previously used practices of the firm or industry 2) the cloud adopter had not been previously using the cloud or adopted a new cloud service or deployment model, 3) sufficient information was provided to understand the effect of cloud adoption, and 4) the innovative deviation from previously used practices is evident beyond the realm of the IT department. Furthermore, case studies repeating identical innovative practices from others were often discarded in the final analysis, so as to avoid redundancy. The case studies meeting these conditions were analyzed, and extrapolated to test their concurrence with our underlying goals of the four innovation stages. This will test the model, either confirming or underlining any shortcomings of the model.

Why use this approach? To answer this question, it is important to emphasize that cloud computing is not a specific technology, but rather a model under which technology and solutions to problems are created. Some current research calls for the innovative power of cloud computing to be measured by compiling cases in where cloud computing is used, and study those deductively to arrive at a conclusion for which components of cloud computing are provide the most innovative capacity (Clohessy & Acton, 2013). However, by studying cases describing how cloud computing has been used, one would not be describing the potential of cloud computing, but rather the already-realized ability of cloud computing in unique cases. By instead connecting cloud computing to underlying goals which foster innovation, one can pursue these goals using new or existing technologies within cloud computing.

With this in mind, the research will conclude with a discussion and conclusion of the findings, which will provide considerations for cloud adopters to take into account when adopting the cloud for innovative purposes, as well as a suggested direction for future cloud technology, and future empirical research.

Chapter 1

Innovation

1. What is Innovation

Innovation has been a topic of discussion for many hundreds of years (Trott, 2008, p. 7). However, due to the wide range of fields and contexts in which this word can be used, it is not easy to achieve a concise and fully encompassing definition of what exactly innovation is. Anahita Baregheh, et al. attempt a more comprehensive definition of innovation by bringing together a range of definitions formulated throughout the past eighty years from a range of disciplines. Their results underline three essential attributes of innovation, which answer what an innovation is in its most basic sense, why organizations innovate, and the different types of innovations there are. The authors explain these as the nature, aims, and types of innovation (Baregheh, Rowley, & Sambrook, 2009, p. 1334). Exploring these more closely helps us arrive at exactly what innovation is.

1.1 Nature of Innovation

The nature of innovation, as explained by Baregheh, et al., "refers to the form of innovation as in something new or improved" (2009, p. 1331). The authors also mention the nature of innovation having been defined in some works as a change (Baregheh, Rowley, & Sambrook, 2009, p. 1331). The implication from this is that what is considered an innovation is less dictated by the inherent newness of something, but instead whether there is a sort of evolution between the then and after.

This is well illustrated by the example of Thomas Edison's light bulb. As Joe Tidd and John Bessant point out, "Edison recognized the electric light bulb was a good idea it had little practical relevance in a world where there was no power point to plug it into. Consequently, his team set about building up an entire electricity generation and distribution infrastructure, including designing lamp stands, switches and wiring" (Tidd, Bessant, & Pavitt, 2002, p. 16). This example distinguishes the ideas of innovation versus invention. While the light bulb was a great invention, the innovation was not the light bulb in itself, but rather the series of changes that made illuminating households with electricity possible. The light bulb was just one of the items that helped make this possible.

Another important attribute that the case of the light bulb illuminates is the importance of the environment in which an innovation is created. Illumination via electricity was, even at Edison's time, not a completely new idea, but had been around for many decades. However, the idea had never been made into one that was ripe for the market, due to the short life of electric arcs using the devices of the time, as well as the cost and design factors that made them unsuitable for use in homes and offices. What Edison did was provide a suitable device for the need of an alternative lighting source to the gas-based lighting of the time. He also came together with institutions, such as J. P. Morgan to help bring this idea to market (Hargadon & Douglas, 2001, pp. 477-481).

What qualifies the case of the light bulb as an innovation is not that it was a new idea. But rather an idea that brought change. This change occurred because an invention met market viability, or as put by Tidd, et al., "[Edison] put to good use an understanding of the interactive nature of innovation, realizing that both technology push . . . and demand pull need to be mobilized" (Tidd et al., 2009, p. 15). This is not to say that an innovation needs to have market sustainability or success, but rather that it needs to at least be implemented and used, so as to bring about change.

1.2 Aim of Innovation

A second defining factor of innovation is its aim. Baregheh et al. define aim of innovation to be "the overall result that the organizations want to achieve through innovation" (Baregheh et al., 2009, p. 1332). The overall objective with innovation is to improve performance, and stay competitive. Various evidence suggests a positive relationship between innovation and firm performance, through improved financial performance, market penetration, production improvements, and other means (Abernathy & Clark, 1985), (Abernathy & Utterback, 1978), (Burns & Stalker, 1961), (Christensen & Bower, 1996).

Many different results can be achieved, such as differentiation, cost reduction, and other strategic purposes. **Figure 1** below reviews the reasons of innovation for small and medium size enterprises in Macedonia, and reveals many of the reasons why firms innovate. One can notice an alignment between the innovation typology in the previous section, and the reasons for innovating in the bottom, noting the relationship between aim and type of innovation. Some reasons focus on the product, such as increasing quality. Others have a process or operational focus, such as better way of working, ecology, reduction of production costs, and possibly keeping market share. Also, a large amount share a focus on positional innovation, with approaching new markets, diversification, increasing product line, improving flexibility.

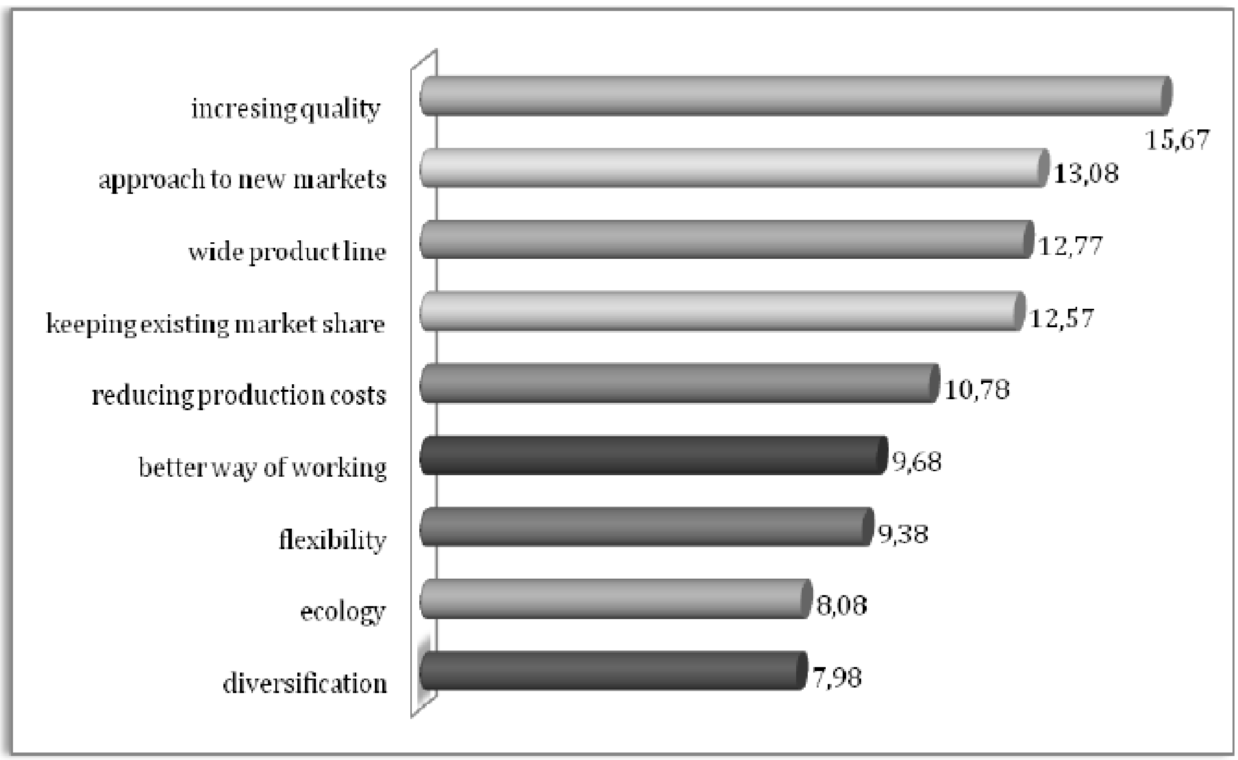

Figure 12: Reasons for undertaking innovative activities. Source: Bureau for protection of the intellectual property in the Republic of Macedonia. Retrieved from: Ramadani, V., & Gerguri, S. (2011). Innovations: principles and strategies. Strategic Change, 20(3-4), 101–110.

The overall objective of almost any business aim is of course competitiveness, achieved through these various strategies. Innovation has distinct effects on various attributes of an organization and the organization's offerings through which to pursue these strategies. Abernathy and Clark link innovative activities with the innovation's impact, noting examples in both technology/production innovations, as well as market/customer innovations. Areas discussed include innovations product designs, production systems, skills, capital equipment, customer relationship, distribution and service channels, modes of customer communication, and others (Abernathy & Clark, 1985, p. 5). These are good examples of various competitive aims that can be taken into consideration individually for the purpose of developing broader organizational strategies.

1.3 Type of Innovation

Baregheh, et al. explain that "type of innovation refers to the kind of innovation as in the type of output or the result of innovation, e.g. product or service" (Baregheh et al., 2009, p. 1331). Using output as the defining factor of innovation types, many different typologies are possible. Indeed, in academic studies, various typologies exist, as exhibited in **Figure 2** below.

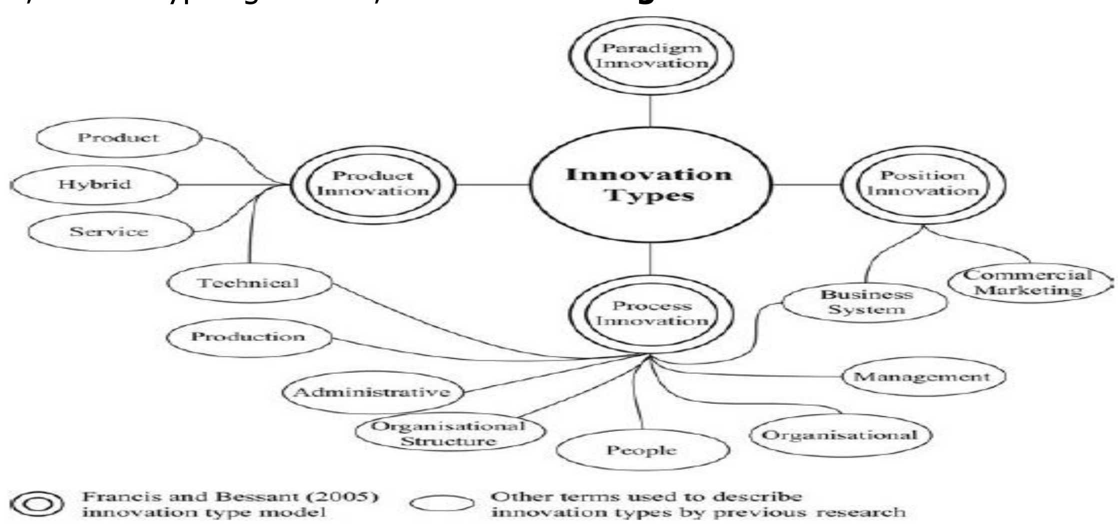

Figure 2: Innovation-Type Mapping Tool. Retrieved From: Rowley, J., Baregheh, A., & Sambrook, S. (2011). Towards an innovation-type mapping tool. Management Decision, 49(1), 73–86.

While this figure does not cover all the academic typologies of innovation, it provides a good view of many of the most relevant, classified into four separate groups: product innovation, process innovation, position innovation, and paradigm innovation, as recommended by authors Francis and Bessant. Bessant gives a definition of these four types in his and Tidd's book *"Innovation and Entrepreneurship:"*

- 'Product innovation: changes in the things (product/services) that an organization offers
- Process innovation: changes in the ways in which they are created and delivered
- Position innovation: changes in the context in which the products/services are introduced
- Paradigm innovation: changes in the underlying mental models which frame what the organization does' (Bessant & Tidd, 2011, p. 13)

These definitions allow for some ambiguity to what type an innovation fits into which category, which is reflected in **Figure 2** above, as some of the sub-categories belong to more than one category. This is seen to be the case for technical innovation, which is both a process and product innovation, and also for business systems innovation, which can be both a process and position innovation. Furthermore, the four main types are not alternatives to one another, meaning more than one can be pursued at a time (Francis & Bessant, 2005. p. 172). This shows that, even for a typology as the one provided, there is a strong interrelation between the various types of innovation. To help further explain these relationships, it is merited to provide a more detailed explanation for each of these main categories.

1.3.1 Product Innovation

An important aspect of the authors' definition of product innovation is the flexibility put on what is considered a product. As can be seen, product innovation also encompasses services, product/service hybrids, as well as some technical innovations (Rowley, Baregheh, & Sambrook, 2011, p. 82). While each of these types are often interrelated, each also has certain type-specific attributes.

To help understand these differences, it is necessary to start with the fundamental differences between products and services. Service is defined by Spohrer and Vargo as "the application of competences (knowledge and skills) for the benefit of another party" (Spohrer, Vargo, Caswell, & Maglio, 2008, p. 4). Three key aspects in this definition help explain the uniqueness of service innovation. Unlike the innovation of material products, services are innovated by an alteration in knowledge, skills, or the application thereof.

As these alterations are not of a material nature, the resources required to innovate services are not of a material nature either. Jay Kandampully proposes that the three contributing resources to service innovation include technology, knowledge, and networks (Kandampully, 2002, p. 20). The resource of new knowledge directly affects the inputs of service described as knowledge and skills. Technology has the ability to change how the service is delivered, while networks affects to who it is delivered.

Meanwhile, products share certain similarities to services. Although products are more-likely to be tangible than services, product innovation also requires certain intangible resources and competencies, such as understanding of customer needs, manufacturing know-how, etc., on top of tangible resources as well (Danneels, 2002, p. 1102). Thus, for product innovation to be possible, both of these areas must meet at a common result.

Likewise, a hybrid innovation is an innovation including both product and service, which involves a similar combination of tangible and intangible resources. As explained by Velamuri, et al., "[hybrid products] are the result of an innovation strategy, shifting the business focus from designing and selling physical products to selling a combined system of products and services which are jointly capable of fulfilling specific client demands" (Velamuri, Neyer, & Möslein, 2008, p. 2). This type of innovation attempts to go beyond the traditional thinking of fulfilling need through one solution at a time, to instead create a combination of products and services that compound from one another to fulfill a market need.

Lastly, technical innovation, as explained by Rowley, et al. "refers to any type of innovation structured from a technical viewpoint and which lies at the heart of operations; such innovation influence the flow of product or process operations" (Rowley et al., 2011, p. 76). Thus the idea of technical innovation refers more towards its place in the organization rather than its tangibility. This is considered a product innovation due to the fact that this change can be brought on by implementing a new product or service, but it also shares classification with process innovation, which will be discussed in the following section.

1.3.2 Process innovation

The overlap of technical innovation as also being considered a process innovation gives explanation to the slight ambiguity to defining process innovation. Rowling, et al. define process innovation as "the changes to organizational operations and production. . . also usually initiated by technological advancements" (Rowley et al., 2011, p. 76). This hints that process innovation is very often reliant on product innovation, or more specifically, technological advancements. Nonetheless, it is necessary to make this differentiation. For instance, the invention of the light bulb was clearly a product innovation. However, the ability to give light to certain workspaces that may have otherwise been in the dark, opens up possibilities for new work practices. Therefore, study in any of these changes would require a focus on what part of the process is changed rather than a focus on the product that enabled this change.

Also, when studying process innovation, the process which is being innovated needs to be defined. While the common understanding of a process is a series of actions or steps, which steps to include in a single "process" is not always clear. As explained by author Thomas Davenport, "the difficulty derives from the fact that processes are almost infinitely divisible, the activities involved in taking and fulfilling a customer order, for example, can be viewed as one process or hundreds " (Davenport, 2013, pp. 27-28). Davenport uses the process of taking a customer order, which could include the point to where the customer places a request for quotation, or arguably much before this, when the first sales contact was initiated.

Moreover, the process can even span beyond organizational boundaries. Authors Marcia Perry, et al., discuss a process innovation of Quick Response supply chain alliances, which "refers fundamentally to speed-to-market of products which move rapidly through the production and delivery cycle, from raw materials and component suppliers, to manufacturer, to retailer and finally to end consumer" (Perry, Sohal, & Rumpf, 1999, p. 19). This Quick Response system is an innovation effort which covers the full vertical supply chain until the end consumer. The scope of this system is determined by the need for the innovation, which in this case is product time-to-market. While this is an innovation effort focused around that need, many individual product innovations are included, such as point of sale scanners, bar coding, logistics improvements, electronic data interchange, and others (Perry et al., 1999, p. 120). This shows the connected relationship that product and process innovation often have. On one side, product innovation may enable many process innovations. Likewise, a need for process innovation might give suggestions as to what product innovations need to be realized.

