Cloud Suitability Assessment Method for Application Software

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Abstract: The advantages and initial adoption success stories of the Cloud computing inspire enterprises to migrate their existing applications to the Cloud computing technology. As a result, the trend of migrating existing application software to the Cloud grows steadily. However, not all applications are ideal candidates to be ported. Moreover, very often client organizations do not have the appropriate methods to determine which of their IT services are appropriate for migration. In this respect, a method is required to assess the suitability of the existing applications before embarking on migration. This study designs a method to assess Cloud suitability of exiting application software following the design science approach. The method is a multi-step approach composed of seven activities, devised with the goal of reducing the risk of making wrong migration decisions. Further research will be used to validate and refine the proposed method.

1 INTRODUCTION

The trend for adoption of Cloud computing has been increasing from time to time but the migration of the existing systems to Cloud solution is still in its infancy (Banerjee, 2012; Loebbecke et al., 2012). However, to benefit from Cloud solution, the number of organizations migrating existing software systems to Cloud computing environments have been growing steadily (Juan-Verdejo et al., 2014; Binz et al., 2011). Beside the potential advantages, the initial success stories of Cloud computing adoption inspire enterprises to migrate their existing applications to a Cloud-based architecture (Andrikopoulos et al., 2014, 2013; Juan-Verdejo, 2012).

Migration of an application on to Cloud also looks as an attractive investment for enterprises (Banerjee and Mohapatra, 2013). However, not all applications are ideal candidates to be ported to a Cloud platform, or hosted on a Cloud infrastructure (Chantry, 2009; Böhm et al., 2010; Abduljalil et al., 2012; Jamshidi et al., 2013). In this respect, the Cloud suitability of application software must be assessed before embarking on migration. But, client organizations lack appropriate method to assess Cloud suitability of IT services (Loebbecke et al., 2012; Banerjee, 2012).

Cloud suitability assessment is an initial activity of the migration method (Khajeh-Hosseini et al., 2012). The outcome of this assessment phase determines whether or not to proceed with further analysis.

Relatively less emphasis has been given in the literature to Cloud suitability assessment method. Literature also revealed that most of the Cloud computing adoption decisions are made in qualitative manner (Kaisler et al., 2012). Even the existing quantitative methods aggregate the value for all criteria as a single value to make decision (Deb, 2010; Beserra et al., 2012; Menzel and Ranjan, 2012; Menzel et al., 2013). But in real cases, the value of certain criteria must achieve a minimum benchmarked value and it might not be also compensated by positive value of other criteria for the migration to be effective. Hence, a new systematic method which handles such kind of non-compensated criteria independently is required.

The method we have proposed considers the technological, the target Cloud, the risk willingness, the application nature, and the organization and business as decision area to assess Cloud suitability

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of the existing application software. This method guides the decision maker to make an informed migration decision. As a result, the risk of making a decision contrary to the organizational objectives can be reduced.

The remainder of this paper is organized as follows. Section 2 gives a brief description of the related work. Section 3 presents the approach used to develop the method. Section 4 introduces the activities of Cloud suitability assessment method. Section 5 gives conclusions and future research.

2 RELATED WORK

Most of the migration approaches proposed in the literature uses different approach to check the alignment of legacy applications with Cloud (Beserra et al., 2012; Khajeh-Hosseini et al., 2012; Menzel and Ranjan, 2012; Menzel et al., 2013; Andrikopoulos et al., 2014). But there are very few exceptional works which tried to assess Cloud suitability of enterprise application software (Deb, 2010; Kishore et al., 2011; Misra and Mondal, 2011; Juan-Verdejo and Baars, 2013; Frey et al., 2013).

Deb (2010) proposed an approach to determine suitability of enterprise applications for the Cloud based on the Analytic Hierarchy Process (AHP) approach. The method evaluates Cloud suitability of applications in three dimensions: business, technology and risk appetite of an enterprise.

Kishore et al. (2011) assessed Cloud suitability of a particular web service using a Turing machine approach and classified the web service as suitable or unsuitable to be deployed over Cloud. The authors consider properties of web services and Cloud services as evaluation criteria.

