2015

# The determinants of Cloud Computing Adoption by Large European Firms

Xiaolin Cheng
*University of Paris-Sud, France*, xiao-lin.cheng@u-psud.fr

Ahmed Bounfour
*University of Paris-Sud, France*, ahmed.bounfour@u-psud.fr

# THE DETERMINANTS OF CLOUD COMPUTING ADOPTION BY LARGE EUROPEAN FIRMS

*Research in Progress*

Xiaolin Cheng, University of Paris-Sud, Sceaux, France, xiao-lin.cheng@u-psud.fr
Ahmed Bounfour, University of Paris-Sud, Sceaux, France, ahmed.bounfour@u-psud.fr

## Abstract

*This paper reports ongoing research into the human and non-human factors underlying the adoption of cloud computing in large European firms. To assess these determinants, we develop a model based on the Technology Acceptance Model (TAM) and the Technology-Organization-Environment (TOE) framework. We develop a questionnaire to collect data on each of variables identified in the proposed model.*

***Keywords:*** *Cloud computing adoption, TOE and TAM frameworks, large European firms, Survey methods, Regression analysis*

# Introduction

Theoretically, cloud computing offers a vast opportunity for organizations and enterprises to improve the flexibility and smooth operation of their business models (Accenture, 2012). Consequently, it would appear that these organizations would find it very easy to migrate to cloud computing. However, in practice, the debate rages regarding cloud adoption (Khajeh-Hosseini et al., 2010). As cloud computing requires a high level of commitment, research frameworks may help to reduce the perceived technical, financial and social risks (Barki, 2007; Eze et al., 2011; Silva, 2007).

Early studies on cloud computing adoption tend to be skewed toward benefits and challenges (Lorraine, M. et al. 2013), and only a few have addressed it from a human perspective (see Table 1). There is currently no holistic evaluation of the human and non-human determinants of adoption. In this study we address this crucial gap by developing an integrative research model that combines the Technology Acceptance Model (TAM) and Technology-Organization-Environment (TOE) framework. We use the model to evaluate the determinants of cloud computing adoption in an organization. This study therefore presents a more holistic assessment of the determinants of cloud computing adoption than earlier work. In addition, this investigation of the determinants of adoption in large European firms contributes to the wider body of scientific knowledge that has so far paid little attention to the issue.

In the domain of Information System (IS), theories aim to understand, explain, or predict how, why and to what extent individuals, firms or organizations adopt and agree to deploy a new technology. Based on this earlier work, which forms the background for the problem, the main research question for this study is: what are the key determinants that influence the organizational adoption of cloud computing by large European firms?

The following sub-questions are framed to address the research problem.

1. What are the theoretical frameworks for the adoption of cloud computing by large European firms?
2. How does the heterogeneous network of human and non-human factors influence the adoption of cloud computing by large European firms?

## Literature review

Cloud computing research is still in its early days. Much of the current literature focuses on its benefits and risks, organizational case studies of cloud adoption and cloud computing architectures (Bhattacherjee and Park, 2013). A methodological approach to the comparison of cloud versus in-house solutions has been proposed that is based on an assessment of the direct economic impact of migration to the cloud (Naldi and Mastroeni, 2014). This approach uses Net Present Value and stochastic models of storage costs and memory requirements. The adoption of new technologies, such as cloud computing, is a complex phenomenon with a high level of ambiguity and a variety of opportunities and challenges. We carried out a detailed analysis of the literature on cloud computing adoption based on the articles summarized in Table 1.