As shown in the diagram above, process innovation encompasses the processes involved with production, administration, management, people, as well as organizational structure. A last category is noted, labeled as business-system innovation. Innovating a business system involves innovating the focus of an organization, such as in market focus. Rowley, et al. explain that this sub-type of innovation shares commonality between both process and position innovation "when business systems innovation is concerned with both administrative and marketing side of the operations" (Rowley et al., 2011, p. 83). For the two operational areas to work together towards a business system innovation, a change in processes is required. This relationship will be discussed in more detail in the following section.

1.3.3 Position Innovation

Rowley, et al. define position innovation to be "changes in the context in which products / services are introduced" (Rowley et al., 2011, p. 80). An example of this change above includes commercial/marketing innovation, in which the focus of an organization is changed, in terms of market focus, goals, etc. A noted example is in a multinational Mexican cement company, Cemex. Bala Chakravarthy and Sophie Coughlan explain:

> '[Cemex] launched the Patrimonio Hoy program that allowed groups of three families to pool their savings and leverage these with loans from Cemex, providing access to microloans for construction materials and labor as well as technical assistance. In this way, they could build or renovate three houses over the course of five years. . . . The Patrimonio Hoy project had a 99 percent repayment rate and became a self-sustaining project: CEMEX sold 100,000 tons of cement through it each year. . . By filling the financing gap, Cemex was able to sell existing products to new consumers at the bottom of the economic pyramid.' (Chakravarthy & Coughlan, 2011, p. 30)

While many of the market demographics for Cemex may have been the same during their Patrimonio Hoy program, the innovation was the focus on individual families to groups of families, and a focus on microloans that made construction projects financially viable. Thus, the market focus increased to include families in lower economic situations. Beyond increasing their market focus to lower-income families, Cemex also created a new revenue streams through collecting interest on the outstanding loans. It can be presumed that the innovation in revenue streams and market focus took a combined effort between multiple departments, innovating some of the company's processes and perhaps products as well.

While the case of Cemex reflects a marketing innovation, it could also create a business systems innovation if it were to change the processes involved with creating products. For example, if the company wanted to create a more comprehensive construction product portfolio, including such things as caulk, masonry equipment, etc., this would require a change in their production and administration processes, including it also in process innovation.

1.3.4 Paradigm innovation

The fourth and last form of innovation proposed by Rowley, et al., is paradigm innovation. David Kolb explains paradigm innovation to require a series of events, causing a change in the way of thinking and operational structure. The events include a concrete experience, observations and reflections, formations of abstract concepts and generalizations, and testing implications of concepts in new situations" (Kolb & others, 1984, p. 21). Thus, a paradigm innovation does not necessarily have to be one that shows external physical change, but rather an internal revolution of mind which can alter behaviors.

From this idea of internal versus external paradigm change, Francis and Bessant separate the idea of paradigm innovation into two types: A and B. Type 'A' is considered an inner-directed paradigm change. Binney and Williams explain the nature of Type 'A' paradigms, stating that "underlying the patterns of behavior that define organizations are the mental models that people have, the assumptions and frameworks that enable them to make sense of the world" (Binney & Williams, 1997, p. 207). On the other hand, type 'B' paradigms are innovations in outer directed paradigms. Francis and Bessant explain these to be in visible attributes of the organizational norms, or "the system of coherent, comprehensive, explicit and/or implicit constructs used by managers to understand their firm and shapes its development" (Francis & Bessant, 2005, p. 177). These could include such things as company policies, and the overall business model.

1.3.5 Incremental vs. Radical Innovation

Another area necessary to mention is the distinction between incremental and radical innovations. While not a "type" of innovation in the same meaning as the aforementioned types, the categorization between incremental and radical innovation describes how new or disruptive an innovation is. Thus, a product is not either incremental or radical, but rather falls within a continuum between the two. The extremes of this continuum have themselves various dimensions. As noted by researchers John E. Ettlie, et al., "One aspect of this dimension appears to be whether or not the innovation incorporates technology that is a clear, risky departure from existing practice" (Ettlie, Bridges, & O'keefe, 1984, p. 683). This dimension takes into consideration the relationship of newness of the product to the firm which is bringing about the innovation.

Another dimension includes the newness of the knowledge required to bring about this product, as highlighted by Xu, et al., "for incremental innovation, the type of knowledge involved is generally similar to the firm's existing knowledge base. . . On the other hand, for radical innovation, the type of knowledge involved is often novel and beyond a firm's current technology trajectory" (Xu, Wu, & Cavusgil, 2013, p. 753). Therefore, the level of newness in knowledge in the firm is also a determining factor to how radical or incremental the innovation is considered.

Not all the dimensions have to do necessarily with the firm, but also the industry and market. Jenny Darroch and Rod McNaughton elaborate on this idea by quoting various researches, stating, "as an aside, radical innovations can be both new-to-the-world and new to the firm since both represent risky departures from existing business practices (Barczak, 1991, Green et al., 1995; Hage, 1980). However, new-to-the-world innovations represent either a pioneering breakthrough or a new combination of existing technologies, where new-to-the-firm innovations might not" (Darroch & McNaughton, 2002, p. 213). This underlines the aspect of perspective in consideration to innovation type, in that while an innovation may be a large change for an organization, it does not necessarily mean the innovation is radical.

Incremental and radical innovations also are related with each other, and are used to explain industry cycles. Trott mentions studies by Abernathy and Utterback that document this, stating, "at the birth of any industrial sector there is radical product innovation which is then followed by radical innovation in production processes, followed, in turn, by wide-spread incremental innovation. This view was once popular and seemed to reflect the life cycles of many industries" (Trott, 2008, p. 7). A good example of this could be Apple's iPhone. The first version of the iPhone, many would agree, was a fairly radical innovation. Thereafter, Apple incrementally innovated various features as the smartphone market evolved.

Chapter 2

Fostering Innovation

1. Innovation Models

Once it is seen the many different types, and purposes of innovation, it is not surprising that the methods in which to innovate are many. However, to create value to business managers, an explanatory model, which avoids undermining the complexity of innovation, while flowing logically enough to allow a comprehendible and valuable study into how an organization may foster innovation, the appropriate model should be chosen. A litany of models has been created throughout the recent century, which evolve and enhance the concept of where innovations come from, and what effect their success. Larisa V. Shavinina typifies these models into six different generations:

> '(1) First generation – the black box model;
> (2) Second generation – linear models (including technology push and need pull);
> (3) Third generation – interactive models (including coupling and integrated models);
> (4) Fourth generation – systems models (including networking and national systems of innovation);
> (5) Fifth generation – evolutionary models; and
> (6) Sixth generation – innovative milieu.' (Shavinina, 2003, p. 45)

Within each generation lie various distinct models of innovation, sharing similar characteristics as mentioned above. The next sub-sections will explain each of these generations in more detail.

1.1 The Black Box Model

With regards to the black box model, the black box is the terminology used to describe the source of innovation. This model describes the source of innovation, or "box" as non-transparent, and only focuses on the output of the box. Therefore, no focus is directed towards innovation as a process, or the inputs to that process, but solely on what is created from innovations, and the resulting implications. This model describes innovation in its relation to the success of the firm and development of markets (Kline & Rosenberg, 1986, pp. 278-279).

1.2 Linear Models

Linear models include popular innovative theories such as push and pull models. The earlier of the two, push models, describes a situation in which discoveries and breakthroughs in science result in technological innovation, which is then marketed to become commercialized. This idea evolved towards recognition for a need of a pull model. In a pull model, instead of a product being created, then marketed, instead the market is analyzed to determine which product to create. Thus instead of marketing being performed after manufacturing, it is instead done before. Linear models work sequentially, with one step following another (Shavinina, 2003, p. 46).

1.3 Interaction Models

The next development in models came through interaction models, which begin to show the interrelatedness of many of the variables. As can be seen from **Figure 3**, this model takes into consideration the linear models from the past. The interactive model then expands by explaining innovation as a process beginning with the creation of an idea, which goes through a system within an organization before coming out as a final product. Furthermore, this process is constantly affected by both the needs of society, and external developments in science and technology. While some

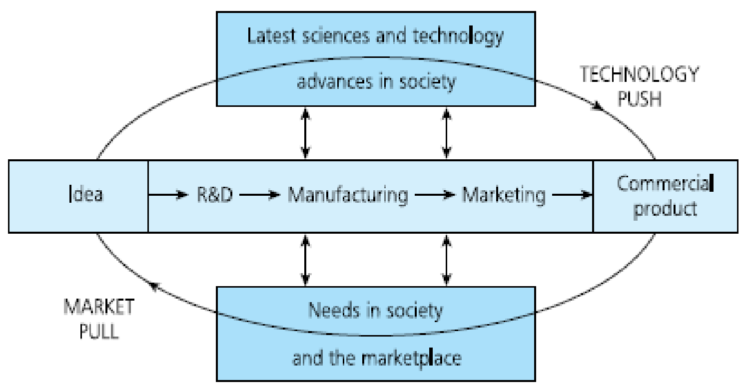

Figure 313: Interactive Model of Innovation. Trott, P. (2008). *Innovation management and new product development*. Pearson education. Retrieved from:http://books.google.es/books?hl=en&lr=&id=9hv4GqUq1E0C&oi=fnd&pg=PR17&dq=trott+innovation&ots=uUuuD7yWtG&sig=QCtlqETBBYLVjNKfdFqYL2x6oRk

interaction models may skew slightly from this exact process, the interaction of the variables remains (Trott, 2008, pp. 24-25).

1.4 Systems Models

Systems models begin to incorporate factors coming from various institutions and innovation alliances that are frequently practiced between firms. Freemen explains a common system model called the national system of innovation, which explains the interaction and learning between organizations, effect of governmental policies on innovation, role of science and learning institutions, and other such factors (Freeman, 1995). Systems models begin to integrate various networking considerations that better reflect the permeability of innovation environments.

1.5 Evolutionary Models

The aforementioned systems models are elaborated in evolutionary models by looking into the interrelatedness of innovation environments. These models emphasize the idea of a type of ecosystem in which organizations compete in. Innovations are describes as mutations, some successful and others not. This model attempts to explain organizations less in traditional market economics with complete information and market balance, and more towards an ecosystem with incomplete information resulting in change and innovation (Shavinina, 2003, p. 49).

1.6 Innovative Milieu

The idea of innovative milieus brings about the idea of spatial considerations in innovation, or the way in which distance between parties affects innovative outcomes. This approach builds on traditional approaches, incorporating governance, evolutionary theories, networks and alliances, and competition. It expands the idea of communities by not just looking at the general makeup of the community, but also considering proximity and relations within the community (Crevoisier, 2004).

2. Choosing a Model

As the above models illustrate, innovation can be seen from many perspectives, and can take many forms. This gives innovation a strong complexity which makes the description of how one can foster innovation also complicated. In order to explain how innovation is fostered, following one of the aforementioned models gives a structure and focus. Therefore, the first objective is in deciding the best model that will provide an explanatory value to a reader trying to learn how innovation is fostered.

As one can see from the development of innovation models, each generation retains a level of uniqueness. It is important to note that one model is not necessarily better or worse, or more right or wrong than another, but that they simply describe different characteristics of innovation. For instance, the linear and interactive models show innovation as a series of steps, breaking innovation into logical components. Meanwhile, the evolutionary model underlines an idea of unpredictability and the complexity of the innovative ecosystem. It is both true that innovation occurs in a series of steps, as well as rather unpredictable, to a point.

While the study of innovation has been well documented, explaining those features which foster innovation has for the most part been limited to scattered details of innovative practices, and findings, instead of structured (Quinn, 1985, p. 73). Furthermore, one can find many descriptions of individual innovative practices an organization can assume, but less on broader categories which demonstrate the underlying idea behind those practices.

Thus, for the purpose of leveraging a certain technology for innovative purposes, I believe innovation to be best explained as a process with a series of stages, each having underlying goals for the given step. This allows the ability to analyze distinct features of the technology, demonstrating how it fits through each stage of the process.

Therefore, the following sections will demonstrate the innovative process in a series of steps: recognition of the need, coalition building, implementation, and diffusion. Each step will be explained, followed by underlining factors in each of those steps which leads to innovation. It must be mentioned that while this gives a perspective on fostering innovation, no framework will be able to address a comprehensive solution for every organization, and every type of innovation.

3. Need Recognition

The first step in innovation is typically recognizing a need. While some technologies may be pushed into the market, it is far more common that a need is recognized, and solutions are proposed. This is supported by a widely cited research by Myers and Marquis, which notes that only about a fifth of innovations come from technical ideas that were pushed into the market, while three-fourths were instead generated by a perceived need (Myers et al., 1969). The identification of this need is of critical importance in innovation, and in many cases can be the determining factor to innovative success. Mowery and Rosenberg discuss findings from a study of more than 80 innovations receiving the Queens Award, explaining that while need identification is important in all innovations, it was found to be the major reason why an award-winning firm succeeded in that innovation instead of the competitors in about 16.7% of cases.

As mentioned above, innovations can serve a range of purposes, including improving processes, diversifying with new products, or others. Therefore, the need to be recognized can be both internal and external to the organization, taking the form of any of the various types of innovation. The next section will illustrate the process involved with recognizing a need.

3.1 Process of Recognizing a Need

Before a need surfaces, an event must take place which invokes this need. Donald Schon explains that needs and the ideas which come from them are first triggered by a certain disruptive event, which leads to the surfacing of ideas which encourage people to join together, forming networks. The competing solutions are then debated and decided on, causing eventually the decline and decay of the problem. This transformation is represented in **Figure 4** above.

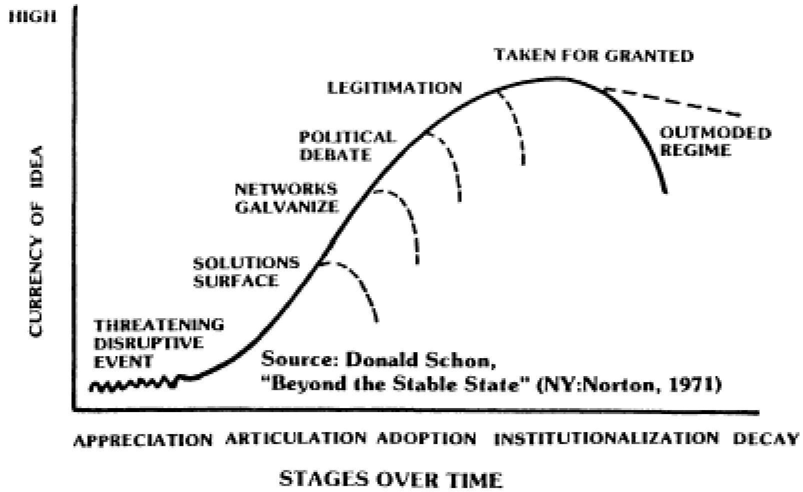

Figure 4: Life Cycle of Ideas. Retrieved from: Van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science*, *32*(5), 590–607.

However, the above figure leaves out an essential process between the disruptive event and the creation of solutions, which involves conceptualization of the problem through information. Van de Ven references this, stating that "invention is an act of appreciation, which is a complex perceptual process that melds together judgments of reality and judgments of value. A new appreciation is made as a problem, or opportunity is recognized" (Van de Ven, 1986, p. 592). The author uses the word "appreciate" to describe the discovery or realization of a problem. This hints at an idea that problems may be present, but it is when they are appreciated as a problem or opportunity that ideas for solutions are created. However, as is well known, not all solutions are successful.

This can be due to the misalignment of the reality, and judgments of reality and value. Once a disruptive event takes place, information on this event must be created in some form in order for the need to be recognized, whether it be through direct observation or communicated through a third source. The information perceived may vary in complexity. Van de Ven explains the relation between this complexity and the analysis of information, stating:

> "As decision complexity increases beyond [seven objects], people become more conservative and apply more subjective criteria which are further and further removed from reality. . . [thus] as decision complexity increases, solutions become increasingly error prone, means become more important than ends, and rationalization replaces rationality. (Van de Ven, 1986, p. 595)

While the idea of seven objects may be somewhat ambiguous in terms of many types of information, the logic of increasing complexity and variables nonetheless remains persistent. The more complex a problem is, the more information gathering and checking should be considered in order to reduce errors.

In the academic literature, the person who gathers information on the disruptive event to formulate an idea is called an idea champion. The idea champion plays a fundamental role in the innovation process, as mentioned by Van de Ven when stating, "[an idea champion] apply different skills, energy levels and frames of reference (interpretive schemas) to ideas. . . [and] become attached to ideas over time through a social-political process of pushing and riding their ideas into good currency" (Van de Ven, 1986, p. 592). This underlines the very human element behind innovation, as a something that cannot be automated, and relies on one's frame of reference to recognize and develop an idea.

