A Review of Cloud Migration Strategies in the Developing Country

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Abstract— According to a recent market study by International Data Corporation (IDC), cloud computing is growing by 19% about consumption, while the failure rate of the cloud adoption stays in the relatively low value of 1%. However, the majority of cloud adoptions are only observed in several developed countries such as Japan, Australia, and the United States. Meanwhile, the developing countries are struggling to overcome several issues that hinder cloud adoption, such as unsupportive policies, cloud migration issues, and conservative business culture. This article reviews certain cloud adoption methods that were initially designed or has been properly implemented for developing countries. Questionnaires consisting of 20 assorted questions were employed as data collection method. The results are then validated by drawing a comparison from the best practice methodologies. The article provides insights of several cloud adoption strategies that are most likely to be successful to be implemented in the developing countries.

Keywords—cloud computing, cloud migration strategy.

I. Introduction

Compared to conventional computing paradigm, cloud computing provides an approach to run computing workloads on the internet. As an IT platform, it provides better resource allocation, cost option, scalability for future needs, workload portability, and high availability [1] . Despite the benefits, there are challenges and issues to adopt the cloud such as:

- The transparency of the storage location, the trust and privacy issues, and policy making [2]. – Australia

- The cloud adoption alignment between business needs and the regulatory requirements, the expense of financial and managerial resources to adopt the cloud [3]. – Norwegian

- Data sovereignty, competence and awareness, implementation of domain-specific technology, and security, privacy, and trust matter [4]. – Malaysia

- Hardware modularity, software modularity, cost-effectiveness, network infrastructure, and human resources training as the main structural that utilization of cloud computing [5].

Based on the previous researchers, it is shown that the three main challenges on the cloud migration between on-premise to the cloud computing environment are policy, privacy, and resources. The challenges are solved through several proposed cloud migration techniques that classified into three categories framework model, automated migration, and estimating techniques.

Framework model discuss how to migrate from the non-cloud to the cloud by considering end-to-end process. Some of the proposed frameworks are:

- A decision framework model for migration into cloud [6]. This framework provides step by step to migrate the existing workload to the cloud by following three steps: define migration portfolio, risk identification, requirement and assurance analysis, and cloud migration decision and strategy.

- Cloud Genius framework [7]. This framework provides decision support system based on analytical hierarchy's process to migrate single web application into the cloud.

- Framework to enable migration process to educational clouds [8]. This framework provides organizational and technological success factor for migrating the resources to the cloud in the educational domain.

- A systematic cloud migration framework for Small Medium Enterprise based on Service Oriented Approach [9]. This migration technique provides step-by-step from elicitation to the deployment to the cloud.

Automated tools discuss how to migrate to the cloud by using specific tools for specific technical constraint. Some of the proposed tools are:

- Rapid migration of legacy application using tool namely AppCloak [10]. This tool provides interface-based migration through intercepting system calls.

- Automated cloud migration bases on network dependency [11]. This migration technique provides a strategy to migrate a virtual machine from on-premise to the cloud or from cloud to another cloud.

- Decisions support tools for cloud migration in the enterprise [12]. This migration provides tools that can be used to compare the cost of cloud vendors, deployment strategy, and usage scenario.

Estimation effort uses analysis and estimation technique to estimate the migration success rate. Some of the estimation techniques are:

- A theoretical migration analysis for the end user [13]. This technique proposes migration theory based on factors in the end-users.

- Effort estimation to the cloud [14]. This migration technique provides an empirical way to measure the effort to migrate to the cloud.

- Size estimation with Cloud Migration Points [15]. It provides software metrics approach to measure the size of cloud migration.

By looking at the previous researchers, it is found that there are numerous migration techniques. Although, it can be categorized into three main techniques which are framework-based cloud migration techniques, tool-based cloud migration techniques, and estimation-based cloud migration techniques. The organization still faces problems in cloud adoption especially in the developing country that has a limited budget, time, and resources.