Misra and Modal (2011) identify a company's suitability for migrating to the Cloud environment and model Return on Investment from using Cloud computing. Companies' business key characteristics as well as pre-existing IT resources were used to identify suitability of companies for Cloud. They used mathematical modeling approach to compute a suitability index based on credit they assigned to different factors. The model set an upper and a lower cut-off point to assess organization as suitable, may or may not be suitable or unsuitable.

Frey and Hasselbring(2011) proposed CloudMIG approach to migrate software system to IaaS or PaaS Cloud environments. The approach classifies existing software systems regarding their Cloud suitability into five classes as: Cloud incompatible, Cloud compatible, Cloud ready, Cloud aligned, and Cloud optimized.

Juan-Verdejo and Baars (2013) proposed a framework to assess suitability of software components migrating to a hybrid Cloud deployment model. The framework was modeling the interdependencies between the software components taking into account many parameters.

The method we propose assesses the Cloud suitability of targeted application based on multiple criteria decision making approach and assign to preference-ordered predefined classes. It considers Cloud suitability assessment as classification or sorting problem. Unlike other methods proposed in the literature, our method doesn't aggregate the whole criteria as a single value to compute suitability index. Rather, it classifies criteria as the one that can be compensated or not compensated by merit of other criteria to conduct sorting into two stages. But none of the proposed methods in literature performs like that.

3 RESEARCH METHODOLOGY

As the output of this research is an artifact that is a method, design science approach is used to design this method. Design science research is well suited for a research that needs to create practical IT artifacts such as construct, model, method, or an instantiation (Hevner et al., 2004). Design science research project must contain three clearly identifiable and closely related cycles (relevance, design and rigor) of activities (Hevner, 2007). Hence, our research method was structured based on these three-cycles of activities as shown in figure 1.

Figure1: Methodology adopted from (Hevner et al., 2004).

To ensure the rigorous of the research, proposed method was grounding on theory and involves expert evaluation. In the design cycle activity the method is going to built based on multi-criteria decision making approach (MCDMA) and evaluated by the domain expert iteratively. In the following subsection, MADMA steps used to designing the cloud suitability assessment method are detailed.

4 CLOUD SUITABILITY ASSESSMENT METHOD

Multi-criteria decision making approach is used to develop Cloud suitability assessment method. The method we propose involves a number of activities as shown in the Figure 2. These activities are generic, later to be tailored to a specific organization and to specific multi-criteria decision making techniques and tools.

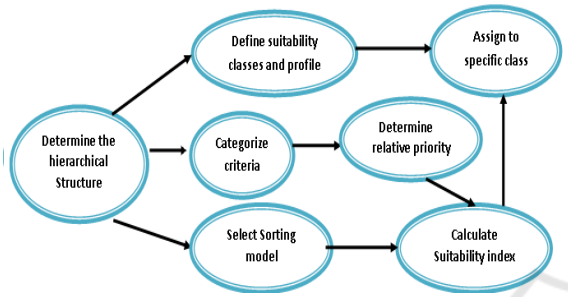

Figure 2: Activities for Cloud suitability assessment.

4.1 Determine Hierarchical Structure

To assess the Cloud suitability of application software, different decision areas or components must be considered. Lantana Consulting Group states that suitability is difficult to define and measure precisely, and therefore it is easiest to look at suitability in terms of components (Lantana Consulting Group, 2011).

In this step, all criteria and sub criteria in each component must be identified iteratively to construct hierarchical structure. The literature review and stakeholders interviews are used to identify these components and criteria in the hierarchical structure.

There have been a few attempts to model Cloud suitability of enterprise application software, but none of them incorporate all the necessary components. Some of them consider the suitability of applications for Cloud only from the technical point of view (Frey and Hasselbring, 2011; Menzel and Ranjan, 2012). The other studies consider it from economical point of view (Khajeh-Hosseini et al., 2012; Misra and Mondal, 2011). But in the Cloud environment, the decisions taken at business level will raise constraints to the technology and *vice-versa* (Orue-Echevarria et al., 2012). This study incorporate all together and identified five different decisions areas from literature such as: technology, business and organization, nature of application, risk willingness and targeted Cloud (Banerjee, 2012; Beserra et al., 2012; Orue-Echevarria et al., 2012).