While the character of idea champions may not always be identical, it may be possible to find underlying patterns in the type of people who eventually are involved in bringing ideas to fruition. Schuler and Jackson demonstrate some of the most common characteristics that innovative people tend to have:

> '(1) a high degree of creative behavior, (2) a longer-term focus, (3) a relatively high level of cooperative, interdependent behavior, (4) a moderate degree of concern for quality, (5) a moderate concern for quantity, (6) an equal degree of concern for process and results, (7)

> a greater degree of risk taking, and (8) a high tolerance of ambiguity and unpredictability.'(Schuler & Jackson, 1987, pp. 209-210).

Many of these qualities resemble characteristics of the individual themselves, such as creative behavior and interdependent behavior, while others demonstrate the individual's relation to the firm, such as interdependent behavior, and concern for quality and quantity. This reflects how an organization can influence the presence of idea champions both through human resource practices, as well as management of the environment.

Compounding on this idea Van de Ven references that idea champions generally work in an environment with moderate stress. This type of environment means that one is active, while also having enough slack time and resources to foster creativity and enable creation and decision making (Van de Ven, 1986, p. 597).

An environment such as this, with moderate stress and a connection to resources does not fully explain all positions. More senior positions, for example, are known as coming with a greater deal of stress, supposedly deafening innovative ideas. Thus there is a factor to where in an organization innovative ideas are found. Galbraith demonstrates that, "while ideas can come from anyone, anywhere, they tend to come from people at low levels of the structure who have direct contact with problems and try to solve them. . . [their] low status allows them to try new things since they have very little to lose" (Galbraith, 1983, p.8). This underlines the idea of innovation coming with a certain amount of risk, whether social or monetary. Being in a position where you have less to risk, and increases the likeliness of innovating. Furthermore, people at lower levels of the organization are uniquely connected in ways that those at the top might not be. Quinn finds that those at the lower areas of the organization are well connected throughout the organization, importantly with technical and marketing people, which Quinn finds is an effective attribute of innovative people (Quinn, 1985). This has logical value, as this position puts one both near to the end users through the marketing side, as well as those who are able to create an innovation through the technical side.

Beyond looking within a given organization for idea champions, a company can also look externally. Idea champions can be found throughout society. Galbraith discusses how an individual working as the head of business development would actively seek out idea champions in places such as research labs on the weekends, as individuals were investing their own time into their own ideas. The development manager would have the intention of investing in these ideas for hopes to bring them to fruition (Galbraith, 1983, p. 14).

4. Fostering Need Recognition

With regards to fostering need recognition, the focus is on two key relationships. First, the idea champion needs to be connected in some way to the disruptive event, and the information around that event. Second, the organization hoping to innovate needs to be connected in some way to the idea champion.

4.1 Idea Champion to Disruptive Event

When an idea champion connects in some way to a disruptive event which creates a need, he or she then brainstorms ideas for solutions to this need. This, as mentioned, is a very internal process which happens inside of the individual's mind. Although this process is internal to the person, an organization can have a positive effect on the efficiency of this process. One commonly used method is allowing slack, both with time and resources. Slack is allowing additional resources than what is necessary. When the resource allowed is time, an individual can focus on a project that he or she feels passionate about to try to create a solution. Additionally, when the resources are available to even create a test product, the individual may be even more motivated. A popular outcome of this method includes the well-known Post-its created by 3M. A company should try to determine the right balance of slack time, where too little results in a highly disciplined environment, and too much may result in careless exploration (Nohria & Gulati, 1997, pp. 603-610).

Furthermore, one can manage the environment around an idea champion towards trying to improve the creative process. A field of research is devoted to these "creative knowledge environments" which have the aim of increasing creative efficiency. This term encompasses various components, including task characteristics, group characteristics, physical environment, and organizational environment, among others. These environments surround the individual with physical and verbal cues to allow ideas to develop (Hemlin, Allwood, & Martin, 2004, pp. 1-7).

Another major area which can be managed is one of the components in these environments: people. A company can focus on which type of people they bring into the organization, focusing on those with greater creative capacity. Furthermore, filling the environment with creative capacity creates a synergy between the various creative people within an organization, as the environment is flooded with ideas. Mumford lists three key considerations for the study of creative though in individuals: knowledge, process, and work styles.

Hiring people with the right knowledge helps to ensure productivity in creating creative solutions. Mumford uses the words knowledge and expertise interchangeably, claiming that the longer a person is in a certain line of work, the more he or she grows a level of knowledge upon a steady foundation of though. He continues by claiming three benefits of knowledge in the context of solving problems, which include acquiring new knowledge quicker, better use of systematic problem solving, and combining ideas from previous solutions to new problems (Mumford, 2000, p. 314). The idea that the longer an individual works in solving problems, the more ideas and systems they will have from throughout the years in which they can apply to new problems, helping to streamline the creative process.

However, without a process, knowledge cannot achieve anything. The process in which an individual uses to generate ideas to solve a problem is a crucial component of creativity. A demonstration of a process would be how and how long a person spends defining a problem, finding relevant goals, key information, and other aspects of the problem. This could be followed with the individual reaching back to their internal knowledge base, reorganizing prior knowledge of systems, concepts, and information to create solutions. Mumford claims the internal process of solving problems to be the most important aspect to determining an individual's creativity, and claims that selecting people for their ability to combine creative concepts could be one of the most effective and simple human resources strategies for enhancing innovation (Mumford, 2000, p. 315-316).

The third component is work styles. How an individual behaves in the work environment and towards task completion can be a deciding factor in success idea creation. Such personality traits as how a person responds to judgment, how disciplines one is, how long they can pay attention, how easily one is distracted,, and much more all help determine whether or not an individual will be able to take what is inside his or her mind, and make it tangible (Mumford, 2000). Work styles may be more difficult to manage, given that everybody's work style is different and may not be immediately obvious. However, a manager can help by focusing on the work environment, as mentioned above, by doing such things as eliminating distractions. Also, creating certain cultures to encourage certain risk taking, and sharing of ideas can help improve how open one feels during the creative process.

4.2 Organizations to Idea Champions

As much as can be done to help an idea champion find his or her idea, if the organization does nothing to harness and evolve the idea to a workable concept, the idea will be lost and forgotten. In order to overcome this, the organization needs to achieve a level of interconnectedness between itself and the external environment, reaching past the boundaries that divide the various departments from each other and outward. **Figure 5** demonstrates these boundaries that exist within a firm.

While **Figure 5** is in the perspective of the R&D department, the boundaries exist just the same for the individual departments as well, as well do they exist during each phase of the innovation process. Within these boundaries, it can be assumed in many cases that much information and ideas are already shared. However, for an idea champion to succeed, it is necessary that he or she spans across these boundaries, reaching both the external market and the internal technicians within. It is also necessary to point out that not all idea champions are within an organization, but also from the outside labor market.

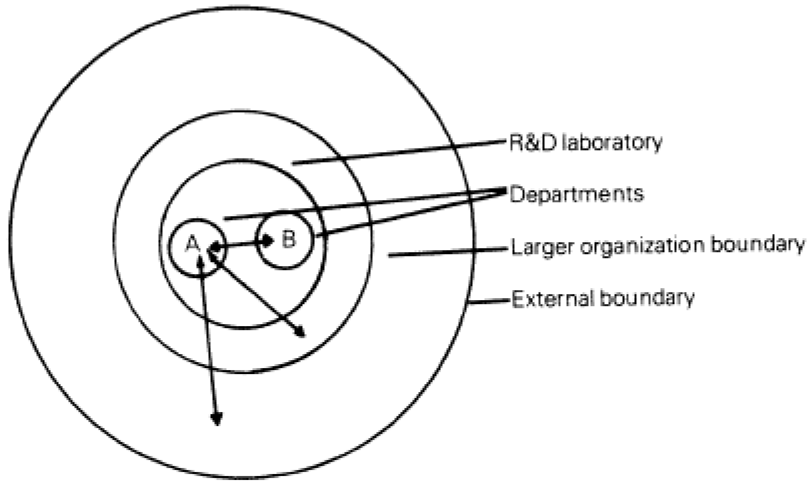

Figure 5: Organizational Boundaries. Retrieved from: Tushman, M. L. (1977). Special boundary roles in the innovation process. ***Administrative Science Quarterly*****, 587–605.**

4.3 Finding Idea Champions Within an Organization

There are many ways in which an organization can reach within itself to find the idea champions it has. Much researcher has noted that integrating the communication throughout an organization can have benefit results for innovation and idea creation (Rogers & Shoemaker, 1971). There are many ways in which an organization can increase organizational communication. A study by Laursen and Foss highlight many common human resource practices that share a positive correlation with innovation, including the presence of interdisciplinary workgroups, quality circles, employee proposal collection, job rotation, responsibility delegation, performance-related pay, and most especially internal and external training (Laursen & Foss, 2003, p. 253). Many firms with a focus on innovation select and implement some or all of these practices to supplement their innovative efforts, although the success of each may vary.

The most common innovative management practice is the use of cross-functional team (Rao & Drazin, 2002, p. 491). These teams consist of a small number of employees from different functional areas within the organization, guided by managers of project leaders, and which are brought together to achieve a specific purpose (Webber, 2002, p. 201). As this explanation suggests, a cross functional team is for short-purpose projects, such as overcoming temporary problems or accomplishing individual tasks. As companies want to pursue an innovative idea, this is means to include representatives from various areas within the organization.

As can be imagined, the selection of which individuals to include in these cross-functional teams is paramount. Cohen and Levinthal underline the importance of choosing the correct degree of diversity for this type of team, stating, "While some overlap of knowledge across individuals is necessary for internal communication, there are benefits to diversity of knowledge structures across individuals that parallel the benefits to diversity of knowledge within individuals" (Cohen & Levinthal, 1990, p. 133). Therefore, while it is necessary that diversity exists within a team, there also needs to be a certain level of communality between people to help intercommunication of ideas.

Aside from various teams and coordination practices a manager can pursue, a more permanent innovative focus is altering an organization's structure. There are various ways to pursue and think about organizational structure. One dimension to consider is structural archetypes. These archetypes describe an organization's makeup of skills, centralization, size, and market type. Mintzberg describes six such types of organizations, their key features, and the implications on innovation:

Organization Archetype	Key Features	Innovation Implications
Simple structure	Centralized, small, quick to respond to changes, clear purpose, limited resources.	Highly creative, simple and focused. Weaknesses in long-term stability and growth, and overdependence on key people.
Machine bureaucracy	Centralized, designed like a complex machine, organized by function, interchangeable parts. Ability to handle complex integrated processes.	Depend on specialists for innovation, mass production capability. Stable, capable of handling complex tasks. Often rigid and inflexible.
Divisionalized form	Decentralized organic form designed to adapt to local environmental challenges. Larger organizations with semi-independent units.	Generic innovation carried out centrally, while specific work carried out within the divisions. Able to develop competency in niches, and share knowledge. Pulls away from centralized R&D.
Professional bureaucracy	Decentralized mechanistic form. Power with individuals, coordinated by standards. High levels of professional skills. Specialist teams.	Typifies design and innovation consulting activity within and outside organization. High technical ability and standards. Difficulty of management

Adhocracy	Project type of organization, designed for instability. Highly flexible, usually short-lived. Team-based, with high individual skill. Minimal rules and structure.	Associated with innovative project teams. High creativity and flexibility. Lack of control and possible over-commitment to the project.
Mission-oriented	Shared common values. Held together by commonality between members. High commitment and individual initiative. Shared goal.	Requires energy and a clearly articulated sense of purpose. Quest for continuous improvement. Overdependence on key visionaries.

Table 1: Mintzberg's Structural Archetypes. Summarized from: Tidd, J., Bessant, J., & Pavitt, K. (2002). Managing innovation: integrating technological, market and organizational change (4th edition). West Sussex, England: John Wiley & Sons.

Another structure worth mentioning is the concept of a matrix structure. Matrix structures were initially developed for the purpose of fostering innovation. Kanter explains that with this structure:

> 'mid-level employees report to both a project boss and a functional boss, force integration and cross-area communication by requiring managers from two or more functions to collaborate in reaching a decision or taking some action.' (Kanter, 2000, p. 177)

The nature of such a structure forces interdisciplinary collaboration, as a given manager oversees multiple departments simultaneously, and must work with another manager who oversees multiple employees. Through this collaboration is essential to success, and linkages throughout the organization are greater.

There are various considerations when deciding which structure to strive for. Tidd and Bessant highlight a few such considerations, stating as an example, "less programmed and more uncertain the tasks, the greater the need for flexibility around the structuring of relationships. . . but others require judgment and insight and vary considerably from day to day" (Tidd et al., 2009, p. 106). This underlines that not all structures are beneficial for all types of organizations. An organization can reference these various structures to adapt them to their needs and help guide their innovation efforts.

Creating and managing an organization that is interconnected and where ideas are shared is crucial. Beyond this, these ideas need to eventually find their ways to those who make the approving decision to continue with them. Many ways are possible to do this, and Galbraith discusses one great strategy employed by 3M to generate business ideas internally, in which employees volunteer to share their ideas through an internal trade show. Galbraith explains, "just as managers go to trade shows. . . they can also go to an internal fair where booths are created by [idea] champions to display their ideas" (Galbraith, 1983, p. 14). This practice allows and motivates creativity in an organization, giving employees a platform to try to reach the next stage in making their innovation a reality. The options available to an organization to foster and promote idea generation internally are limited only by the creativity of those in the organization.

4.4 Finding Idea Champions from the Outside

Beyond looking within a given organization for idea champions, a company can also look externally. Idea champions can be found throughout society. As Rao and Drazin point out, "surveys of practitioners have indicated that recruiting talent from competitors is the second most frequently used method, after use of cross-functional teams, for promoting product innovation" (Rao & Drazin, 2002, p. 491). The use of outside talent can be an alternative to building knowledge internally, and instead adopt an individual's knowledge and skills obtained from outside the organization, and possibly from competitor firms.

A large body of research notes that the acquisition of ideas and people from outside of the organization is the most effective innovative practice a firm can use, showing that most of all innovations occur in this way.(Cohen & Levinthal, 1990, p. 128). Thus, the method of finding individuals from outside of the organization very quickly connects an organization to this outside knowledge.

There are many ways in which an organization may seek to recruit external talent. Some most obvious ways include traditional hiring and recruiting practices, but external idea champions can also be actively sought. Galbraith discusses how an individual working as the head of business development would actively seek out idea champions in places such as research labs on the weekends, as individuals were investing their own time into their own ideas. The development manager would have the intention of investing in these ideas for hopes to bring them to fruition (Galbraith, 1983, p. 14). This example shows that business leaders can look towards those areas in which the idea champions are found working on their ideas, instead of waiting for one to apply.

Aside from the external labor supply, an organization can reach out to another organization in order to create a type of innovation-based alliance. Doz and Hamel typify four such types of alliances that a firm can establish to pursue innovation: co-specialization alliance, co-specialized competence leverage network, internalization alliance, and a competence acquisition network (Doz & Hamel, 1995, table 1). **Figure 6** demonstrates the characteristics of these four alliances.