***Table 1*** *Literature review*

| Article | Framework | Constructs | | | |
|---|---|---|---|---|---|
| | | Technology | Organization | Environment | Human |
| (Lin & Chen, 2012) | DOI | √ | | | |
| (Ratten, 2012) | Social cognitive | | | | √ |
| (W. W. Wu, 2011) | TAM | √ | | | √ |
| (Lee et al., 2013) | PEST | √ | | √ | |
| (Misra & Mondal, 2011) | No framework | | | √ | |
| (Low, Chen & Wu, 2011) | TOE | √ | √ | √ | |
| (Gupta et al., 2013) | No framework | √ | | | |
| (Hsu et al., 2014) | TOE | √ | √ | √ | |
| (Nkhoma & Dang, 2013) | TOE | √ | √ | √ | |
| (Che Hussin et al., 2013) | TOE | √ | √ | √ | |
| (Alshamaila et al., 2013) | TOE | √ | √ | √ | |
| (Lee, Park & Lim, 2013) | PEST | √ | | √ | |
| (Wu et al., 2013) | DOI | √ | | | |
| (Oliveira et al., 2014) | TOE and DOI | √ | √ | √ | |
| (Borgman et al., 2013) | TOE | √ | √ | √ | |
| (Benlian & Hess, 2011) | No framework | √ | | | |
| (Cegielski et al., 2012) | TOE | √ | √ | √ | |
| (Current study) | TOE and TAM | √ | √ | √ | √ |

Note: Diffusion of Innovation (DOI); Technology Acceptance Model (TAM); Technology-Organization-Environment (TOE); Political-Economic-Social and Technological (PEST)

This literature review helped us to understand the background for cloud computing adoption and related research. We then developed a research model that highlights nine factors influencing cloud adoption. Subsequently, we created a questionnaire in order to collect empirical data and test our hypotheses. In further research, the data will be analyzed using the Partial Least Square (PLS) method. The results of this study will not be only useful for large European firms who must decide whether to adopt the new technology, but also as a basis for further research into this subject.

# Research model and hypotheses

The Technology Acceptance Model (TAM) (Davis, 1989) was the first attempt to develop an overall approach to the issue of adoption in the domain of IS (Barki, 2007; Eze et al., 2011; Silva, 2007). The model considers perceived usefulness (PU) and perceived ease of use (PEOU) as the key determinants of the adoption of information technology. Despite its widespread diffusion and implementation in IS research, the model suffers from the narrow focus on only two main dimensions, while other use factors are ignored. Other research has extended the scope of the analysis and added other dimensions: the Technology, Organization and Environment (TOE) framework is a notable example (Awa, H.O. & Vkoha, O. 2012).

The TOE framework identifies various influential factors in the innovation adoption process (Tornatzky & Klein, 1982). There are features of the TOE framework that make it appropriate for the investigation of cloud computing adoption, which is unlike conventional innovation adoption and diffusion scenarios. Cloud computing services are usually provided to firms and organizations by a third party (cloud service providers). Thus, unlike conventional innovations, cloud computing technology has three main players: cloud-based services, cloud users and cloud service providers. As a result, its adoption is influenced by three major factors: 1. the characteristics of cloud computing technology, which is a function of both

technologies that are both internal and external to the company; 2. the characteristics and resources of firms and organizations that provide the organizational context; 3. the characteristics of the environmental context in which a firm conducts its business: its industry; competitors; access to resources supplied by others; and dealings with the government.

In this study, we integrate constructs from both the TOE method and the TAM framework in order to include both human and non-human actors in the network. Based on the references given in Table 2, we developed the hypotheses outlined below.

***Table 2*** *Constructs and their resources*

| Constructs | Variables | References |
|---|---|---|
| Human | Perceived usefulness | (Oliveira et al., 2014), (Moore & Benbasat, 1991) |
| | Perceived ease of use | (Moore & Benbasat, 1991), (Gupta et al., 2013) |
| Technology | Complexity | (Low et al., 2011), (Moore & Benbasat, 1991), (Ifinedo, 2011) |
| | Compatibility | (Low et al., 2011), (To & Ngai, 2006), (Ifinedo, 2011), (Zhu, Dong, Xu & Hally, 2006) |
| Organization | Top management support | (Low et al., 2011), (Zhu, Li, Wang & Chen, 2010), (Chwelos, Benbasat & Dexter, 2001) |
| | Adequate resources | (Chang et al., 2007) |
| Environnent | Vendor support | (Thong, 2001) |
| | Government policy | (Zhu & Kraemer, 2005), (Marston et al., 2011) |
| | Competitive pressure | (Low et al., 2011), (To & Ngai, 2006), (Pan & Jang, 2008), (Ifinedo, 2011) |

## Hypotheses

- **Perceived usefulness**

Perceived usefulness refers to the degree to which a person believes that the use of a system will improve his performance.