This article will be focused to map the existing cloud migration strategy to the condition and the situation of the organization in the developing country. The mapping process will be done systematically through proposed research method. As a result, this article will help the organization who want to implement cloud based on the specific requirements and by considering the limitation on the developing country.

II. RESEARCH METHOD

This article proposes three steps to gather proper migration strategy with the condition of the developing country. This research uses Indonesia as the example of the developing country. Indonesia is chosen because of several reasons [16].

- The third most populous in democracy. Therefore, it has a potential customer in the cloud with various degree of needs.

- Active in several international trades and security organizations. Therefore, the Indonesia movements are aligned with the several international trade constituency

- It has cheap manufacturing cost. Therefore, it has open for business including cloud.

The three steps of research method are described as follows:
- Questioner data gathering.

- Data gathering analysis and evaluation

- Recommendation with the existing migration strategy

A. Data Gathering Strategy

This research is using questionnaire data gathering strategy because the nature of opinion should be reflecting the society of the developing country. The questioner is adopted based on a forecast of cloud computing [17]. The questions are combined with IEEE cloud computing survey [18] and Worldwide Cloud Computing 2017 [19]. The questions of the survey are divided into three section which are:

- Understanding the basic profile of the user (BP). These questions ask the basic profile of the user.

- Understanding the cloud computing knowledge (CK). These questions ask the basic knowledge of cloud computing and its difference with the general computing.

- Understanding the cloud usage (CU). These questions ask how participant use the cloud computing in their organization.

- Understanding the cloud computing adoption (CA). These questions ask migration and adoption experience from the former solution to the cloud.

Table I shows the list of the questions.

TABLE I. QUESTION LIST

No	Question	Option Answer	Section
1	Be related to using cloud computing services, what's your current role?	• User • Service Provider • Academics	BP
2	What are the industries in which you work today?	• Education • Engineering • Finance (Excluding Insurance) • Government • Healthcare • Insurance • Manufacturing • Media and Entertainment • Retail, Transport, and Logistics • Service (Including Hotel and Leisure) • Software and Technology • Telecommunications • Utilities (Oil and Gas, Energy, Water, and Power)	BP
3	What is your job current position?	• Executive • Director/Manager • Cloud Architect • Developer • IT Professional • DevOps • Other	BP
4	How long has the institution or company where you are working have used cloud computing services?	• 0-6 months • 6-12 months • >12 months	CU
5	What kind of cloud computing has been applied to your institution or company?	• Public • Private • hybrid	CU
6	What kind of cloud computing services has been implemented in your institution or company?	• Infrastructure as a Service (IaaS) • Platform as a Service (PaaS) • Software as a Service (SaaS)	CU
7	In the implementation process of cloud computing services, which company do you trust the most?	• Microsoft • Oracle • Amazon • Digital Ocean • IBM • Google • Other	CU

No	Question	Option Answer	Section
8	According to you, how important is the implementation of cloud computing services in your institution or company?	• 1= Very Unimportant • 5=Very Important	CK
9	What is the impact of cloud computing services at your institution or company?	• Securing corporate data • High flexibility and scalability • Data center storage • Can invest for the future • Other	CU
10	In the implementation of cloud computing services, what the percentage of your institution or company invests the budget?	• 0% - 5% • 5% - 20% • 20% - 50% • >50%	CU
11	How much time does your institution or company need in the process of adopting cloud computing services to get the expected results?	• <1 year • 1-2 years • >2 years	CU
12	What techniques are used by your institution or company in implementing cloud computing services?	• Migrating directly • Upgrade gradually • Parallel to On-premise Environment (Hybrid) • Piloting to Small System Part	CA
13	What is your institution or company strategy for implementing cloud computing services?	• Top-Down. Instructions from top management • Bottom-Up. An initiative from managerial and supervisor to top management	CA
14	What makes you feel most satisfied with the current implementation of cloud computing services?	• Minimize public infrastructure investment costs • Increasing work productivity • Opening new business opportunities • Facilitate the integration of applications with different devices • Other	CA
15	According to you, what is the disadvantage of the current implementation of cloud computing services?	• The cost is relatively expensive • Service Level Agreements • Susceptive to ownership of data • The risk of deviation from the compliance level of the provider • Other	CK