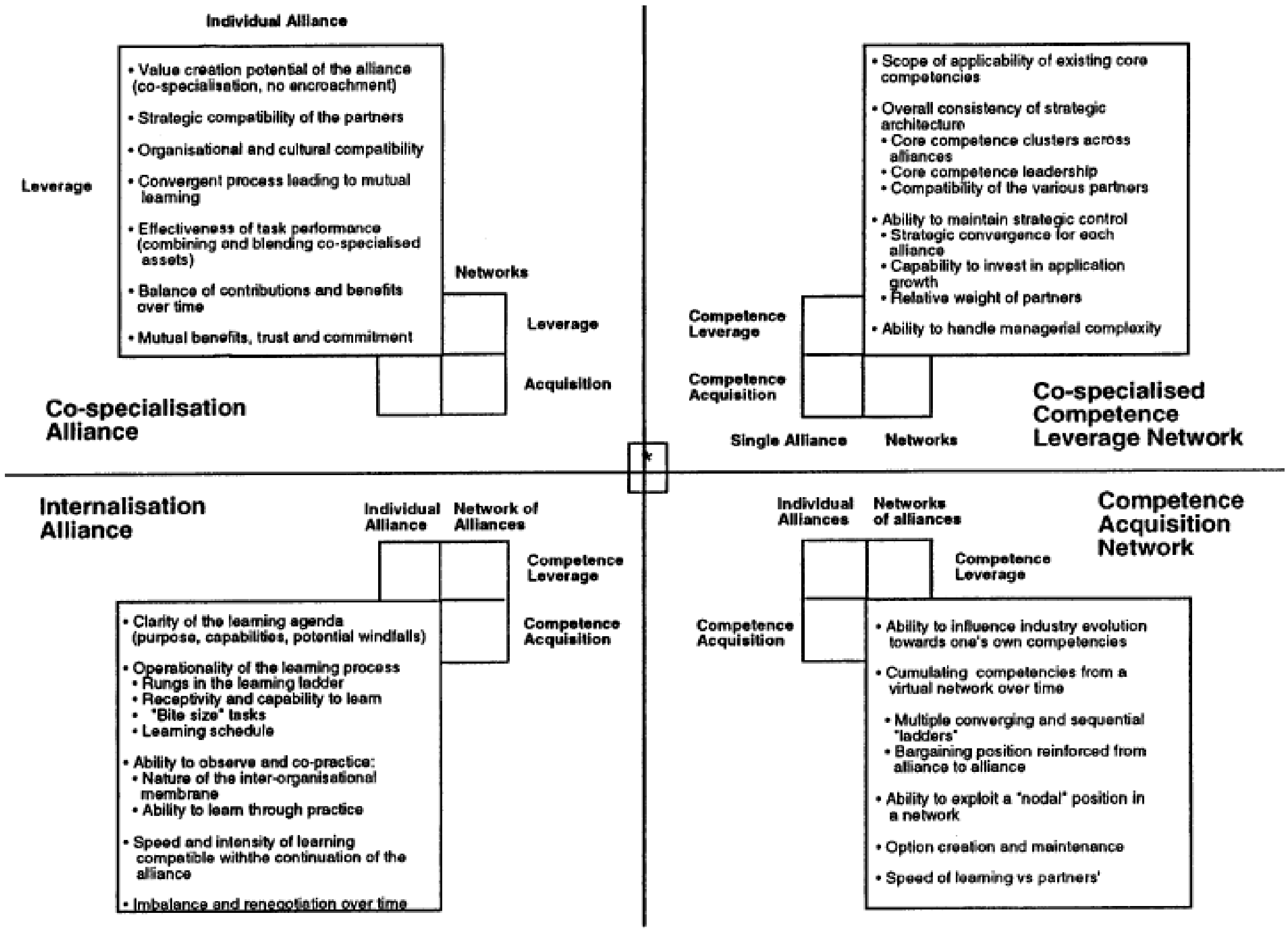

Figure 14: Typology of Technology Alliance Management Issues. Retrieved from: Doz, Y. L., & Hamel, G. (1995). The use of alliances in implementing technology strategies. INSEAD. Retrieved from https://flora.insead.edu/fichiersti_wp/inseadwp1995/95-22.pdf

Figure 6 is organized with individual alliances on the left, network alliances on the right, leverage of competence on the top, and acquisition of competence on the bottom. As can be seen, the benefits of these types of alliances can exceed just sharing ideas and brainpower, but in turn allow inter-organizational resource sharing and commercialization in the later stages of the innovation process.

5. Coalition Building

Coalitions form for the general purpose of gathering the aforementioned factors necessary in order to move an idea towards implementation. These factors can have either a political purpose, for getting the right permission from the necessary parties, or technical purpose, for finding the technical requirements to create an actual solution (Kanter, 2000, p. 187). Many innovations may require the combined effort of many departments working together on certain tasks. Thus, the more complex the innovation, the wider technical network the innovation will require.

Findings from a large group of coalitions show that membership ranged anywhere from six to several hundred members from diverse backgrounds. In not one of these coalitions did the membership exceed 25 percent from any one type of organization, such as religious, advocacy, social service, grassroots, or others. Furthermore, this membership stayed consistent for the vast majority. In this study, coalition formation took place a range of reasons, including constituent empowerment, social and economic justice, education, and others (Mizrahi & Rosenthal, 2001).

Furthermore, a coalition can form from more than one group of stakeholders. As seen above, many coalitions form beyond functional, organizational, and even industry boundaries. However, even beyond innovations from these various producers, the end user is often exploited in the coalition building process. Strong support from this group can be used as an incentive to management, partners, and others to partake in the innovation process to help an idea become realized (Baldwin & Von Hippel, 2011, pp. 3-5).

5.1 The 3 “Power Tools” to Coalition Building

Once an idea champion has recognized an idea, he or she then must attain the support to bring the idea to fruition. This support can come from various sources and in various forms. However, it is not necessarily as important from whom the support comes from than in what form. Kanter acknowledges three commodities, or “power tools” that can further the progress of a new idea: information (data, technical knowledge, political intelligence, expertise); resources (funds, materials, space, time); and support (endorsement, backing, approval, legitimacy)" (Kanter, 2000). For an idea champion, having access to these commodities is the difference between having the idea heard or letting it die.

5.1.1 Information

Access to information is crucial throughout the innovation process, although differing somewhat in each stage. The first source of information is identical to as mentioned in the prior section. Idea champions need to be connected to pools of information located internally to the organization, as well as externally. The organization needs to be structured in a way in which ideas and relationships flourish. The more exposure to different problems, solutions, needs, ideas, and so forth, will improve innovation will flourish.

The difference in information in this stage, however, is not towards the disruptive event in itself, but rather information regarding the company. Innovative ideas require support and resources from multiple areas in the organization, and certain information often needs to be gained from these areas to see if the innovation may be feasible. As Kanter discusses, the ability to freely communicate important information can be a serious determinant in innovation. She explains in her research that many innovative managers found the lack of information sharing to be the most common roadblock in their innovation efforts, while in more of a quarter of the cases, cooperation between the given departments was crucial for their innovation efforts (Kanter, 1984, p. 160). Thus, being able to connect with the stake holders and key parties within the organization can be a large determining factor to the innovation's success.

5.1.2 Support

Once an idea champion has this information, he must recapitulate it in a way that will be able to sell the idea to potential supporters. This information gained in the need recognition stage will need to be articulated in a way that will convince the interested parties to buy-in to the idea. While this information many would think has a lot to do with the expected value of the idea, the real factors to idea acceptance differs notably. Kanton notes the more salient of the determining factors to idea acceptance:

> 'The most salable projects are likely to be trialable (can be demonstrated on a pilot basis); reversible (allowing the organization to go back to pre-project status if they do not work); divisible (can be done in steps of phases); consistent with sunk costs (build on prior resource commitments); concrete (tangible, discrete); familiar or compatible (consistent with a successful past experience and compatible to existing practice); congruent (fit the organization's direction); and have publicity value (visibility potential if they work). . . marginal (appear off-to-the-side-lines so they can slip in unnoticed) or idiosyncratic (can be accepted by few people with power without requiring much additional support.' (Kanter, 2000, pp. 185-186).

These characteristics fall in with a level of risk and change aversion, where the ideas that cause the least change and seem to have the least risk are those most likely to be accepted. Therefore, information of value is less valuable than information of security when selling an idea.

5.1.3 Resources

Once an idea is supported, the supporting parties will come together to acquire the resources to work to implement the idea. Research suggests that the acquisition of these resources is dependent on both internal and external conditions. Internal considerations include those such as profitability, riskiness, effectiveness, and other performance and quality factors. Meanwhile, external conditions may include buyer and supplier power, intensity of competition, and other industry attributes (Oliver, 1997, p. 698). Factors such as these may be considered on an individual or group basis to determine the buy-in of interested parties who may be interested in investing their own money into the projects, as many coalition members often do (Mizrahi & Rosenthal, 2001).

Beyond idea effectiveness, profitability, and other such considerations, the internal coalition buy-in is highly dependent on individuals' feelings about the idea, stakeholders, and their role in the coalition. They need to believe that cooperation is necessary and valuable, and that the projects benefits outweigh the costs (Foster-Fishman, Berkowitz, Lounsbury, Jacobson, & Allen, 2001, pp. 248-249). These considerations are key to the possibility of acquiring member resources such as time, money, knowledge, and much else.

6. Fostering Coalition Building

The focus when fostering the coalition building stage of innovation is on making available the various power tools to the idea champions. Information, support, and resources need to be able to be easily found and accessed by those with a winning idea.

One focus is on elimination of structural communication boundaries to pursue open communication throughout an organization. However, many of these boundaries are put in place for increased efficiency in operations. Findings suggest that while in more stable environments, communications boundaries might save time from inefficiencies, allowing employees to focus more on inefficiencies, a more organic structure allows greater innovative performance in more dynamic environments (Puck, Rygl, & Kittler, 2007, p. 233-234).

Another method for fostering the coalition building phase internally is to make those resources necessary to build a coalition more available throughout the organization. Galbraith recommends a separate funding that is spread throughout the organization. As an idea champion has an innovative idea, he or she would not have to climb the organizational structure to the top in order to reach the funds necessary to implement the idea. Instead, if funds are set aside throughout the organization to middle-level managers, the idea champion who is often found in the lower echelons of the organization does not need to look far to get the support he or she seeks (Galbraith, 1983).

In an inter-organizational view, the previously mentioned focus on partnerships and alliances are a way not only to get information about various disruptive events, but also help fuel other stages of the innovation process with ideas, resources, and support (Goes & Park, 1997, p. 677). Studies suggest the benefits of having semi-formalized networking alliances in forms of influencing innovative behavior. Galaskiewics and Wasserman explain how this work:

> By tapping those in their networks, managers learn about options and strategies that they themselves might adopt. The sociological literature on social contagion has extensively documented how ideas, information, and technology (or know-how) spread throughout a population via social networks. . . The assumption is that actors will first exchange information and then one will persuade the other to "give it a try." (Galaskiewicz & Wasserman, 1989, pp. 455-456)

The resources gained from these types of partnerships exceed simply information and technology, but the social support that is key in the cumbersome task of coalition building.

Many more areas can be explored; however, the main purpose in this stage is the acquisition from information, resources, and support from internally, through organizational networks, and the end consumer. Connecting an idea champion to these helps those idea champions begin the implementation stage.

7. Implementation

Once the stakeholders and interested parties gather into a coalition, and the task is approved, or at least not yet denied, the innovation is sought to be implemented. This stage may be known by various names, including the choosing stage, executing stage, or R&D stage. Nonetheless, the main purpose remains the same: exploring and selecting the most suitable response to the disruptive event, and ensuring they align with the overall organizational strategy and resource availability. The end result in this stage is a solution to the perceived need identified in the first stage.

As Tidd and Bessant explain, “at the early stages there is high uncertainty . . . but gradually over the implementation phase this uncertainty is replaced by knowledge acquired through various routes and at an increasing cost” (Tidd et al., 2009, p. 81). Thus this stage can be seen as both a clarification of the problem, and an assessment as to if the organization should address the problem, and how. Tidd and Bessant continue, claiming this stage to have three distinct parts: acquiring knowledge, executing the project, and launching the innovation (Bessant & Tidd, 2011, p. 82).

7.1 Acquiring Knowledge

As in the previous stages of the innovation process, information leading to knowledge is of great importance in the stage of implementation. It is, in effect, the knowledge capabilities of the parties involved in the innovation that determine the outcome in the implementation stage. An organization uses their existing internal knowledge, as well as absorbs external knowledge, in order to decide on a potential solution to the need. This knowledge is attained, then eventually transferred to the development stage, where a proposed solution is further tested to test plausibility. If a project

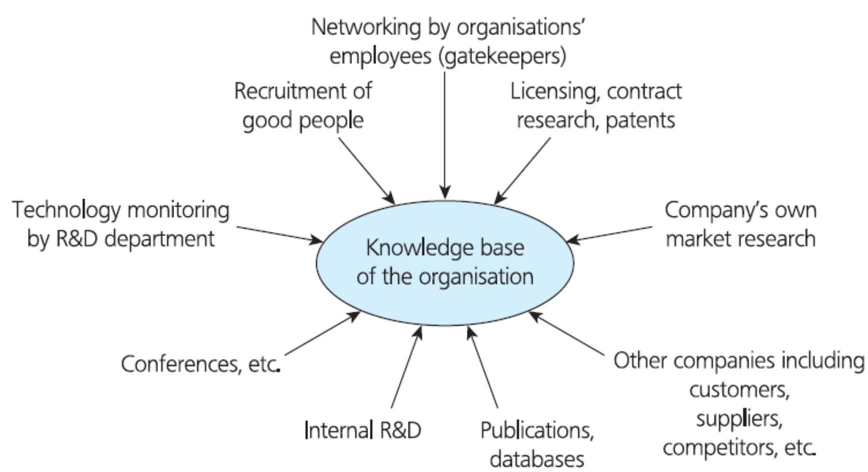

Figure 715: Knowledge Base of the Organization. Retrieved From: Trott, P. (2008). Innovation management and new product development. Pearson education. Retrieved from: http://books.google.es/books?hl=en&lr=&id=9hv4GqUq1E0C&oi=fnd&pg=PR17&dq=trott+ innovat

is found implausible, the project team then returns to the information gathering stage to be improved or abandoned (Tidd et al., 2009, p. 82).

The knowledge attained by the organization can come from a various number of sources, as exhibited in **Figure 7** above. Internal focuses such as recruitment (as discussed earlier), R&D, employee networking, and conferences all help build organizational knowledge. Likewise, external factors such as technology monitoring, market research, database searches, research on patents and licensing, as well as contact with customers, suppliers and competitors are all strategies for attaining knowledge from outside the organization to bring in.

These sources of information can be used to answer a number of key questions, such as what the current and future customer needs, which trends and technological developments are going to have an impact on the business, what might be promising avenues for new solutions, and so on (Luthje, Lettl, & Herstatt, 2003). The organization attempts to answer all relevant questions regarding the discovered need in order to establish an understanding of the quality factors of the solutions they will propose in the following stages.

7.2 Execution of the Project

Once the working group decides they have sufficiently understood the problem, a solution is then proposed to be executed. Trott explains the three components to a proposed solution, which include form, technology, and need:

- Form: This is the physical thing to be created (or in the case of a service, the sequence of steps by which the service will be created). It may still be vague and not precisely defined.
- Technology: In most cases there is one clear technology that is at the base of the innovation (for the 3M Post-It it was the adhesive; for the instamatic camera it was the chemical formulation which permitted partial development in light).

- Need: The benefits gained by the customer give the product value.

Each of these three components are involved in innovative concept developments, although often in different strengths depending on the innovation in question (Mascarenhas, Kesavan, & Bernacchi, 2004, p. 490).

Once an innovation's form, technology, and need are decided, it is then to be sent through a series of screens to test its market viability. A series of proposed solutions are first skimmed through, eliminating those with obvious problems, such as poor strategic alignment, clear technical infeasibility, etc. The remaining solutions may be discussed with potential customers who provide feedback and give insight to market receptiveness. Furthermore, technical personnel will perform a more detailed screening to ensure the idea is plausible. Finally, a more comprehensive screening will take place, weighing in factors such as potential returns on investment, potential marketing plans, manufacturing planning, and other factors necessary to consider the idea's full business integration (Trott, 2008, p. 489-490).

7.3 Launching the Innovation

While in some instances, the innovation launch is defined similarly to market diffusion, in this case it is referred to as the last screening process to test the potential of an idea. This stage involves the creation of a prototype of the innovation which is to be tested in the market, to see if it is ready for diffusion. The first objective is to create a prototype of the innovation, followed by the second objective, which is to test it.

A prototype is when the proposed solution is created into a finite form, or tangible good. Depending on the number of proposed potential solutions, many prototypes may be made and tested. (Trott, 2008, p. 491). This allows the organization to have something that is able to be brought to the end user, or testing stages in order to further approve the idea.

Once a prototype is available, the next step is to perform a market test. This stage may be done conjointly with various departments, including marketing, R&D, and others (Dougherty, 1992, p. 198). The result is to bring the prototype to the market in order to receive feedback from the end user. The effectiveness of this stage is contentious. Some argue it is necessary to gain the insight from the end users, while others claim that if an innovation has come this far, it is necessary to go ahead and launch it. Studies show that soliciting user feedback actually stifles innovation and organizational performance in the long-run (Trott, 2008, pp. 492-493).

The academic literature also explains many difficulties in this stage, such as unsuitably designed prototypes, new technical knowledge required for adoption, detachment between decision makers and end users, required paradigm change for adopting the innovation, insufficient investment, and the premature abandonment of the idea. Due to these and other reasons, nearly 50% of innovations tend to fail during this stage (Klein & Sorra, 1996, p. 244).

8. Supplementing the Implementation Stage

The goal in the implementation stage is to create a product that is ready and appropriate for the market. The result should be something that the end user accepts and embraces. To help link the need recognized to a suitable solution, a working team combines knowledge and creativity to help construct a solution. Thus, a team assigned to the innovation must contend with the challenges of remaining sufficiently isolated as to avoid interrupting creativity, while interconnected enough to have access to the correct information.