**H1** Perceived usefulness is positively related to organizational adoption of cloud computing

- **Perceived ease of use**

Perceived ease of use is described as the degree to which a person believes that the use of a system will be effortless.

**H2** Perceived ease of use is positively related to organizational adoption of cloud computing

- **Complexity**

Complexity describes "the degree to which an innovation is perceived as difficulty to understand and to use"

**H3** Complexity is negatively related to organizational adoption of cloud computing

- **Compatibility**

Compatibility reflects the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of receivers.

**H4** Compatibility is positively related to organizational adoption of cloud computing

- **Top management support**

Top management support can contribute to the adoption of innovation by creating a fertile environment and providing resources (Premkumar & Roberts, 1999).

**H5** Top management support is positively related to organizational adoption of cloud computing

- **Adequate resources**

Adequate resources are also critical to the success of adoption. If the budget is sufficient, positive support will be provided by human resources.

**H6** Adequate resources are positively related to organizational adoption of cloud computing.

- **Vendor support**

In cloud computing technology, the customer is highly dependent on the vendor to achieve the desired level of security. This dependency is highlighted in low-tech companies, which lack information technology expertise. Therefore, vendors must guarantee security, availability, and performance through clear Service Level Agreements (SLA)

**H7** Vendor support is positively related to organizational adoption of cloud computing

- **Government policy**

Government policy is another environmental factor that affects innovation diffusion. Companies operating in an environment where government policies are restrictive have a low level of technology adoption.

**H8** Government policy is negatively related to organizational adoption of cloud computing

- **Competitive pressure**

Competition pressure is defined as "the degree that the company is affected by competitors in the market" (Zhu, Xu & Dedrick, 2003). Firms react by adjusting their offers and greater competition forces a firm to allocate more resources to innovation.