No	Question	Option Answer	Section
16	What cloud vendor are you using today?	• Amazon Web Services • Microsoft Azure • Google Cloud Platform • IBM Cloud • Local Cloud Provider • Other	CU
17	Based on the implementation of cloud computing services that your existing institution or company is currently implementing, what are your plans to support the optimization of cloud computing services?	• Switch using cloud computing services 100% • Using Hybrid • There will not any changes because it is still comfortable with the current system	CA
18	Are you planning to switch services from the currently used cloud computing provider?	• Yes, the Current budget is swell • No, there is a return on investment as expected • Doubtful, Still comfortable with the current service	CA
19	Are you planning to switch services from the use of cloud computing services that your existing institution or company is currently using?	• Yes, expected results are not appropriate • No, still stunted by cost	CA
20	Are you planning to change the implementation of cloud services that have been implemented in your institution or company?	• Yes, currently still using hybrid • No, currently using public service • Doubtful, Still comfortable with the current service	CA

The survey was distributed through an online mechanism by utilizing Microsoft Forms and Social Media. The survey addressed the cloud computing consumer. This is to make sure that the questions can be answered based on the experience of the sample.

B. Data Gathering and Analysis

In order to ensure scientific accuracy, the research uses several descriptive statistics [20] such as:

• Measuring the central of the tendency of each question.

• Measuring of Confidence intervals between the result and the

• Measuring of Correlation between the research result with the previous researchers.

C. Recommendation with the migration strategy

The result of the analysis is mapped with the existing recommendation from the previous research. On this step, the activities are:

• Rank the migration strategy based on the survey

• Map the answer on the survey with the previous research.

III. Survey Outcome

There are 35 samples that fill the survey. The survey distribution is done for a month. The result of the survey is participated by 3% cloud provider, 77% cloud consumer, and 20% researcher. They work for the industrial segment which is shown in Fig 1. Based on Fig 1, it is shown that the academic and technology is the most segment that uses cloud computing for their business.
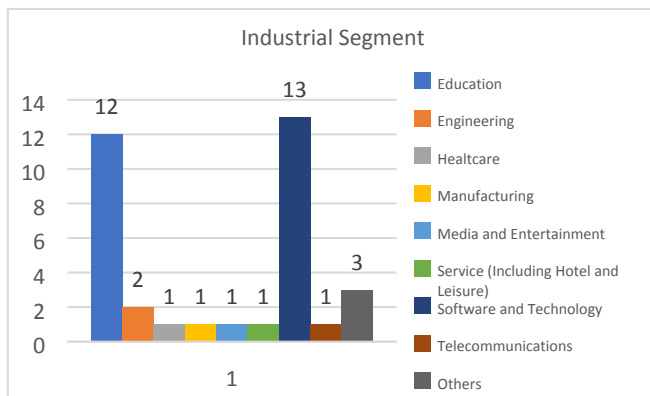

Fig. 1 Industrial Segment

Each participant comes from many different roles which are executives (3%), director/manager (11%), developers (26%), IT Professional (23%), DevOps members (3%), and others (34%).
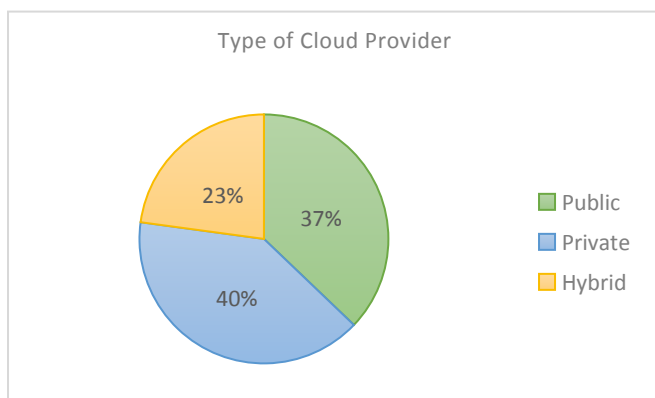

Fig. 2 Type of cloud provider.