Once a coalition is formed, and the team begins to find a solution to the found need, there is a strong need to isolate the team to avoid interruptions in the innovation process. Galbraith explores four ways in which an innovation development team may be able to separate themselves:

1. Physical Separation: Creating or dedicating a separate area in which the team can locate, such as their own floor, building, trailer, etc., distancing the team from many of the typical disruptive.

2. Structural Separation: Separating the development from normal operations, allowing their full focus to be on developing the project, without interruptions from requirements from their traditional roles.

3. Separate Funding: Creation of separate funding streams exclusively for investing into the innovation process.

4. Separations from Control Systems: A distancing from traditional systems used to monitor certain factors such as efficiency, and cost effectiveness. Separation from control systems allow for the trial and error that is generally required for creativity and developing new innovations. (Galbraith, 1983, pp. 9-11)

An organization may separate themselves from the innovative teams through any of these individual methods, or using multiple, or all.

However, while isolation is important when developing the idea, certain connections outside of the working team need to be considered. Foremost, while the working team may constitute a diverse background of work areas, they are not likely to have all the necessary technical information, information about the end user, market conditions, or a range of other fields. Furthermore, their stage of the innovation process is directly before a market launch stage, in which the team will need to hand over their efforts to the rest of the organization, who will bring the product to market. Therefore, coordination needs to be made between this team and the groups necessary in the following stage (Ancona & Caldwell, 1990, p. 2).

In order to facilitate this communication without jeopardizing isolation, certain boundary spanning roles needs to be in place. There are four such boundary spanning roles, as defined by Gladstein and Caldwell:

1. Scouts: bring in information or resources needed by the teams

2. Ambassadors: Carry out items that the group wants to transmit to others

3. Sentries: Control the transactions that occur at the boundaries, deciding how much can come in

4. Guards: Control how much leaves the group. (Gladstein & Caldwell, 1985)

These four roles control the flow or information into, and out of the innovating organization, which helps bring in essential resources and information, while also coordinating with the organization for when the product launch is to come. Furthermore, these roles help protect the innovation from potential competitors learning and replicating the innovation team's work (Kanter, 2000, p. 192).

Furthermore, Kanter mentions two other important consideration for innovation teams: continuity and flexibility. Continuity is a way of ensuring the information gained throughout the process is not lost with the individuals who come and go. The team and organization should work to maintain the individuals who have been involved with the innovation, as to not lose the insight they may have gained throughout the process. Also, the work team must be flexible. They are creating an innovative change in a moving market that is constantly changing. Their efforts might be obstructed by change, bureaucracy, or a range of other factors. These teams must avoid conventional structures, rules, and approval processes which slow the innovation task (Kanter, 2000, pp. 194-197).

9. Innovation Diffusion

Once the innovation team has decided on the final output, the last stage is to diffuse the innovation to the market, or end users. This is the point in which the innovation team begins to dissolve, and the innovation spreads among members of a social system (Rogers & Shoemaker, 1971). This social system is typically the targeted market and end users of a given innovation. Mahajan and Peterson explain that innovation diffusion involves seven elements: "the innovation itself, adopters of the innovation, innovation channels, time and space, change agents, and the social system" (Mahajan & Peterson, 1978, p. 1589). I would contend an eighth element should come between the innovation and the adopters, which is the innovating organization, although this may be considered as part of the social system.

While an organization is not always necessary for an innovation, many intentional innovations involve an organization and transference between it and an innovation team which it employs. This transfer from an isolated innovation team towards full organizational cooperation may or may not be difficult, depending on many factors. One such factor is how closely the team had been working with the organization through the innovative process. As mentioned, it is important for the innovation team to work in isolation, but at the same time coordinate their efforts with the necessary parties in the organization. Generally, the less coordination that was had in this previous stage, the more difficult it will be to transfer the technology back to the operating organization. Likewise, the more separate the innovation will be carried out from the general organization, the easier this stage will be (Galbraith, 1983, p. 11). Nonetheless, transference to the appropriate individuals and departments is fundamental if the innovation is to successfully be brought to the market.

Once the general organization has the innovation, the next step is to communicate the innovation to the market or end user, in order to convince of its use. This can be done through various communication channels. There are two broad categories of communication channels: interpersonal and mass media. Interpersonal channels involve the direct communication between two distinct parties. This may be through phone calls, meetings, email, or any other direct communication. This type of communication is typically more effective to late-adopters of the technology, which personal persuasion helps to influence, as will be discussed. The second type of communication channel is mass media, which is third party channels, such as radio, newspaper, commercials, and so on. This is generally the more effective way to reach early-adopters, who are generally more willing to take on change (Steven, 2007, p. 42).

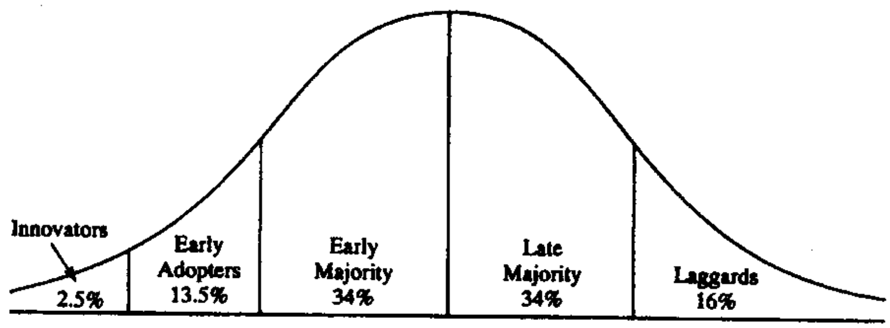

Figure 816: Innovation Adopter Categories. Escobar-Rodríguez, T., & Romero-Alonso, M. (2013). The acceptance of information technology innovations in hospitals: differences between early and late adopters. *Behaviour & Information Technology*, (ahead-of-print), 1–13.

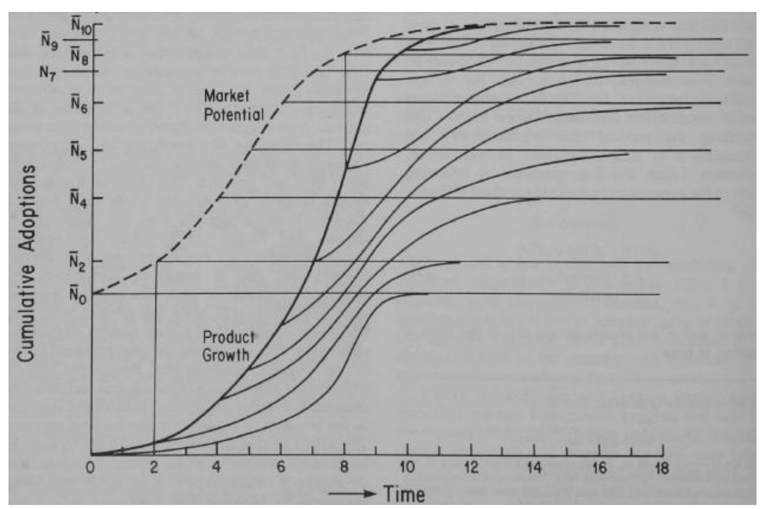

Figure 9: Innovation Adoption Rate. Mahajan, V., & Muller, E. (1979). Innovation diffusion and new product growth models in marketing. *The Journal of Marketing*, 55–68.

The goal of communication channels is to eventually penetrate a given market, and have a successful adoption of the innovation. **Figure 8** demonstrates the general population which adopts the innovation. This demonstrates five distinct groups which adopt the innovation: the innovators, early adopters, early majority, late majority, and laggards. The innovators are typically those involved most directly with the innovation, and therefore encourage its adoption and use. The early adopters are characterized as highly open to innovation adoption, and highly adept at change. Passing this group are the early majority, late majority, and laggards, which respectively are more and more hesitant to adopt the innovation. Between the early adopters and early majority resides a chasm of adoption, in which pushing the innovation past the early adopters proves to be the most difficult bridge between groups to cross, and is essential in successful innovation diffusion (Escobar-Rodríguez & Romero-Alonso, 2013, p. 44). Furthermore, **Figure 9** demonstrates the adoption rate of a range of innovations. As can be seen, in the earlier stages of the innovation's diffusion, adoption is slow, as the adoption categories are the smaller innovator and early adopter groups. However, as the chasm is crossed, and the majorities begin adopting the innovation, there is a rapid increase in the rate of adoption, until later in the innovation in which the laggards are the only group left to adopt.

11. Facilitating Innovation Diffusion

As mentioned, the first important consideration in the diffusion of innovation is the transference from the innovation team to the areas of the organization which will be involved with its diffusion. Therefore, the proximity in which the innovative team works with the organization will be a large contributing factor to how well the innovation is transferred to the organization. For the projects that have more distance from those that will be involved in the diffusion stage, certain bridging structures should be adopted to help with this process. Such structures include working closely with management, a separate internal transferring group who specializes in such tasks, or even involving third party actors for this process (Kanter, 2000, pp. 201-202).

Aside from proximity, the general openness of the organization's activities is a big consideration. As the parties that will become involved are able to see the progress, and think of the implications, they will plan and prepare for the changes. Openness may result in client feedback throughout the innovation process as to improvements or suggestions. Involving them in these stages increases the adoption in the diffusion stage, as the end users become more aware and involved in the innovation.

12. Stage-Based Model for Fostering Innovation

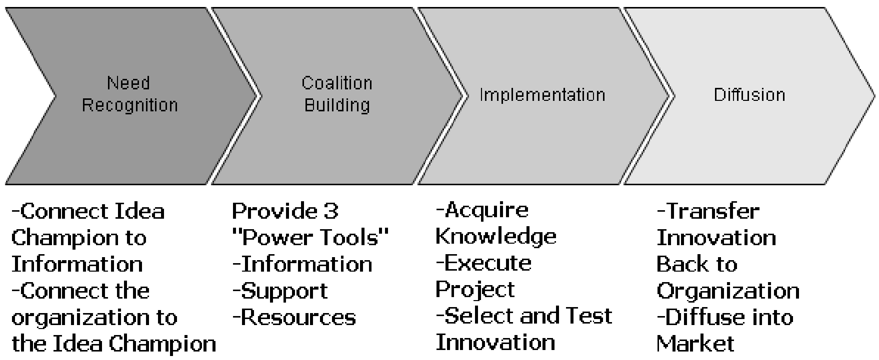

Figure 10: Underlying Goals for Fostering Innovation

Previous sections outline the various stages of innovation that are within an organization's control. With this foundation, the model shown in **Figure 10** has been created to summarize these steps into a comprehensive whole. This model demonstrates the underlying goals of innovative practices in each of these stages. With these goals, the wide subject matter of innovation theory has been made into clear goals to which technologies can strive to fulfill. By fulfilling these goals, a firm is able to build on established innovation practices with new solutions. This can be further simplified by outlining provoking questions regarding our innovation theory, in which we will see if cloud computing is able to answer.

As demonstrated in **Figure 10**, the first stage, Need Recognition, has two underlying goals. The first is to connect the idea champion to the pool of information about disruptive events. The second is connecting the organization to the idea champion. The resulting questions are: *How can cloud computing help idea champions connect to information about disruptive events?* And; *How can cloud computing help connect the organization to idea champions?*

In the Coalition Building stage, the underlying goals include providing the idea champion the three "power tools" from the organization: Information, Support, and Resources. The resulting questions are: *How can cloud computing help provide information to the idea champion? How can cloud computing help provide support to the idea champion?* And; *How can cloud computing help provide resources to the idea champion?*

During the implementation stage, the underlying goals include acquiring knowledge about the problem, executing the project, and selecting and testing a final solution. The resulting questions are: *How can cloud computing help with acquiring knowledge about the problem? How can cloud computing help with project execution?* And; *how can cloud computing help select and test a final solution?*

Lastly, in the Implementation Stage, the underlying goals are transferring the innovation back to the organization, and diffusing the final solution. The resulting questions are: *How can cloud computing help transfer the innovation back to the organization?* And; *how can cloud computing help diffuse the innovation.* A chart of these questions can be found in **Table 2**.

Need Recognition	*How can cloud computing help idea champions connect to information about disruptive events?*
	How can cloud computing help connect the organization to idea champions?
Coalition Building	*How can cloud computing help provide information to the idea champion?*
	How can cloud computing help provide support to the idea champion?
	How can cloud computing help provide resources to the idea champion?
Implementation	*How can cloud computing help with acquiring knowledge about the problem?*
	How can cloud computing help with project execution?
	How can cloud computing help select and test a final solution?
Diffusion	*How can cloud computing help transfer the innovation back to the organization?*
	How can cloud computing help diffuse the innovation?

Table 2: Questions Asking How Cloud Computing Can Innovate

By answering these questions with the cloud computing case studies, three tasks can be accomplished: confirm the validity of the model, demonstrate realized cases of how cloud computing has fostered innovation, and identify potential areas in where cloud computing may be able to further assist innovative efforts.

Chapter 3

Cloud Computing

1. Cloud Computing

Cloud computing is defined by the American National Institute of Standards and Technology (NIST) as, "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Clohessy, Acton, & Coughlan, 2012). An important distinction from this definition is that cloud computing is not necessarily a specific technology, but rather a model created through technology.

The cloud computing model is described by Clohessy, Acton, and Coughlan as having three base layers, as demonstrated in **Figure 11**. The bottom layer consists of five essential characteristics of cloud computing, including broad network access, rapid elasticity, on-demand self-service, measured service, and resource pooling. The middle layer shows the four different deployment models of cloud computing, which include public, private, hybrid, and community clouds. The uppermost layer shows three service models found in cloud computing, such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (Clohessy et al., 2012, p. 33). This model provides a strong framework for a more holistic look into cloud computing through exploring each of the individual components.

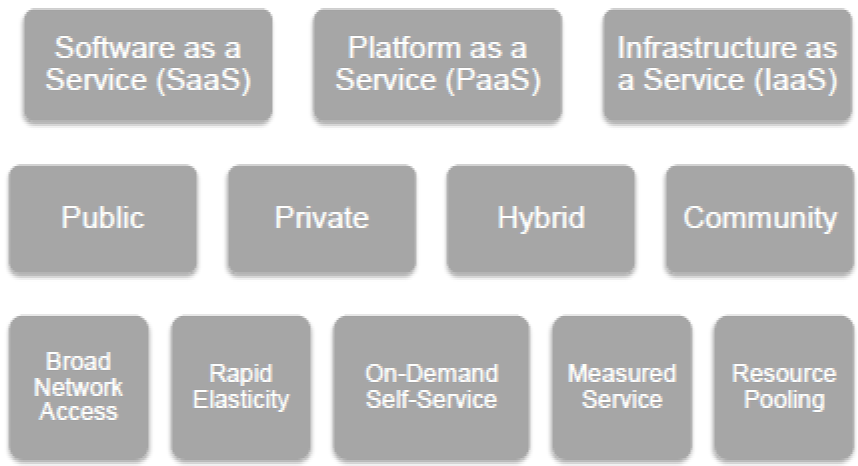

Figure 11: The 5-4-3 Model of Cloud Computing. Retrieved from: Clohessy, T., Acton, T., & Coughlan, C. (2012). Innovating in the Cloud. *International Journal of Innovations in Business*, *2*(1), 29–41.

1.1 Five Essential Characteristics

The essential characteristics layer explains five attributes which can be found in cloud computing, which includes broad network access, rapid elasticity, on-demand self-service, measured service, and resource pooling. As Clohessy and Acton note, "the manifestation of these 5 characteristics in an organization is largely dependent on the deployment model utilized" (Clohessy & Acton, 2013, p. 424). Therefore, while all generally are present in any given cloud solution, they exist in different degrees.

1.1.1 Broad Network Access

NIST describes broad network access, explaining that "capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations) (Mell & Grance, 2011, p. 2). This explains that the services from a cloud computing provider can be accessed remotely through various devices.

In a traditional IT structure, information is usually accessed from the server located within the organization. Therefore, any workstation not connected to this server is not able to access the information, and software. Since cloud computing uses internet to access a virtual server, it does not necessarily matter where a given workstation is located, as long as it has reliable access to the internet (Wang et al., 2010, p. 142).

The ability to access all of one's necessary information can have a wide range of benefits. For example, if an individual saves a document on their worktop computer, or server, and decides they need it when they are not at that computer, or within that network, they are able to access it from the nearest device they can find, as long as it is compatible with the cloud in which the document is saved. Or, an individual who may realize on their way home from work that they needed to make a change to a certain document, they would not need to drive back to work, but instead just fix it from their personal device when they get home. As mentioned, the cloud services can be accessed through various devices, such as thin and thick clients, as well as mobile devices.

Thin clients include those devices without hard drives, or DVD-ROMs, whose purpose is to serve as an interface for the user to interact with information presented on the device, but stored elsewhere. For this reason, thin clients have a high level of security, in that information is not kept on the device itself, but through the network in which it is located (Velte, Velte, & Elsenpeter, 2009, p. 92).