**H9** Competitive pressure is positively related to organizational adoption of cloud computing.

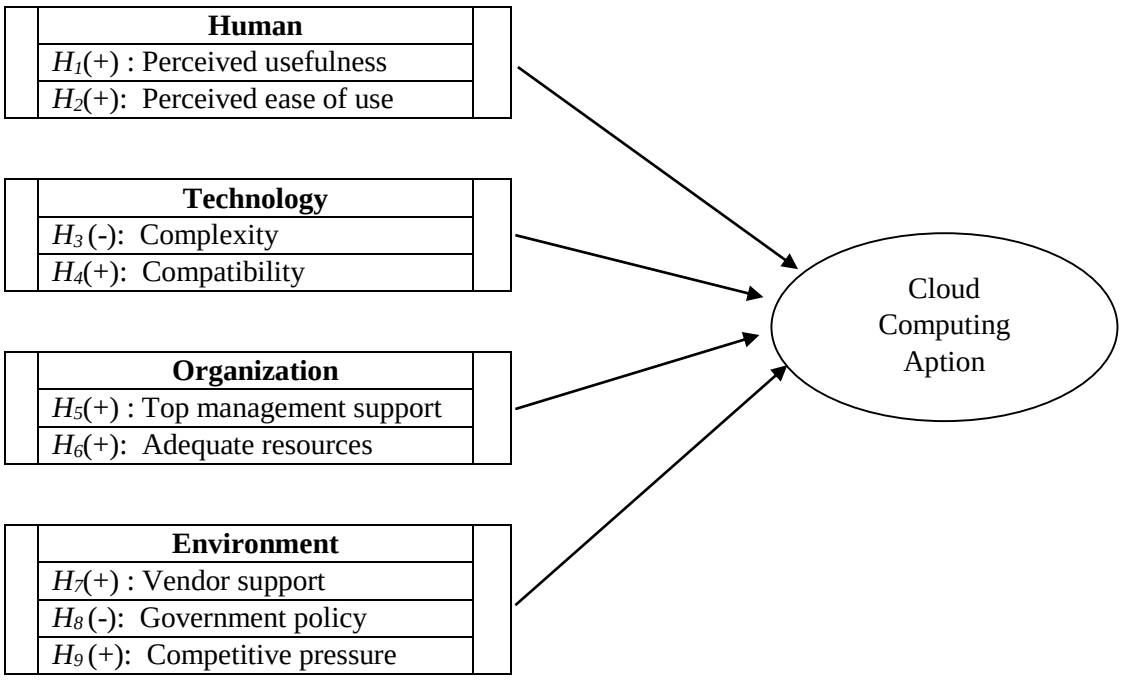


***Figure 1*** *Research Model*

# Method

To test the hypotheses outlined above, we used a questionnaire to collect data on each of the variables given in the proposed model. The sample consisted of large European firms in high-tech industries. Variables were measured on a five-point Likert scale, with values ranging from 1 (strongly disagree) to 5 (strongly agree). Information technology (IT) staff and managers of high-tech firms were targeted as they are best placed to understand their firm's current IT operations and future trends.

The first step consisted of a pilot study designed to ensure that the questionnaire was suitable for the research context. This consisted of personal interviews that aimed to verify the efficiency of the questionnaire. Associate professors of IT (specialized in cloud computing) and other IT professionals were asked to review the questionnaire. Based on their feedback, some items were modified to improve clarity. The questionnaire itself will be distributed using the firms' own platforms, to increase the response rate. The constructs in the questionnaire were developed from the literature reviews described in Table 1 and Table 2, and were modified to fit the context of cloud computing adoption. The questionnaire was divided into two parts:

1. Demographic characteristics including: the number of employees; capital; annual revenue; and adoption of cloud computing services
2. Evaluation of the nine predictors using a five-point Likert scale

Table 3 was constructed to support the hypotheses, from which we can find the loadings for each hypothesis. And all the used references were outlined in Table 2.

***Table 3*** *Measurements and their loadings*

| Measurements | Loadings |
|---|---|
| Perceived usefulness | Compared to current technologies, cloud computing enables tasks to be accomplished more efficiently<br>Cloud computing contributes to the agility of the enterprise<br>Cloud computing technology helps to reduce operational maintenance, updating and training costs |
| Perceived ease of use | A good internet connection and speed of cloud services are necessary<br>Cloud tools and data can be used and accessed from anywhere<br>Negligible learning time for all employees |
| Complexity | Cloud computing is too complex for business operations<br>The skills needed to adopt cloud computing are too complex for employees<br>The complexity of transferring current systems to a cloud computing platform is a concern<br>Uncertainty about the location of data limits the use of cloud computing services<br>The risk of a security breach limits the use of cloud computing services |
| Compatibility | Cloud computing technology is compatible with current practices<br>Cloud computing technology is consistent with the firms' core values and goals |
| Top management support | Cloud technology can easily be integrated into existing IT infrastructure<br>Applications are loosely coupled and independent<br>The company's top management provides strong leadership and engages in information systems' policy<br>The company's top management is willing to take risks in the adoption of cloud computing |
| Adequate resources | Does the firm have enough resources to support the development of cloud computing technology?<br>Does the firm have enough time to develop cloud computing technology?<br>Does the firm have an adequate budget for the development of cloud computing technology?<br>Does the firm have enough human resources to develop cloud computing technology? |

| | |
|---|---|
| Vendor support | There is a service level agreement (SLA), guaranteed by the vendor<br>The vendor will cooperate in returning data if the company decides to change vendor<br>The firm will receive adequate compensation for a vendor breach of the SLA<br>Support is easily available from cloud computing vendors during implementation<br>Adequate training is provided by vendors |
| Government policy | The government encourages firms to apply cloud computing<br>There are intermediate organizations that support enterprises during implementation<br>Appropriate regulations are in place to deal with any legal challenges related to cloud computing |
| Competitive pressure | The firm thinks that cloud computing has an influence on competition in their industry<br>The firm is under pressure from competitors to adopt cloud computing |
| Intention to adopt | The firm has already planned to use cloud computing services<br>The firm plans to adopt cloud computing in the next year<br>Cloud computing is a solution that the firm is ready to accept |

All items are based on five-point scale

# Analysis

There are several analytic methodologies for measuring cloud computing adoption, such as the Mann-Whitney test (Borgman et al., 2013) and hierarchical regression (Cegielski, 2012). The Partial Least Square (PLS) approach has emerged as the most popular and widely-used methodology due to its effectiveness and ease of use.