4.1.1 Technology

A technology component refers to technology up on which an application relies to give services. As the Cloud computing technology gives its service based on the Internet, the decision of migration of an application to Cloud must consider the availability of network infrastructure and the network bandwidth. Network bandwidth is a critical factor to be considered because higher bandwidth usually means higher costs (Banerjee, 2012) and low bandwidth may seriously hamper the availability of the application in view of candidate workloads.

4.1.2 Risk

Risk refers to chance of dangers that are associated with “living in the Cloud”. Migrating application is expected to respect constraints imposed by the Cloud provider and to provide expected quality of service. These constraints may affect the enterprise policies related to privacy and/or security, for instance, to share virtual machine with other customers of the provider. This condition may result in security or privacy breaches. Therefore Cloud suitability decision must consider the risk appetite of the organization (Deb, 2010; Beserra et al., 2012).

4.1.3 Nature of Application Software

Nature of application software assesses how the migrating application software characteristics fit with the Cloud computing environment. To fit to Cloud environment an application may need to be adapted, therefore the migration complexity and cost depends on the way that application was previously designed. For instance an application implemented as service oriented architecture can be migrated to the Cloud platform in an easier manner when compared to a composite application that is implemented in a multi-tier architecture. Therefore, different factors related to nature of application must be taken into consideration to determine how well an application is suited for Cloud.

4.1.4 Business and Organization

The criteria on Business and Organization refer to the economical aspect of the migration and traits of organization owning the application. The migration of application software is not simply lifting and putting the application to different platforms. It requires assessing the application with respect to the organization’s portfolio to determine how well it is suited for Cloud environments. For instance, legal

and regulatory constraints like enterprise-specific policies, industry-specific laws and regulations, and national privacy legislation that have to be respected after the application and enterprise data have been migrated (Juan-Verdejo, 2012). Beside socio technical suitability, the migration of an application must be economically feasible for the organization to be able to reap benefits from the migration.

4.1.5 Targeted Cloud Environment

The targeted Cloud environment refers to different characteristics of the targeted Cloud and constraints that are imposed by Cloud providers. It is important to consider characteristics of the Cloud as it is the destination for the application to be migrated. The characteristics of the Cloud like scalability, availability and reliability (Kishore et al., 2011) affects the suitability for an application running on the Cloud. A migrated application is also expected to satisfy the constraints imposed by the Cloud provider, for instance, the access to the file system, the number of files, or number of calls to specific methods (Frey et al., 2013). Likewise, the Cloud environment has to comply with security, privacy, performance, availability and regulatory requirements of the targeted application (Banerjee and Mohapatra, 2013).

4.2 Define Suitability Classes and Profile

Garg et al.(2011) defined suitability of a Cloud provider for customer requirements and quantified as values between 0 and 1(as ratio scale). Kishore et al. (2011) measure suitability using nominal scale(yes/no). Other scholars measure suitability using ordinal scale (Frey and Hasselbring, 2011; Misra and Mondal, 2011).

Similar to Frey and Hasselbring (2011) our Cloud suitability assessment method uses five ordinal scales (extremely suitable, very suitable, suitable, slightly suitable, and unsuitable) to measure or describe the Cloud suitability of an application software. These measurement scales are considered as classes to sort applications software based on their suitability for the Cloud migration. Sorting of the application requires to compare aggregated value of an application with some reference profiles that distinguishes the classes.

Reference profile r_k of a class k is defined as a vector of local profiles (r_k=(r_{k1}, r_{k2}, … , r_{km})) for each criterion (C_1; C_2; . . . ; C_m) where r_{km} is the local profile class k for C_m criterion. The local profile refers to the minimum performance on each positive criterion or maximum performance on each negative criterion that application software satisfies to be belongs to a class. The local profile for each class is determined by the organization's decision analyst based on the business needs of that organization. Sometimes it is difficult to define the reference profile of a class. In that case, it is required to define the central profiles of a class (Ishizaka et al., 2013) as an average value an application software system must satisfy on each criterion to belong to a class. If there is equal distance between two central profiles, then the reference profile of a class is determined as an average value of the central profile of a the class and preceding class (r_k=(r_k + r_{k+1})/2).