Thin clients on the other hand, as the name suggest, are thicker. It is important, however, to assert that a device is not simply either thin or thick, but rather fall on a continuum between thinness or thickness. Satyanarayanan explains this by stating that "thick clients tend to be larger, heavier, require a bigger battery, and dissipate more heat" (Satyanarayanan, 2001, p. 6). So while thin clients generally have less hardware such as memory, DVD-ROMs, and others, thick clients are considered thicker with the additional technology built-in. While thin clients hold no internal memory, thick clients do. Even still, thick clients can still connect to networks in the same way (Velte et al., 2009, p. 9).

The third type of client is mobile. While mobile clients lie somewhere between thin and thick client, they are distinguishable in their portability, and include such things as smartphones, laptops, and PDAs. These clients are typically used less for information entry than for information access while on the go (Velte et al., 2009, p. 92). The availability of the various clients in an employee's workplace, home, and commute means an increased availability of the individual's work-related data, which enables greater levels of interaction.

1.1.2 Rapid Elasticity

NIST explains that rapid elasticity means "capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time" (Mell & Grance, 2011, p. 2). This idea of elasticity demonstrates that cloud services are scalable.

Scalability has long been an important technological issue. With the advent of grid computing, a step forward was achieved with the scalability of working nodes. Now with cloud computing, companies are able to scale their virtual hardware resources as well (Vaquero, Rodero-Merino, Caceres, & Lindner, 2008, p. 54). In other words, with cloud computing, an organization has access to extremely high levels of computing power at the times that they need.

This computing power comes from the cloud holder's cloud infrastructure. This is basically a highly securitized bunker holding multiple servers, backup devices, etc. The organization accesses this through the use of the internet, and the organization pays for the services on a usage-based system. Therefore, at peak hours, when the organization has requirements for more computing power, it is available. And when the organization needs very little, they will still only pay for what they use. On the other hand, in the traditional model, a company would need to purchase enough equipment to meet their highest needs, which would remain unused at less-busy times, creating waste (Chieu, Mohindra, Karve, & Segal, 2009, p. 281).

For example, with cloud computing's pay per usage, if an organization at one hour had twenty users, and at another had fifty users, the company would pay for a total usage of seventy users. However, without scalability, this organization would need to have the capacity to support seventy users for both hours, resulting in a waste of capacity in the computing power of twenty users. As the usage is measured not in users, but computing resources used, the total usage is much more unpredictable, and much harder to manage under the old system.

Furthermore, if an organization had the computing power to support fifty users on perhaps a single server, then if the company grew to more than fifty, an entire new server would need to be purchased to avoid poor performance.

Therefore, while being under capacity is a waste, reaching full capacity is a risk. Cloud computing's scalability avoids this.

1.1.3 On-Demand Self-Service

NIST explains that with on-demand self-service, "a consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider" (Mell & Grance, 2011). Therefore, to add, remove, or change the services one uses through a cloud provider, the user can make those adjustments through the cloud provider's automated systems. There are two types of service provisioning plans: the reservation plan, and on-demand plans.

With the reservation plan, the client can reserve to provision a certain number of resources at a defined date. This plan is generally cheaper, as the payment for the resources is made beforehand. However, there is the risk of over- or under-provisioning resources, by which the client is left without enough resources or with too many.

This is avoided with an on-demand plan, wherein the client simply provisions the resources he or she needs at the time in which they need them. While this type of provisioning plans may be more expensive, costs may be avoided by ensuring the correct amount of resources (Chaisiri, Lee, & Niyato, 2012, p. 164).

1.1.4 Measured Service

NIST explains measured service, stating:

> 'Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both

the provider and consumer of the utilized service.' (Mell & Grance, 2011, p. 2).

This implies that the service level can be gauged based on how much of the cloud services a client uses. While traditional technologies can also be monitored, this is instead done by the cloud provider rather that any internal IT staff. This is an important aspect of cloud computing due to its pay-per-use model, wherein charges are made concurrently with the amount of services being used. Being able to monitor resource usage helps towards ensuring supplier integrity, creating transparency in the process.

Furthermore, the ability to put service quality on a contract, rather than the flat out purchase of any hardware or software, causes the need to ensure that this quality is being met. This is done through a Service Level Agreement (SLA). As explained by Patel, Ranabahu, and Sheth, "this SLA serves as the foundation for the expected level of service between the consumer and the provider" (Patel, Ranabahu, & Sheth, 2009). Thus, a cloud provider and their client agrees on such areas as response time and throughput, and it is the responsibility of the provider to meet these minimum service levels.

There are various ways in which this can be done, based on the needs of the consumer. Varying consumers require varying measurement of service, based on their needs for the service level data. For example, one may want the collection of raw data that has not be formatted or changed, while others may want the data customized, put into context, or even specify how the data should be collected. (Patel et al., 2009). Therefore, a cloud user should determine precisely what they want as far as measuring the services they want, to match their capabilities and their personal ends which they have for adopting cloud computing.

1.1.5 Resource Pooling

NIST explains that with resource pooling, "the provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand" (Mell & Grance, 2011, p.2). This describes one of the main roles and benefits of cloud computing, which is to provide access to various technological capabilities through one place, on demand. This is done through resource pooling, as multiple organizations share the costs, and eliminate many of the wastes involved in traditional computing.

There are many areas in which resource pooling is beneficial. For example, cloud computing reduces the underutilization wastes of servers and desktops, increasing efficiency. A study of various corporate data centers revealed that most of their servers were just using 10-30% of their computing power, while desktops had an average utilization of less than 5% (Marston et al., 2011, p. 176). Reducing this waste is an important concern for reducing IT costs. As servers are gathered together in a centralized area, it is easier for the cloud provider to help maximize capacity. As more users join the system, the load balancer allocated the amount of work for the hardware evenly, improving further the economies of scale experienced (Marston et al., 2011, p. 178). This idea falls within the older idea of economies of scale, which are achieved when one centralizes an activity to achieve a greater efficiency. For example, a company may have a special room or area in which they keep hardware such as servers. This area may not have been specially designed for this, which means that there could be extra space that the organization is paying for, or not enough causing relocation of either the equipment or the company. A cloud database is specially designed to hold such technology, and with greater numbers can do this more efficiently.

The saving is more than just on space, but all the small overhead costs associated with maintaining in-house technology. For example, servers and machines need to be kept below a certain temperature to ensure they do not fail or break down. As these technologies create heat when in use, cooling has to be maintained, which adds to the already existent electricity premiums involved with having this hardware. Companies have reported decreased costs on commodities such as electricity by switching to a cloud environment, as was noticed in the case of CA Technologies, whom saves $6.5 million in labor costs, and $2.4 million in operational costs in five years, because they were able to close nineteen server sites after they converted to cloud computing (Chang, Wills, & Walters, 2014). Aside from reducing costs, resource pooling also have significant implications for smaller organizations, allowing them to better compete technologically. As noted by Federico Etro,

> "One of the main obstacles to entry in new markets is represented by the high up-front costs of entry, often associated with physical and ICT capital spending. Cloud computing allows potential entrants to save in the fixed costs associated with hardware/software adoption and reduces the constraints on entry and promotes business creation" (Etro, 2009, p. 181).

The reduction of costs come from the fact that companies that use cloud computing, whether in a public cloud, community cloud, or a hybrid cloud, are able to share the same hardware and software purchases with others, reducing the high start-up costs that are usually associated. The ability to split the costs of such purchases gives small businesses greater access to high quality software that was once not easily available for smaller firms.

Beyond higher quality software, these companies also achieve higher quality security through cloud computing. As cyber security is becoming exponentially more complex, the ability to defend against this threat is becoming more and more expensive. These costs can be prohibitive for small businesses. However, cloud computing helps provide higher level security to these smaller organizations at a much lower cost than what would have otherwise been possible (Widjaya, 2013). Traditionally, a small business might own their technology in a locked room, encrypted, behind a firewall, and with other basic protection. But with a cloud database, the technology is guarded in a military style bunker with state-of-the-art security measures to protect against outside and inside threats, as well as natural threats such as fires or floods. Technical measures include: patching operating systems, internet browsers and software applications, installing anti-virus, anti-malware tools and firewalls, implementing multifactor authentication, encrypting data travelling between the cloud and the browser, encrypting data stored in the cloud, and intrusion detection and prevention systems and network monitoring. Physical security measures include: perimeter security, shielded server rooms and cages, surveillance, access control, and facility access logs. Finally, organizational policies, awareness and training measures include, ICT acceptable use policies, password policies, user access management policies, BYOD policies, staff training, and background checks of cloud service provider staff. Obviously, for a small business to be able to provide all of these on their own could cost at least hundreds of thousands of dollars (Widjaya, 2013, pp.5-6). Cloud computing opens the doors for small businesses to run a technologically sophisticated operation at an otherwise more affordable cost.

The benefits of giving smaller organizations better opportunities to compete are not just good for those organizations, but society in general. Etro also notes that increased competition has benefits such as helping economies recover from a downturn, improve innovation, improve productivity, and more (Etro, 2009, p. 178-80).

1.2 Four Deployment Models

The four deployment models of cloud computing articulate the various types of cloud an organization may adopt, defined in relation to who owns the cloud and is responsible for its upkeep, and to whom the end users of the services are. There are four such type models: public cloud, private cloud, community cloud, and hybrid cloud (Mell & Grance, 2011, p. 3). These deployment models have unique characteristics in many attributes such as security, migration costs, elasticity, and multi-tenancy.

1.2.1 Public Cloud:

The public cloud is the most popular deployment model for cloud computing (Dillon, Wu, & Chang, 2010, p. 27). NIST defines public cloud computing to be where "the cloud infrastructure is provisioned for open use by the general public. It may be owned, managed and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider" (Mell & Grance, 2011, p. 3). Therefore, public clouds generally consist of two parties: the provider, who owns and controls the cloud technology, and the user, who pays for those services provided by the technology.

Some of the largest arguments against public clouds are in the form of privacy concerns. This is due to the technically complex nature of public clouds, which arises due to fact that so many unique clients share the same components and resources in the cloud architecture. Therefore, various technologies are incorporated into public clouds, such as those for metering resources, monitoring service levels, managing quotas, and many more. Complexity and security are inversely related, as the additional components allow additional methods in which a user's data can be compromised. Through public clouds, the users are more connected to other users, some of whom may have incentives to access another's information. Furthermore, having services delivered through the internet opens another path for hackers to access a user's data (Jansen, Grance, & others, 2011, pp. 10-12).

On the other hand, the elasticity available in public clouds is unmatched by other deployment models. The cloud providers are generally large, and have many computing resources which can be easily put into use, giving the cloud using nearly infinite scalability, allowing a more diverse range of computing needs to be performed. Furthermore, this model has often found to be the most cost effective (Brebner, 2012).

1.2.2 Private Cloud

NIST explains that in a private cloud, "the cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises" (Mell & Grance, 2011, p. 3). Therefore, a cloud service provider creates a cloud architecture for the sole use of a single organization.

As noted by Dillon, et al., there are many reasons an organization may seek to adopt a private cloud model. These reasons include maximizing and optimizing utilization of existing resources, data privacy concerns, cost comparison of migrating data compared to public cloud models, and increased control over computing resources. (Dillon et al., 2010)

Optimizing the utilization of existing resources, such as servers, is a necessary focus of any business manager. As noted by Velte et al., "[private cloud] environments consist of both physical and virtual servers, and typically support high rates of change as virtual servers are easily added, subtracted, or moved to improve server utilization and maintain service levels" (Velte et al., 2009). This differs from a traditional client server network, in which a server is dedicated to determined clients, disallowing it to be easily removed from a network. When switching to a private cloud, the servers can be virtualized, enabling a single server to allocate its capacity to various departments. In the case of overcapacity, the work can then be shared with another server, disallowing the need to have multiple servers running simultaneously under-capacity (Barham et al., 2003, pp. 165-166).

Also, as mentioned for public cloud deployment models, security is a concern due to multi-tenancy. Since the purpose of a private cloud is to serve only a single organization, the data within the cloud is not shared on the same physical hardware as with users outside of the organization. This narrows from where an attack can come, improving security concerns (Ramgovind, Eloff, & Smith, 2010).

Beyond security measures, the general cost comparison may be the most important factor for choosing a private cloud. Using a private cloud computing deployment model, some studies suggest savings of over 36% in comparison with using a public cloud in the first three years. While the initial costs of migrating to a private cloud are larger, savings over time from managerial oversight, infrastructure management costs, and most importantly, costs of outsourcing one's network result in overall savings. However, this may vary depending on applicable regulation and required security levels (Singh & Jangwal, 2012, pp. 24-26).

1.2.3 Community Cloud

NIST explains that in a community cloud, "the cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns" and continues, "It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises" (Mell & Grance, 2011, p. 3). Thus community clouds are a type of cooperation between users who wish to pool their resources together, leveraging their operational similarities for cloud cooperation.

There are various benefits to a community cloud over private or public clouds. Alexandro Marinos and Gerald Briscoe describe ten important features:

> 1. Openness: removing vendor dependencies and struggles found in issues such as code, standards, and data.
>
> 2. Community: A sense of community ownership, with economic benefits such as improved competitiveness, and avoidance of innovative stifling as found in vendor cloud solutions.
>
> 3. Individual Autonomy: Nodes are expected to act in their own self-interest, decentralizing the cloud structure, and improving individual autonomy.

4. Identity: Each user can create their own identity, allowing the ability to access various services through that identity, instead of creating multiple identities to access multiple services.
5. Graceful Failures: The cloud solution is not dependent on the success of any one organization, making the cloud environment more robust and resilient, and not subject to the failure of one or a small number of users.
6. Convenience and Control: Community clouds have less conflicts of interest compared to vendor-supplied cloud models, resulting in a more democratic computing experience.
7. Community Currency: A community cloud requires an agreed upon method for paying for resource use, which sometimes may need to span internationally.
8. Quality of Service: The issue of ensuring quality of service throughout the community cloud is a more difficult proposition than in other cloud models.
9. Environmental Sustainability: Community cloud is expected to have a small carbon footprint than vendor clouds.
10. Service Composition: Community members can work together for creating new applications to transform their service offerings.
(Marinos & Briscoe, 2009)

One can see from these features that in a community cloud, there is a strong alignment between the users of the cloud and how the cloud is managed. Therefore, community members generally have a need to be similar or have ends that can coexist.

1.2.4 Hybrid Cloud

NIST explains that in a hybrid cloud, the cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by a standardized or proprietary technology that enables data and application portability (Mell & Grance, 2011, p. 3). Therefore, a hybrid cloud mixes two or more of the aforementioned cloud deployment models. In this way, one can take advantage of the benefits, and minimize the shortcomings of any certain model.

An example of this is as when one takes advantage of the privacy benefits of a private cloud, while keeping available the elasticity of a public cloud. Ruben Van den Bossche, et al., explain this structure as "surge computing – outsourcing tasks from an internal data center to a cloud provider in times of heavy load." The authors explain the purpose of this "is to maximize the utilization of the internal data center and to minimize the cost of running the outsourced tasks in the cloud, while fulfilling the applications' quality of service constraints" (Van den Bossche, Vanmechelen, & Broeckhove, 2010). With this arrangement, an organization can take advantage of using their existing technology, while not having to worry about overcapacity in the case of volatile capacity requirements. Thus the cost benefits of a private cloud are achieved, while the elasticity benefits of a private cloud.

While the idea of a hybrid cloud sounds ideal, it is not without complications. As Zhang, et al. point out, "designing a hybrid cloud requires carefully determining the best split between public and private cloud components" (Zhang, Cheng, & Boutaba, 2010, p. 10). This is due to what is called cloud bursting, or when the internal information on a private cloud is sent, or burst, into a public cloud. When designing a hybrid cloud, an organization must determine the nature of the information to be shared, and how it is shared. Data considerations such as sensitivity, criticality, and the regulation surrounding the data must be accounted for to be properly managed (Nair et al., 2010). So while one can take advantage of the benefits between both public and private clouds through a hybrid solution, more planning and technological consideration must be taken into account.

1.3 Three Service Models

NIST suggests three service models involved in cloud computing. The service model describes the type of capability being provisioned to the cloud computing consumer. The three service models of cloud computing include Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

1.3.1 Software as a Service

NIST explains SaaS, stating:

> 'The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.' (Mell & Grance, 2011)

Therefore, in a SaaS service model, the cloud provider procures software, and makes that software available virtually to their users, without necessitating download.

As noted by the NIST explanation, while SaaS is one of the service models of cloud computing, certain SaaS services, such as web-based email, have been around longer than the cloud computing model itself. As Jeremy Deyo explains, "many of the early adopters of SaaS were small businesses, primarily due to the low upfront costs and simplistic integration." Deyo continues with stating "the most popular uses of SaaS included human resource offerings, customer relationship management, and collaboration tools" (Deyo, n.d., p. 4). This underlines the cost saving associated with software procurement through a SaaS model for many common business needs.