The methodology has been used to validate measurements and to test hypotheses. We will test our research hypotheses using PLS-based structural equation modeling. Unlike parameter-oriented and covariance-based structural equation modeling, the component-based method is prediction-oriented and places minimal restrictions on sample size and residual distributions. Furthermore, there are no data normality requirements. The technique employs a component-based approach for model estimation and is best suited for testing complex structural models. A two-step approach will be used: first, the quality of measures will be assessed using the measurement model; then the hypotheses will be tested using the following structural model. Let $X=\{X_i \, I \, i=1, 2, \ldots\ldots, 9\}$ be the set of determinants, $\beta=\{\beta_i \, I \, i=0, 1, \ldots\ldots, 9\}$ be the parameters and Y was defined as the intention of cloud computing adoption.

$$\mathbf{Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\mu}$$

Although we assume that all the explanatory variables are independent in this equation, in reality there are interdependencies. To address this limitation, we will model the relationships between multiple attributes in the analysis of the survey results.

## Conclusion and future research

No previous research has drawn on innovation adoption theory that considers both the human and non-human factors that impact cloud computing adoption. This study addresses this gap in the research. It combines the TAM method and TOE framework in order to assess the factors influencing the adoption of cloud computing from human and non-human perspectives. A questionnaire was designed to collect data related to the research variables. Future research will focus on the development and diffusion of the questionnaire and the analysis of the results.

## References

Accenture. (2012). A new era in banking cloud computing changes the game. Accenture.

Alshamaila, Y., Papagiannidis, S., & Li, F. (2013). Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework. Journal of Enterprise Information Management, 26, 250–275.

Awa, H.O., Ukoha, O. (2012). Integrating TAM and TOE frameworks and expanding their characteristic constructs for e-commerce adoption by SMEs. Proceedings of Information Science & IT Education Conference (InSITE)

Barki, H. (2007). Quo vadis, TAM? Journal of the Assocition Fo Information Systems, 8(4), 211–218.

Benlian, A., & Hess, T. (2011). Opportunities and risks of software-as-a-service: Findings from a survey of IT executives. Decision Support Systems, 52(1), 232–246.

Bhattacherjee A. and Park SC. (2013). Why end-users move to the cloud: a migration-theoretic analysis. European Journal of Information Systems 1-16

Borgman, H. P., Bahli, B., Heier, H., & Schewski, F. (2013). Cloudrise: Exploring cloud computing adoption and governance with the TOE framework. Proceedings of the Annual Hawaii International Conference on System Sciences, 4425–4435.

Cegielski, C. G., Jones-Farmer, L. A., Wu, Y., & Hazen, B. T. (2012). Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach. International Journal of Logistics Management, 23(2), 184–211.

Chang, I. C., Hwang, H. G., Hung, M. C., Lin, M. H., & Yen, D. C. (2007). Factors affecting the adoption of electronic signature: Executives' perspective of hospital information department. Decision Support Systems, 44, 350–359.

Chwelos, P., Benbasat, I., & Dexter, A. S. (2001). Research Report: Empirical Test of an EDI Adoption Model. Information Systems Research, 12(604), 304–321.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-340

Davis, F. D. (1989). User Acceptance of Computer TEchnology: A Comparison of Two Theoretical Models. Management Science, 35(8), 982-1003

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. International Journal of ManMachine Studies.

Eze, S. C., Okoye, J. C., Nebo, O. G., Ohakwe, S. N., Chukwuemeka, E., & Anazodo, R. (2011). Using the Characteristics of Small Business Managers to Understand Information Technology ( IT ) Adoption in Nigeria. International Journal of Business and Social Science, 2(13), 82–91.

Gupta, P., Seetharaman, a., & Raj, J. R. (2013). The usage and adoption of cloud computing by small and medium businesses. International Journal of Information Management, 33(5), 861–874.

Hsu, P. F., Ray, S., & Li-Hsieh, Y. Y. (2014). Examining cloud computing adoption intention, pricing mechanism, and deployment model. International Journal of Information Management, 34(4), 474–488.

Ifinedo, P. (2011). Internet / e-business technologies acceptance in Canada ' s SMEs : Focus on Organizational and Environmental Factors.