Fig 2 shows the type of cloud provider. The number of implemented public and private cloud is almost equal, with 37% and 40%, respectively. In spite of the high flexibility and convenience level in Platform as a Service (PaaS) for application developers, the result shows that PaaS only implemented 14%. The result also presents that Software as a Service (SaaS) is the most implemented cloud services, with 69% of adoption. Only 17% of the respondents selected Infrastructure as a Service (IaaS). It is shown on Fig 3.
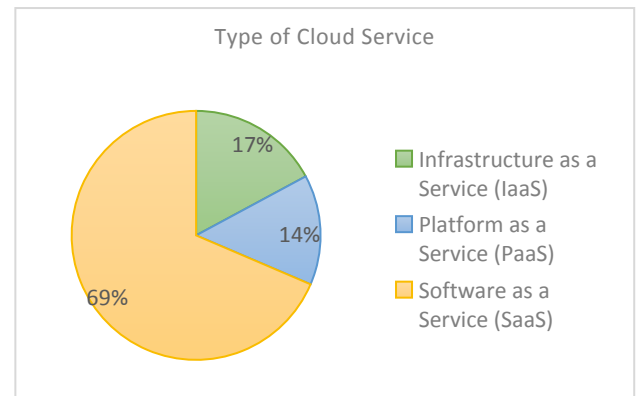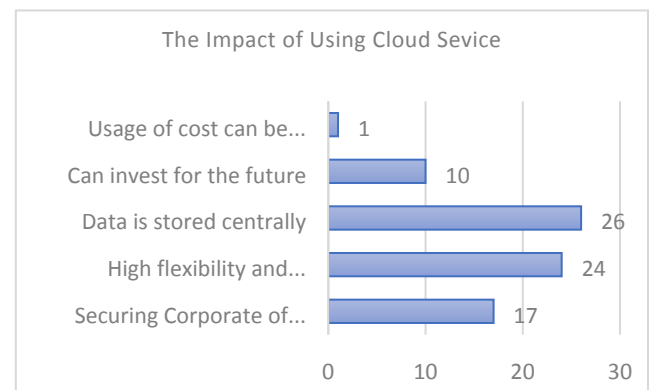

Fig. 3 Type of cloud services.

Fig. 4 The impact of cloud adoption.

The result discovers that there are several impacts in cloud adoption. First, 33% of the respondents felt that centralized data storage ensures company's data security. Furthermore, 30% of the respondents said that cloud offers high flexibility and scalability level, which simplifies the company's business processes. It is shown on Fig 4.
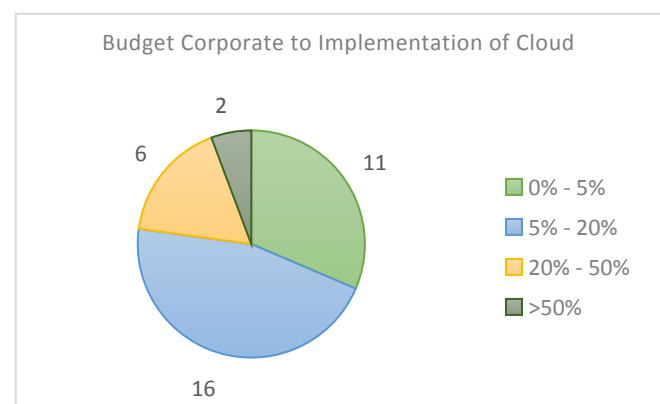

Fig. 5 The percentage of the allocated budget for cloud adoption.