The cost savings come from many areas. Highlights a number of cost-saving areas experienced through SaaS:

- 'Lower up-front capital investment in hardware and software
- Service can be up without the need to add server or any other internal infrastructure upgrades
- Pay-as-you-go pricing allows quick roll-out and ROI
- Maintenance costs are eliminated, allowing the IT department to focus elsewhere
- Updates to the software (and patches) occur without disrupting the organization' (Clair, 2008, p. 8).

As the first two bullets mention, since the software is hosted on the provider's infrastructure, a user does not need additional hardware requirements to purchase SaaS. The user simply pays a fee based on usage, which allows return on investment to be achieved quicker. Also, since the additional hardware is not required, the additional maintenance on that hardware is avoided. Finally, since software updates are done by the provider, the concurring downtime of updating software or renewing licensing is avoided.

While this shows that SaaS retains many benefits, there are also a number of disadvantages, especially in the long term, which should be considered in terms of SaaS. First, the pay-as-you-go pricing may not include certain less obvious costs from such things as enforcing SLAs, requesting maintenance or support, configuration services, and others. Furthermore, outsourcing the technology reduces the amount of organizational learning through the IT department, as their job is bypassed and given to another company. There is also significant opportunity costs as the number of SaaS vendors increase, and some go out of business, resulting in data insecurity, and poor optimization. Also due to the outsourcing of what was once a traditional IT department duty, the selection of software might not integrate well with other software used by the firm. The organization adopting SaaS also loses a certain amount of control of such things as personally changing or enhancing the software to meet their unique needs. Also, there is a significant risk of vendor lock-in, as data is entered into a SaaS solution that cannot be easily switched to another vendor or personal solution. In these cases, it may be difficult to change a solution down the road, as the organization becomes more and more invested with a certain vendor (Deyo, n.d., pp. 11-13).

Many vendors of SaaS exist in many industries. Some of the most well-known of these include Intuit's QuickBooks, Google Apps, Microsoft Office Live Small Business, and IBM's blue cloud. Many of these are general services that can be used in a wide range of industries for common business needs. However, there are also industry-specific SaaS offerings, namely in the healthcare, construction, retail, and banking industries. (Velte et al., 2009, pp. 178-191).

1.3.2 Platform as a Service

NIST explains that with PaaS:

> 'The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.' (Mell & Grance, 2011, pp. 2-3).

Therefore, PaaS is a cloud solution provided to help developers create applications. The cloud platform offers various ways to help in this type of project. As David Linthicum explains, "PaaS typically provides a complete set of tools and technology from the interface design to process logic, to persistence, to integration.(Lawton, 2008, p. 13).

This can be thought of in the sense of an auto mechanic. While many people have the tools to do certain fixes, or jobs, using PaaS gives the tools needed to do many more, easing some of the manual labor, such as finding tools, finding and buying a workshop, etc. In the sense of PaaS, a programmer is able to avoid much of the manual labor from such things as configuring servers, integrate management tools, security issues, patching, and scaling their deployment environment, resulting in time saved, and quicker product to market(Lawton, 2008, p. 14).

1.3.3 Infrastructure as a Service

NIST explains infrastructure as a service, stating,

> 'The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).' (Mell & Grance, 2011, p. 3)

Therefore, infrastructure as a service allows an organization to maintain the typical computing experience, such as the software operating system and software applications they may use, while using the provider's infrastructure.

There are various benefits from utilizing this type of service model. Traditional infrastructure can face various expenses, including procurement, maintenance, administration, facilities, cooling, and much more. Meanwhile, the infrastructure is generally run well under capacity. With IaaS, these resources are instead purchased from the provider. The provider achieves many cost advantages through economies of scale. Through the use of virtualization, a provider can make their hardware serve multiple clients at one time, reducing unused capacity. Furthermore, facilities are designed to house such technology, ensuring they are based around the longevity and performance of the equipment, with such factors as cooling and maintenance. Instead, the purchaser pays monthly rate based on use. Savings have been estimated to reach over 70% of overall traditional internal hardware costs. Beyond cost savings through technology, IaaS has also shown cost savings through increased efficiency as workers who might normally be interrupted mundane IT issues could instead focus on those tasks that provide the most beneficence, while the lesser effective tasks are handled by the provider. Lastly, clients are better prepared for disaster recovery, as data is made increasingly redundant and backed up (Yuan, n.d., pp. 6-7).

Chapter 4

Fostering Innovation with Cloud Computing

1. Introduction

This section will combine the inductive conclusions above on how an organization can foster innovation, and applies findings from a sample of case studies to demonstrate how cloud computing fits in with the underlying principles in this framework, in order to draw conclusions on how cloud computing is and can foster innovation.

2. Methodology

The development of cloud computing has risen beyond some of the more traditionally articulated benefits, such as lower IT costs, and grown into a useful tool which can help foster innovation. Many case studies have been produced and made available, which demonstrate various cloud solutions adopted by organizations, and the effect those solutions made on business performance.

I have analyzed around two-hundred such case studies, choosing about fifty which demonstrate cloud computing’s capabilities in fostering innovation. The group of case studies analyzed in this research was found through various online sources, such as the websites of cloud producers, cloud adopters, technology journalists, and so forth. The cloud solutions outlined in these cases cover each deployment model, and service model as mentioned in the NIST definition above.

To create a model which explains how an organization can leverage cloud technology to foster innovation, I have applied the results found in the case studies to the framework provided above for fostering innovation. The following sections with outline the findings from the case studies, in order of the stage of innovation in which they are shown to facilitate.

3. Fostering Need Recognition with Cloud Computing

As mentioned, need recognition involves an idea champion attaining information about a disruptive event, or market conditions, and processing that information to come up with solutions. These individuals are found by the organization through collaboration and intercommunication, both within, and across organizational boundaries. It is thus necessary for individuals to both have access to information within and beyond organizational boundaries, as well as the time and ability to convert that information into ideas.

3.1 More Time for Innovation

Streamlining activities allows employees to use more of their time for creative purposes. Many of the benefits of cloud computing's essential characteristics, such as broad network access, rapid elasticity and on-demand self-service, allow an organization to streamline their activities, saving their employees time which can be dedicated to innovation oriented activities. This is especially true for the processes of many IT departments. This is reflected in the case study of HTC Corporation's Connected Services Division (CS), which is one of HTC's preeminent service creating departments for their company. CS implemented various Amazon cloud services, freeing them from many of the tedious tasks, such as acquiring infrastructure, routine maintenance, etc. Senior director and Head of Connected Services, James Pratt, explains that "using [Amazon Web Services] helps our developers to be more creative and to spend less time on infrastructure – it gives them a solid, predictable base layer that they don't have to worry about" (Case Study, "HTC," n.d.-b). Other activities that can be avoided include searching for, testing, and integrating multiple vendor components, as experienced by Affiliated Computer Services, Inc. (ACS). Instead, ACS is able to maintain focus on serving customers, and innovation ("Case Study 'ACS,'" n.d.).

However, not only the IT department is better able to streamline business processes. When running certain applications, such as enterprise resource planning (ERP) software, the benefits of cloud computing are extended to the rest of the organization. In the case of Columbia Sportswear, their company's ERP system was hosted on a RISC-based IBM iSeries servers. Since server technology changes relatively quickly, scaling up proved disruptive, as new technologies must integrate with old, slowly disabling and complicating many of the service offerings provided by their ERP system. Integrating to a cloud environment centralized their technologies, allowing them to work from a single SAP ERP system, speeding up business processes by reducing complexity (Case Study Columbia Sportswear, n.d.). However, this does not necessarily imply decreased complexity in the back-end solutions. As illustrated in the case of the technology company CIS Valley, implementing a cloud-based environment allows the automated coordination of many different technologies, increasing complexity. However, due to the automation solutions available, the increased complexity does not increase manual labor involved in managing the systems, but the opposite. Using thinner Blade servers and Cisco Intelligent Automation for the cloud, the company is better able to provide a wider range of services. This includes extending deployment capabilities to their clients, allowing those clients more immediate control of their IT environment, while freeing the CIS Valley staff from those tasks, which allows them to focus on creating new products for their customers (*Case Study, CIS Valley*, 2013).

3.2 Greater Connection to Market

As mentioned, connection to information is key to idea generation. It is also well known that the amount of data available has expanded to unprecedented levels in the 21st century. It is estimated that nearly 2.5 quintillion (2,500,000,000,000,000,000) bytes of data were created in 2012 – every day, which demonstrates that ninety percent of all data created in human history had been created in two years (Humbetov, 2012). The potential within this information to discover needs and possible solutions is huge. Cloud solutions are available to scan this information, and store it in a data center to be analyzed. The Financial Industry Regulatory Authority (FINRA) is a United States regulatory authority for financial trading practices, and analyzes approximately thirty billion market events daily. Leveraging Amazon's Simple Storage Service allows them to scan markets, compiling necessary information, which they analyze using Amazon's Elastic MapReduce ("AWS Case Study, FINRA," n.d.). Similarly, the University of Southern California (USC)'s Annenberg Innovation Lab has adopted IBM big data solutions to analyze activity on various social networking websites. Discoveries made from analyzing these activities is used to help businesses, nonprofit organizations, and governmental bodies gain new insights about how to better serve their stakeholders ("Case Study, USC Annenberg Innovation Lab" 2013). Extending such services through the cloud allows tremendous capabilities to organizations who would otherwise not have been able to afford the high costs involved with developing or managing such a service. This empowers many SMEs to leverage top technologies that before might not have been possible.

3.3 Increased Collaboration

The ability for an organization to cross individual, functional, and even organizational boundaries empowers members to collaborate on a larger scale, connecting them to one another, and their ideas. Collaboration innovates on one side by facilitating communication processes to provide more time to employees, and on another by supporting a type of innovative milieu within an organization.

The ability to foster collaboration is perhaps among cloud computing's greatest attributes, and has been found in eight of the fifty case studies. One strong example is with the City of Vernon, which utilized Jostle Corporations' People Engagement® platform, which is a SaaS that allows their city employees to easily connect and collaborate with one another over an intranet-type platform. This solution has already incited innovation capabilities, such as new ways to disseminate critical information in cases such as emergency situation updates (Case Study, "City of Vernon," 2013). A similar case involving HR Group has reflected many of the benefits of communication and collaboration channels as well. HR Group utilized IBM's Connections software to improve their text-only communication device, upgrading to wikis, communication communities, and media libraries. This has enabled employees to not only share ideas, but also transform outdated business processes, such as the need of text-only product updates from headquarters, while searching for printed images of the products separately. Similarly, they upgraded to having a single platform to access training videos, merchandise layouts, and more. This has enabled HR Group to adapt quicker to changes, and move together as an organization (Case Study, "HR Group, 2014). A similar solution has been used by Celina Insurance Group, who has used their collaboration tools to set project scopes, schedule events, and even improve vendor relationships, reaching beyond organizational boundaries ("Celina Insurance Group (Case study-USEN)," 2014). Delving in to collaboration software has enabled many of the organizations in the cases studied to innovate their business processes through how employees communicate with one another.

Beyond communication within the organization and supply chain, organizations may find the ability to better extend communication channels to the client. This has been the case in D + M Group, a global company operating in over forty-five countries. Beyond linking D + M Group across organizational functions, and across various countries, the company has employed Cisco® WebEx Meetings cloud services in order to better collaborate with clients through customer presentations, conferences, and more. D+M Group's senior communications manager exclaims that "having people on the same communications system is amazing. It's changing the company culture by creating a global mindset" (Case Study, "D+M Group" n.d.).

This statement reflects how such cloud-based solutions which facilitate collaboration and communication may lead to a more pronounced innovation not only in the processes, but a paradigm innovation in how a company operates. Collaboration allows the organization to connect to their idea champions, as well as the sources for ideas. These new capabilities are making some organizations re-think how they may be able to improve their business practices.

4. Fostering Coalition Building with Cloud Computing

As mentioned earlier, once a need is recognized, and an idea champion is aware of potential solutions, he or she then must gather the "power tools" necessary to implement a solution to the need. These power tools included access to information, support, and resources.

4.1 Access to Information with Cloud Computing

Cloud computing enables organizations better access to information, which is well demonstrated in the cases mentioned in the previous sections. The collaboration and communication enabled by cloud computing serves very much the same purpose in the need recognition stage and the coalition building stage. However, the coalition building stage is also concerned with the right information to turn ideas into action, instead of just idea generation by itself. Sometimes, these two stages may be combined, as actionable information is made immediately visible by decision makers.

This has been the case for New Zealand Post, who uses Oracle RightNow Social software to monitor various social media channels, in order to find information which necessitates a marketing response, such as a post on Twitter (New Zealand Post Case Study, n.d.).

4.2 Access to Support with Cloud Computing

Support involves a community coming together with a common goal. Cloud computing eases the difficulty of finding this community by promoting collaboration and increasing options for people to work together at a distance. As mentioned in the above case study on D+M Group, the organization was able to combine a network spanning dozens of countries and divisions, in order to collaborate and work together.

Another benefit to this aside from the benefits of communicating and sharing ideas is the ability to contact the necessary support for ideas to be decided on quicker. The D+M case study elaborates, stating:

> 'Product launches are faster now, thanks to Cisco HCS and the managed Cisco TelePresence service. For example, instead of emailing product photos before a meeting and discussing them in audio conferences, product managers join Cisco TelePresence sessions to demonstrate product innovations as they discuss them, accelerating decision making. (Case Study, "D+M Group," n.d.).

As the communication channels between communities and decisions makers increase, an organization is better able to facilitate bringing an idea to fruition.

Furthermore, as mentioned previously, the buy-in of decisions makers, and other important members of a coalition is largely dependent on how those members feel about the idea (Foster-Fishman, Berkowitz, Lounsbury, Jacobson, & Allen, 2001, pp. 248-249). More sophisticated communication channels are better able to transmit emotions than more traditional methods, such as text-only, and strengthen the possibility of effectively communicating an idea to receive the support necessary to eventually implement the idea.

4.3 Access to Resources with Cloud Computing

When creating a coalition, many resources need to be found which will make it possible to turn the idea into an innovation that is able to be implemented. These resources can come in many forms, such as time, money, technical resources, and so on.

Cloud computing has many benefits in providing resources to companies. The most widely experienced benefits include savings in operating expenditures, as had been found in nearly all case studies examined, including those less related to using the cloud for innovative purposes. ConnectEDU, a fast-growing organization in the education industry, is one such example. Utilizing a range of

Cisco solutions, ConnectEDU has been able to reduce costs in their data center by 35 percent by avoiding the large capital expenses from a physical rollout of data center equipment, as well avoiding certain costs such as maintenance (Case Study ConnectEDU, n.d.). The avoidance of large resource provisioning costs involved in areas such as buying new server, and instead accessing resources virtually, empowers businesses quicker access to better equipment at lower costs. This gives individuals and groups greater possibility towards any innovation which may require IT infrastructure to be implemented.

Aside from infrastructure, the entire PaaS service model is based around giving organizations the resources to innovate. As mentioned, with PaaS, developers are given a platform with all the tools necessary to create applications, and build on software. In the Nubbius case study, the company leverages PaaS to better focus on developing software through Google App Engine. As founder of Nubbius, Ignacio Zafra, explains, "dealing with infrastructure expenses and maintaining machines would detract from our goal, which was to offer a high-quality, cost-effective service for lawyers," which is something they did, avoiding more than $130,000 per year on infrastructure and staffing costs (*Nubbius Case Study*, n.d.).

Beyond technology-based services, cloud computing also offers benefits to manufacturing companies as well. The well-known Swedish home furniture retailer, IKEA, took advantage of Egnyte's cloud-based file server for their computer-aided design (CAD) files. CAD helps the company design and create their products. However, the size of the CAD files caused logistics issues, as they were unable to be transferred through traditional communication channels such as email. Using a cloud solution, the company was able to handle, and access these files easily, speeding the creative process (*IKEA Case Study*, n.d.).

The capabilities of cloud computing to provide the resources necessary for many business-supporting purposes gives innovation much more potential, as solutions save both costs, and time, while giving better access to high-level solutions. This greater potential has a synergetic effect on the coalition building stage, as support is likely to increase given the better potential of an idea.

5. Fostering Implementation with Cloud Computing

The crucial stage of implementation is one to which cloud computing provides to in a number of ways. As noted earlier, once the coalition is formed, a team which is typically to some degree independent of the organization works to create a solution to the problem. First, relevant information is gathered. This information is in opposed to general information about an existing need, or information regarding the viability of providing a solution to that need, since a decision has already been made to work on the problem. Instead, detailed information is necessary about the need, potential solutions, and congruency between the need and solutions. From these findings, a solution is chosen to be implemented, and tested for practicality of commercialization.