Khajeh-Hosseini, A., Greenwood, D., Smith, J. W., & Sommerville, I. (2010). The Cloud Adoption Toolkit: Addressing the Challenges of Cloud Adoption in Enterprise.

Lee, S. G., Chae, S. H., & Cho, K. M. (2013). Drivers and inhibitors of SaaS adoption in Korea. *International Journal of Information Management*, 33(3), 429–440.

Lee, S., Park, S. B., & Lim, G. G. (2013). Using balanced scorecards for the evaluation of "Software-as-a-service." *Information & Management*, 50(7), 553–561.

Lin, A., & Chen, N.-C. (2012). Cloud computing as an innovation: Perception, attitude, and adoption. *International Journal of Information Management*, 32, 533–540.

Lorraine, M. et al. (2013). Factors affecting the adoption of cloud computing: an exploratiory study. *Proceedings of the 21st European Conference on Information Systems*.

Low, C., Chen, Y., & Wu, M. (2011). Understanding the determinants of cloud computing adoption. *Industrial Management & Data Systems*, 111, 1006–1023.

Lu, J., Yu, C.-S., Liu, C., & Yao, J. E. (2003). Technology acceptance model for wireless Internet. *Internet Research*, 13, 206–222.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing - The business perspective. *Decision Support Systems*, 51(1), 176–189.

Misra, S. C., & Mondal, A. (2011). Identification of a company's suitability for the adoption of cloud computing and modelling its corresponding Return on Investment. *Mathematical and Computer Modelling*, 53(3-4), 504–521.

Moore, G., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*.

Naldi M. and Mastroeni L. (2014). Economic decision criteria for the migration to cloud storage. *European Journal of Information Systems*. 1-13

Nkhoma, M. Z., & Dang, D. P. T. (2013). Contributing Factors of Cloud Computing Adoption : a Technology - Organisation - Environment Framework Approach. International Journal of *Information Systems and Engineering*, 1, 38–49.

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information & Management*, 51(5), 497–510.

Pan, M.-J., & Jang, W.-Y. (2008). Determinants of the adoption of enterprise resource planning within the technology-organization-environment framework: Taiwan's communications industry. *The Journal of Computer Information Systems*, 48, 94–102.

Premkumar, G., & Roberts, M. (1999). Adoption of new information technologies in rural small businesses. *Omega*, 27, 467–484.

Ratten, V. (2012). Entrepreneurial and ethical adoption behaviour of cloud computing. *Journal of High Technology Management Research*, 23(2), 155–164.

Silva, L. (2007). Post-positivist Review of Technology Acceptance Model ., 8(4), 255–266.

Thong, J. Y. L. (2001). Resource constraints and information systems implementation in Singaporean small businesses. *Omega*, 29, 143–156.

To, M. L., & Ngai, E. W. T. (2006). Predicting the organisational adoption of B2C e-commerce: an empirical study. *Industrial Management & Data Systems*, 106(8), 1133–1147.

Tornatzky, L., & Klein, K. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management*.

Wu, W. W. (2011). Developing an explorative model for SaaS adoption. *Expert Systems with Applications*, 38(12), 15057–15064.

Wu, Y., Cegielski, C. G., Hazen, B. T., & Hall, D. J. (2013). Cloud computing in support of supply chain information system infrastructure: Understanding when to go to the cloud. *Journal of Supply Chain Management*, 49(July), 25–41.

Zhu, K., Dong, S., Xu, S. X., & Hally, M. (2006). Innovation diffusion in global contexts: determinants of post-adoption digital transformation of European companies. *European Journal of Information Systems*, 15(October), 601–616.

Zhu, K., & Kraemer, K. L. (2005). Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry. *Information Systems Research*, 16(1), 61–84.

Zhu, K., Xu, S., & Dedrick, J. (2003). Assessing drivers of e-business value: results of a cross-country study. *Proceeding of the 24th International Conference on Information System*, 1–13.

Zhu, Y., Li, Y., Wang, W., & Chen, J. (2010). What leads to post-implementation success of ERP? An empirical study of the Chinese retail industry. *International Journal of Information Management*, 30, 265–276.