Surprisingly, the result discovers in Fig 5 that most companies only allocate a small amount of budget for cloud

implementation. Majority of the companies only allocates approximately 5 to 20% for cloud implementation, while there are only 6% companies that allocates more than 50% for cloud implementation.
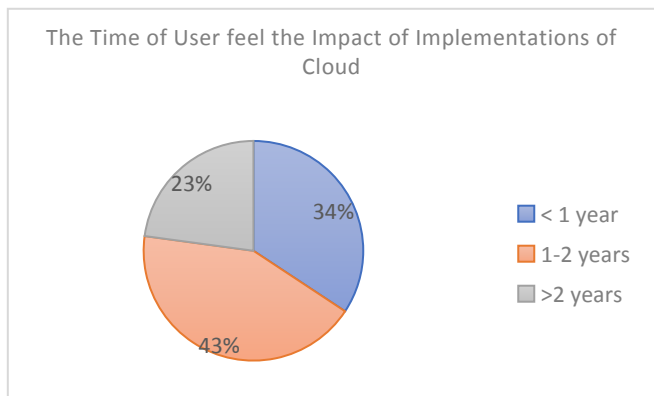

Fig. 6 The time range until the expected impact is met in cloud adoption.

According to the survey, the expected impact is met after one to two years after migration. Moreover, 23% of the companies mentioned that the expected impact is met after more than two years after cloud implementation. It is shown on Fig 6.
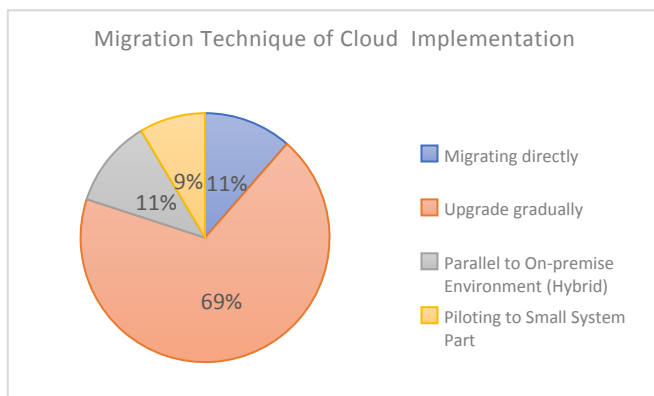

Fig. 7 Cloud migration strategy.

Majority of the respondents, 69%, decided to implement incremental migration, meaning that some parts of the IT services are gradually migrated to cloud. It is shown on Fig 7. On the Fig 9 it is shown that about 13 of the respondents complained that price is the barrier to cloud implementation, because, according to those, current pricing is slightly unaffordable. Data ownership is also another drawback that is felt by 31% of the respondents. More than half of the respondents mentioned that cloud implementation is triggered by managers and supervisors' advice to the top management board as shown on Fig 8.
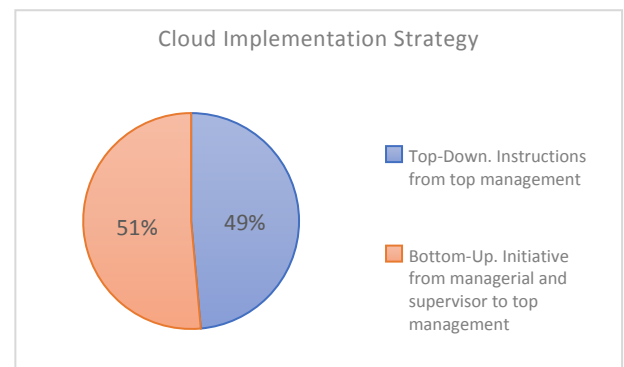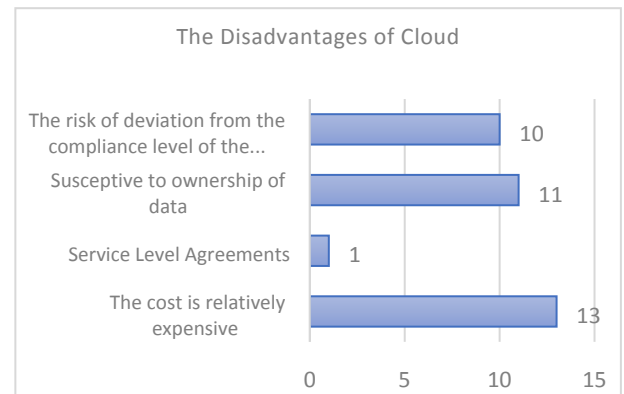

Fig. 8 Cloud implementation strategy.