5.1 Acquiring Information

When implementing an innovation, an organization needs as much relevant information about the problem as possible. An exemplary case of how this is being done can be found in the case study of Conservation International (CI). CI is a charity which collects information about rainforests biodiversity through such things as "camera traps," which photograph wildlife, weather conditions, and other relevant information that can help those studying topics in such a field. Working with HP, CI implemented the HP Vertica platform with analysis tools, enabling CI to drastically reduce processing times in analyzing data. With this solution CI has extraordinary capability to manage data, in one case compiling all the information on a species within a day (Case Study, "Conservation International" n.d.). Similar accomplishments were found in the case of BASF Plant Science. BASF implemented Intel technology resulting a faster and more flexible infrastructure, allowing the company faster insights in research activities (*BASF Plant Science Case Study*, n.d.). The ability to study data quicker, and learn about a problem quicker, expedites the beginning of the implementation stage, which is a stage in which time is a crucial factor, as mentioned earlier. Creating solutions quicker decreases the ability of being beat to the market by competitors, or stalled through litigation issues.

The ability to study databases of information to gain insights about how to create new solutions also reduces the need for a more disruptive source of information, which includes other individuals outside of the innovative team, as mentioned in previous sections. Accessing information in this way creates a necessary wall to protect the team's privacy and efficiency. Furthering the ability to work effectively while separate from the physical organization, cloud computing offers greater mobility, being able to access critical information quickly on a range of devices anywhere internet is available (AmWINS Case Study, 2013).

Beyond being able to access the information on databases more quickly, procuring the actual database itself is also made simpler, as in the case of Allied Irish Bank (AIB). As the author notes, "the time it takes to introduce a new database into the environment, for example, has been slashed from 10 days to two, making AIB more agile when it comes to addressing customer needs" ("Allied Irish Bank," n.d.). The ability to access data centers in such a short time allows an organization to quickly prepare for innovative projects, with little regard to how data-intensive they might be.

5.2 Product Execution

Once the innovation team gathers what is thought to be sufficient information regarding the need, a solution is chosen to be executed. This requires specifications as to how the final solution will look and what it will do. It will also provide an ability to study such things as market viability and potential returns on investment.

Many of the case studies focus on IT partners to larger firms such as Cisco. For these IT partners, who generally buy the components of the cloud infrastructure to create their own cloud environment which they can allocate to their clients, product execution involves deploying an often personalized cloud environment. In cases such as these, the benefits of cloud in terms of product execution are obvious: the cloud infrastructure enables easy deployment of personalized cloud environments, each of which should be seen as a small innovation themselves. In many cases, the times to create this personalized environment decreases significantly, as in the case of ASE IT, where it is stated that the "time from design to deployment of customer solutions reduced from weeks to hours, while the time to build virtual machine reduced from eight hours to just fifteen minutes" (ASE IT Case Study, n.d.). Similar results were found in the Daffodil case study, which purports a saving of 80 hours per month on deployment time every month due to greater ease, and management needs (*Daffodil Case Study*, n.d.)This saving enables organizations to focus less time on choices such as infrastructure. As explained by Pratt in regards to his AWS cloud solution, "AWS is so elastic that we can wait until a month before we ship a service to make capacity choices. That way, we have more time to innovate" ("AWS Case Study," n.d.-b)

The time and cost savings in an IT providers translates to the same savings to that provider's clients, as was seen in the ConnectEDU case. Furthermore, and also in the ConnectEDU case, the equipment that is being rolled out quicker and with less costs, also can help with the performance of project execution. ConnectEDU's CTO, Rick Blaisdell, speaks of the benefits to network and application performance, stating, "our infrastructure is delivering five times more speed, and it allows my team to work faster" (Case Study ConnectEDU, n.d.). This underlines the strength in cloud computing in speeding up the development of new solutions, both my making infrastructure resources more quickly available, as well as increasing the performance for applications used on the infrastructure.

A valuable example of how an organization can take advantage of this rapid elasticity is seen in the case of CareCore National, in their ability to rapidly bring medical treatments to common practice. CareCore National created a platform for evidence-based medicine, which has facilitated the process between where experts agree on a new treatment, to that treatment becoming the standard of care. This process traditionally has taken around ten years, which has been reduced down to about ten days (*CareCore National Case Study*, n.d.). CareCore National is able to make significant findings in the healthcare industry, which they share to the academic and professional community alike.

6. Fostering Diffusion with Cloud Computing

Once the innovation team produces their solution, they then transfer the solution to those who will diffuse the solution. As mentioned, the success of this stage depends to a great extent to how well these two groups coordinate this transfer. Many aspects of cloud computing are beneficial in this diffusion stage, from coordinating the transfer from the innovation team to the organization, easing scalability, lowering cost, and facilitating market penetration.

6.1 Coordinating the Solution Transfer with Cloud Computing

As mentioned, the ability of cloud computing to act as a permeable wall between the innovation team and the rest of the organization, allowing necessary information to get through, also works to move the organization towards to same direction. This was found in the case study on the City of Mesa, Arizona, who were working on conforming their schools onto a private cloud based technology-sharing initiatives. With these initiatives, the city is hoping to reduce the amount of deployed software, to better connect the practices of their school systems (*City of Mesa Case Study*, n.d.). Having an entire school system, or other form of a team, all on the same technology system may enable a culture of collaboration and unity, which may be beneficial in innovation.

Beyond consolidation onto similar systems, we have also seen in the D+M Group case the power of Cloud Computing in collaboration, through using various cloud based communication software. As noted in the case study:

> ‘Collaborating over the network with an in-person experience also helps enable the company to engage more people in product planning, fostering innovation. For example, engineers in one country who are working on a new headset design can more easily collaborate with their peers in other countries to make sure the headset also works well with other D+M Group brands’ (Case Study, "D+M Group” n.d.).

The ability of D+M to access more sophisticated communication tools, and make them available through cloud computing’s broad network access characteristic, enriches the communication that is made. On one note, the communication appeals to more senses, such as seeing an object like the headset, and/or hearing the voice of the person communicating. On another, being able to make this type of enriched communication more widely available is better able to coordinate teams across functionalities and divisions.

6.2 Easing Scalability with Cloud Computing

When diffusing a product innovation, the eventual demand may not always be easily forecasted. Therefore, an organization needs to be flexible in its ability to adapt to the demand. Cloud computing offers scalability as one of its five essential characteristics, which has shown to be an asset in innovation diffusion with a number of cases. In the case of Michael Waltrip Racing, a racecar manufacturer, the scalability of cloud computing allowed for the ability to acquire computing resources to complete certain time sensitive projects which required high computing power (*Michael Waltrip Racing Case Study*, n.d.).

This effect has also been experienced by many companies diffusing applications or other technological solutions to the market. Being able to launch these products within a cloud environment allows for the quick provisioning of cloud infrastructure in the cases of quick spikes in demand (*Daffodil Case Study*, n.d.)(Case Study, “HTC,” n.d.-b)

6.3 Quicker Market Penetration

Crossing the chasm between the early adopters and early majority is the difference between a successful and non-successful innovation. Cloud computing has shown in multiple cases to more quickly penetrate the market resulting in a successful diffusion.

One typical challenge for those with new solutions is reaching the end user. Brilig leverages GoGrid's cloud infrastructure to operate the world's first cooperative data marketplace for online display advertising. Using data analysis techniques, such as those demonstrated earlier, Brilig is able to help their clients better target customers to increase revenue. As explained, "Advertisers can buy space in more than 7,500 consumer segments. Want to reach women earning $100,000 who pamper their dogs? No problem" (*Brilig Case Study*, n.d.). Similarly, in the case of Martini Media, the same approach is taken. However, data collection revolves around affluent customers with control seventy percent of the spending power in the US (Case Study, "Martini Media," n.d.). Being able to analyze cloud-based data centers holding buyer information allows marketers to focus their advertising efforts more effectively, better reaching those who are more likely to make a purchase, and facilitate diffusion.

Beyond better targeting consumers to decide which channels to connect through, cloud analytics also help certain industries adjust their diffusion quickly depending on response. This was found in a video marketing company, Sightly, who finds the right channels to play their clients advertisement videos. However, instead of recommendation where to launch an advertisement, Sightly instead uses data analytics from Google's BigQuery to quickly respond to changes and trends, in order to target the right consumer with the right video advertisement at the right time. With this strategy, Sightly has improved click-through rates for their clients by 300% (*Sightly Case Study*, n.d.)).

6.4 Reduced Diffusion Costs

Being able to launch a solution under a sustainable budget is also a critical factor to meeting return on investment. Cloud computing has been shown in a few of the cases examined to reduce the costs of diffusing certain innovations. Such is the case with Nirvanix, who uses a distributed cluster of storage nodes to run their internet media file system, reducing their content distribution from $15,000 per month to $500 per month.(Case study, "Nirvanix," n.d.).

Another example includes the case study of Drivewyze, with their PreClear product. PreClear allows truckers to bypass weighing stations by verifying necessary screening requirements without stopping, saving time and fuel. Cloud computing enabled deployment of this service, which would not have been economically practical with traditional infrastructure costs (Case Study, "Drivewyze" 2014).

7. New Business Models

While the majority of cases examined fell within the established model for fostering innovation, a few were not easy to place in any of the four stages. In these cases, cloud computing did not necessarily enable any one factor which facilitated innovation, but rather their adoption made possible new ways of business, such as new revenue streams, or almost a new type of business entirely. Aside from helping with the innovative process, cloud computing innovated entire business models which utilized many of cloud computing features, and some of which were entirely cloud-based.

One such case is that of Kaplan, a global education services company, operating in 170 countries. In response to the changing education environment, Kaplan launched their KAPx initiative, creating a widely-accessible, low-cost platform for delivering educational content to large audiences. Kaplan utilized Google App Engine to port this software, creating the new business segment in three weeks (Case Study, "Kaplan," n.d.).

In another case, leading fresh-produce company, Blattwerk Convenience Food AG, was able to deploy a mobile sales force. This was in the form of what they called "Schnägg vans," which were food trucks that Blattwerk loaded with products prepared the same morning, selling them fresh the same day. To make this possible, Blattwerk identified three key objectives for their technology: "create a convenient, wireless purchasing process; enable on-time supply of products; and get the entire operation off the ground quickly and cost-effectively" ("Blattwerk Case Study," 2013). While solutions to these needs have been available, using cloud computing, Blattwerk was able to connect integrate their vans with back-office supply systems, making the project much simpler.

Many other cases could be found showing how cloud computing transforms business models, each showing a different aspect of the cloud's benefit in this regard.

> 'The key customer side characteristics of the Cloud, i.e., pay-per-use –pricing, ubiquitous access, and on-demand availability have a strong impact on the business model elements of software license –based businesses. Especially, the business model elements *Customer segments, Customer relationship* and *Channels* are affected. In addition, scalability and resource pooling – together with ubiquitous access – change the ways of working (*Key activities* and *Key resources*) inside the organizations. Thus, the whole business model and its elements, including *Cost structures* and *Revenue streams*, too, are affected and thereby necessitate major changes.' (Myllykoski & Ahokangas, n.d.)

Depending on a company's strategy, various cloud components and features may be considered for potentially evolving a stronger business model.

This demonstrates that, while our model of underlying goals for fostering innovation has proved resilient when tested by the various case studies examined, another consideration must be made: cloud computing is in itself an innovation. The cloud computing model contains various characteristics and enablers which revolutionize business models, creating new revenue streams. Thus, thought must go beyond if and how one can implement the cloud in their business, to also if and how one could implement their business in the cloud.

Chapter 5

Conclusion and Discussion

1. Conclusion and Discussion

This research has examined the academic fields of innovation and cloud computing. A broad definition of innovation has been articulated, followed by the creation of model for how to foster innovation, based on inductive conclusions from many decades of empirical innovation research. This model highlights underlying goals to be accomplished in order to foster innovation. With these goals established, one can then demonstrate what cloud computing technologies have been shown to meet these goals. This research formed these goals into questions for how they can be fulfilled by cloud computing, and we have arrived at the following results:

-How can cloud computing help idea champions connect to information about disruptive events?

1) Increase time available for innovation by:
   a) Reducing the time required to acquire infrastructure, and perform routine IT maintenance (HTC Case Study)
   b) Reducing time required to search for, test, and integrate multiple vendors (ACS Case Study)
   c) Improve worker efficiency by centralizing the technology they use, such as on an ERP system (Columbia Sportswear Case Study)
   d) Improve the ability to run a more diverse range of programs, through which a company can automate business processes (CIS Valley Case Study)
2) Increasing the connection to market information by:
   a) Enable the ability to inexpensively analyze large data sets about the market (FINRA Case Study)
   b) Inexpensively analyze social media to make valuable discoveries (University of Southern California’s Annenberg Innovation Lab Case Study)

How can cloud computing help connect the organization to idea champions?

1) Increasing Collaboration
   a) Easily disseminating valuable information when necessary, such as disseminating critical information in disaster situations to citizens (City of Vernon Case Study)
   b) Enabling richer communication channels, such as wikis, photo sharing, etc., to improve communication and transform business processes (HR Group Case Study)
   c) Collaborate with clients through rich communication channels (D+M Group Case Study)

How can cloud computing help provide information to the idea champion?

1) The ability to monitor social media to determine possible situations that warrant market responses (New Zealand Post Case Study)

How can cloud computing help provide support to the idea champion?

1) Enable rich communication channels that help an idea champion better communicate their ideas to decision makers (D+M Group Case Study)

How can cloud computing help provide resources to the idea champion?

1) Lower cost of technological resources (ConnectEDU Case Study)
2) Provide an inexpensive platform for developing software (Nubbius Case Study)
3) Enable the ability to inexpensively access and use certain programs which otherwise would be expensive to acquire and use, such as CAD (Egnyte Case Study)

How can cloud computing help with acquiring knowledge about the problem?

1) Quickly and inexpensively access some of the most comprehensive data on a given topic, such as a particular animal species (Conservation International Case Study)

2) Enable faster insights in research activities (BASF Plant Service)

3) Ability to store an access data independently, with reduced need for interacting with the rest of the firm (AM Wins Case Study)

4) Reduced time to implement new data bases to increase a firm's knowledge base (Allied Irish Bank Case Study)

How can cloud computing help with project execution?

1) Allows IT organization the ability to quickly deploy their services (ASE IT Case Study) (Daffodil Case Study)

2) Allows faster network performance, making innovation teams more efficient (ConnectEDU)

3) Increases speed of testing solutions

How can cloud computing help select and test a final solution?

1) Enables a scalable testing environment that can increase the speed of testing solutions (CareCore National Case Study)

How can cloud computing help transfer the innovation back to the organization?

1) Enables an organization operating in multiple location to synchronize and communicate on a single platform (City of Mesa Case Study)

2) More convenient access to communication software which enriches communication channels used, and improves collaboration

How can cloud computing help diffuse the innovation?

1) Ease Scalability
    a) More quickly acquire resources required to complete projects quicker (Michael Waltrip Racing Case Study)
2) Speed Market Penetration
    a) Use data analytics to better target customers (Brilig Case Study) (Martini Media Case Study) (Sightly Case Study

3) Reduced Costs
    a) Run certain systems less expensively, such as file systems (Nirvanix Case Study)
    b) Access scalable infrastructure to quickly and inexpensively meet uncertain demand requirements (DriveWyze Case Study)

Beyond answering these questions, cloud computing also revealed the ability to innovate an organization's business model, bringing clients value in ways that were once not possible, or too difficult (Kaplan Case Study) (Blattwert Convenience Food Case Study).

However, it must be emphasized that these findings are simply recognition of what cloud computing has shown to do, and not what it has the potential to do. These cases may be of value to many, giving guidance on ways cloud computing can change their organization. However, I believe the most value to be not in what cloud computing has accomplished, but what is still left by cloud computing to be accomplished.

The world has seen drastic revolutions that bring people closer together. Vehicles allow us to travel large distances quicker. The telephone has allowed us to communicate to nearly any distance. TV and the internet have allowed us to learn and see places in the world we likely never would have. Now with cloud computing, we are able to span the same great distances with many amazing services the not too long ago would have been impossible to do. Cloud computing is the next step to bridging the space between people, and I am excited to see where it will go.

2. Further Research

The study of innovation has been around for a longer time than many scholarly search engines can reach back to. This research has compiled many decades of innovation research to arrive at a model for fostering innovation. With this model, we have assigned questions which guide what the development of cloud computing should aspire to. However, the quality of a model such as this is only limited to the amount of research used to create it.

Further research should seek to better clarify the study of fostering innovation, compiling and testing more research to arrive at a more perfect model. Furthermore, as the development of cloud computing continues, more in-depth case studies, or other analyses can be used to gain a bigger picture of how the cloud computing model is being used for innovative purposes.

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