4.3 Categorize Criteria

Most of existing Cloud computing adoption decision approaches are based on a qualitative approaches (Kaisler et al., 2012). Even the existing quantitative approaches evaluate the decision in such a manner that the risk or cost of one criterion is compensated by the merit of other criteria, but this is not always true. There is a case where the deficiency in one criterion cannot be compensated by merit of one or more other criteria, for example, an application may be evaluated to have high suitability scores in the application nature, and business value, but it may not be a good candidate for migration if the risk exposure is higher than the level of risk an enterprise is willing to accept.

Taking this into consideration the criteria used to assess Cloud suitability of application software system is categorized as screening criteria and evaluation criteria. Screening criteria are a set of criteria whose limitation should not be offset by the strength of the other criteria. In such a case for an application to be suitable for migration the minimum limit of profit criteria must satisfied or must not exceed the maximum limit of cost criteria. Evaluation criteria are a set of attributes used to assess Cloud suitability of a software system whose value may be offset by the strength of the other criteria. An application can assume any value in these criteria from their domain.

4.4 Determine Relative Priority and Scale

Each dimensions and respective criteria have decisive effect whether to move or not move legacy software system to Cloud, but their relative importance or weight is different (Menzel et al., 2013). Therefore, such weight has to be set based on

the business needs of an organization and type of migrating application.

There are different mechanisms to set such a weight for criteria from decision maker preference score. AHP is one of the mostly used methods to determine relative weights of each attributes from pair wise comparisons of each attributes in multi criteria decision making approach.

Some criteria may not have standards of measurements for instance security. For such kind of criteria it required to set measurement scale and possible value (domain) for criteria.

4.5 Select Sorting Model

Cloud suitability assessment method evaluates application software using a set of criteria and categorizes them into different classes. If these classes are ordered such kind of a problem is said to be sorting problem, otherwise, it is said to be classification problem (Zopounidis and Doumpos, 2002). Sorting or classification model can be developed by different disciplines such as: statistics, artificial intelligence, and operation research. This study considers operation research approach to develop the method. The MCDMA has the following advantages (Zopounidis and Doumpos, 2002): allows to incorporate decision maker's opinion; and needs not be data intensive to generate a classification or sorting model.

4.6 Compute Suitability Index

The method we have proposed first assign a value for application against each screening criteria and then multiply with respective global weight to classify the application using none compensatory multi criteria classification method as that can be adapted for migration, stay on primes, or redeveloped for migration. Then if the application can be adapted for migration, go to second phase of analysis to show extent of its suitability.

In the second phase a weighted value of evaluation criteria aggregated to give suitability index using selected compensatory MCDMA. The suitability index could then be used to assign application into different suitability classes.

4.7 Assign to Specific Class

A degree of alignment during the reengineering process may be different for applications in each class and this degree of alignment is considered as the weight for the class, the weight can be generated from the preference score of the decision maker.

The local reference profile, which is set by the decision analyst, is multiplied by the weight of respective class to determine the global reference profile or global central profile of a class. Then the global reference profiles are aggregated as a single value using similar approach used to aggregate the suitability index. Finally the suitability index of an application compared against this aggregated reference profiles of a class to assign a candidate application software to a specific class.

5 CONCLUSION AND FUTURE WORK

This research proposed a method to assess Cloud suitability of application software in five different decision areas. The three closely related cycles of activity of design science was identified and used to structure this research. In design cycle, based on a MCDMA seven steps proposed to assess Cloud suitability. The proposed method guides the decision maker to make an informed migration decision.

Unlike other existing method this method proposed two stage evaluation approaches to assess Cloud suitability of legacy application based on two different groups of criteria. It is unique approach in considering suitability assessment as multi-criteria sorting problem.

This research is a work-in-progress to assess the Cloud suitability index of an application. In future research, list of criteria in each decision area and their respective measurement scale will be identified and validated using expert evaluation. Finally, the method will be validated empirically taking specific multi-criteria decision making approach.

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