Fig. 9 Cloud drawbacks.

IV. DISCUSSION

According to the survey results, we can infer that some practices can be adapted to developing country like Indonesia by fulfilling these criteria:

- Can be co-existence with the on-premise infrastructure by following hybrid principle. (R01)

- Can be used without additional investment or effort configuration such as SaaS (R02)

- Not only stored in centralized data storage but can be synchronized easily with the local storage. (R03)

- Having medium to small pricing scheme since the allocation of IT budget is not more than 20% for cloud investment. (R04)

- Can be implemented or migrated in short timeframe between 1-2 years. (R05)

- Having a mechanism to implement gradually. (R06)

- Endorsement from top management, it means the service can be measured by business point-of-view. (R07)

Based on these facts there are several cloud adoptions that can be used in the developing country especially Indonesia. Some of the adoption methods can be shown in Table II. Table II shows how the requirements are discussed or considered in the cloud migration strategy. Y symbol means 'yes', ND symbol means 'not discussed'. Not the entire cloud migration strategy is shown in Table II. As shown in Table II, there no migration

strategy or framework that offer the entire requirements. This happens because of several natures of the migration strategy which are:

- Majorly focus on technical aspect of migration strategy that might be specific to an organization such as migrating VM, web, and application.

- The management strategy doesn't cover technical or tactical need such deployment method and others.

TABLE II. REQUIREMENTS MAPPING AND CLOUD ADOPTION STRATEGY THAT SATISFIES THE REQUIREMENTS

Cloud Adoption Strategy	R01	R02	R03	R04	R05	R06	R07
Decision framework to the cloud [6]	Y	Y	Y	Y	ND	Y	ND
Cloud migration framework for SME based on SO [9]	Y	Y	Y	ND	Y	Y	ND
Decisions support tools for cloud migration on education [12]	ND	Y	Y	Y	Y	ND	Y
Migration Process Framework [8]	ND	Y	Y	Y	ND	Y	Y

V. CONCLUSION

Some conclusions that article discussed are:

- The survey result shows that the SaaS is the most preferred cloud type that is used (69%). Public and private cloud is most preferred cloud model (37% & 40%), 5-20% budget is allocated for the cloud (50%)

- The survey result shows that the main reason to migrate the cloud is the storage centralization and security (30%). The migration process usually takes 1-2 years (43%), with upgrading gradually for each component of the system (69%) and successfully implemented through an example from bottom-up (51%).

- The existing cloud migration strategy can be used to migrate the organization in the developing country by fulfilling 7 main requirements. Starting with co-existence with the on-premise environment (R01), minimal investment and configuration effort like SaaS (R02), supporting synchronization with local assets (R03), having small investment and pricing scheme (R04), should be implemented between 1-2 years (R05), gradually or incremental implementation (R06), and endorsement from managerial through example (R07).

- As today no cloud migration strategy that fit-to-all with the requirements. Therefore, there is a room for opportunity to create a cloud migration management and technical framework

REFERENCES

[1] C. Longbottom, *The Evolution of Cloud Computing: How to plan for change*. BCS Learning & Development Limited, 2017.

[2] O. Ali, J. Soar, and J. Yong, "Challenges and issues that are perceived to influence cloud computing adoption in local government councils," in *2017 IEEE 21st International Conference on Computer Supported Cooperative Work in Design (CSCWD)*, 2017, pp. 426–432.

[3] R. F. El-Gazzar and R. Fahim, "An Overview of Cloud Computing Adoption Challenges in the Norwegian Context," in *2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing*, 2014, pp. 412–418.

[4] S. Abolfazli, Z. Sanaei, A. Tabassi, S. Rosen, A. Gani, and S. U. Khan, "Cloud Adoption in Malaysia: Trends, Opportunities, and Challenges," *IEEE Cloud Comput.*, vol. 2, no. 1, pp. 60–68, Jan. 2015.

[5] A. M. Kadhum and M. K. Hasan, "Assessing the Determinants of Cloud Computing Services for Utilizing Health Information Systems: A Case Study," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 7, no. 2, p. 503, Apr. 2017.

[6] S. Islam, E. R. Weippl, and K. Krombholz, "A Decision Framework Model for Migration into Cloud," in *Proceedings of the 16th International Conference on Information Integration and Web-based Applications & Services - iiWAS '14*, 2014, pp. 185–189.

[7] M. Menzel and R. Ranjan, "CloudGenius," in *Proceedings of the 21st international conference on World Wide Web - WWW '12*, 2012, p. 979.

[8] A. Alharthi, M. O. Alassafi, R. J. Walters, and G. B. Wills, "Towards a framework to enable the migration process to educational clouds in Saudi higher education," in *2016 International Conference on Information Society (i-Society)*, 2016, pp. 73–76.

[9] N. Nussbaumer and X. Liu, "Cloud Migration for SMEs in a Service Oriented Approach," in *2013 IEEE 37th Annual Computer Software and Applications Conference Workshops*, 2013, pp. 457–462.

[10] B. C. Tak and C. Tang, "AppCloak: Rapid Migration of Legacy Applications into Cloud," in *2014 IEEE 7th International Conference on Cloud Computing*, 2014, pp. 810–817.

[11] J. Narantuya, H. Zang, and H. Lim, "Automated cloud migration based on network traffic dependencies," in *2017 IEEE Conference on Network Softwarization (NetSoft)*, 2017, pp. 1–4.

[12] A. Khajeh-Hosseini, I. Sommerville, J. Bogaerts, and P. Teregowda, "Decision Support Tools for Cloud Migration in the Enterprise," in *2011 IEEE 4th International Conference on Cloud Computing*, 2011, pp. 541–548.

[13] A. Bhattacherjee and S. C. Park, "Why end-users move to the cloud: a migration-theoretic analysis," *Eur. J. Inf. Syst.*, vol. 23, no. 3, pp. 357–372, May 2014.

[14] Kewei Sun and Ying Li, "Effort Estimation in Cloud Migration Process," in *2013 IEEE Seventh International Symposium on Service-Oriented System Engineering*, 2013, pp. 84–91.

[15] V. T. K. Tran, K. Lee, A. Fekete, A. Liu, and J. Keung, "Size Estimation of Cloud Migration Projects with Cloud Migration Point (CMP)," in *2011 International Symposium on Empirical Software Engineering and Measurement*, 2011, pp. 265–274.

[16] Dita Alangkara, "Indonesia - Statistics, Rankings, News | US News Best Countries," *US News*, 2017. [Online]. Available: https://www.usnews.com/news/best-countries/indonesia. [Accessed: 29-Jan-2018].

[17] L. Columbus, "Roundup Of Cloud Computing Forecasts, 2017," *Forbes*, 2017. [Online]. Available: https://www.forbes.com/sites/louiscolumbus/2017/04/29/roundup-of-cloud-computing-forecasts-2017/#ed8d5d431e87. [Accessed: 29-Jan-2018].

[18] K. McCabe and R. Nachbar, "Survey by IEEE and Cloud Security Alliance Details Importance and Urgency of Cloud Computing Security Standards - Cloud Security Alliance : Cloud Security Alliance," *Cloud Security Alliance*, 2010. [Online]. Available: https://cloudsecurityalliance.org/media/news/survey-by-ieee-and-cloud-security-alliance-details-importance-and-urgency-of-cloud-computing-security-standards/. [Accessed: 29-Jan-2018].

[19] A. Avram, "RightScale Cloud Survey 2017," *InfoQ*, 2017. [Online]. Available: https://www.infoq.com/news/2017/02/rightscale-cloud-survey-2017/#. [Accessed: 29-Jan-2018].

[20] L. M. Rea and R. A. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide, 4th Edition*. Jossey-Bass, 2014.