Factors Influencing the Success of Cloud Adoption in the Semiconductor Industry

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The adoption of cloud-based services stands out among the most innovative appropriations in the current competitive business scene. The semiconductor industry, in particular, is one of the most competitive. Cloud service adoption in the semiconductor sector aims at delivering the right quantity of the right product, at the right time, at minimum cost. Based on an extensive review of the literature, in this study the authors identify factors that contribute to the successful adoption of cloud services in the semiconductor industry related to technology, organization, and environment. Regression analysis of survey data collected from 188 respondents drawn from cloud service providers, the semiconductor industry, and allied fields finds that timely availability of electronic products in the market depends to a large extent on organizational performance, particularly on-demand product delivery, service availability, and top management support. Reduction of cost of a product is linked with customer satisfaction, legal complexities, and partner dependency. Market globalization of the services and electronic products are based on the timely launch of products, top management support, and a sense of help from and cooperation with partners. Understanding these success factors will help to reduce risk and ease adoption of cloud technologies in the semiconductor industry.

KEY WORDS

cloud computing, environmental factors, organizational factors, semiconductor industry, technological factors, TOE model

INTRODUCTION

The adoption of cloud services in the semiconductor industry promises to bring enhanced performance and increased productivity to the industry. Cloud-based supply chain management, for example, can help these organizations adapt to rapidly changing requirements in the current competitive environment. These services also improve information technology (IT) capabilities with the promise of rapid scalability, if and when that is required. By taking advantage of cloud computing and cloud-based services properly, these industries can expect accelerated growth.

Cloud technology provides the ability to integrate and share data and information across organizational boundaries on a real-time basis. This facility has already been adopted in many industries. Usually, each organization has its own strategy for adopting cloud services. Mehrsai et al. (2013) suggested there should be a coordination effort between the cloud service provider and the client's industry. As in the case of conventional information integration, adoption of cloud services should also take place in an integrated manner. Information and data should be accessible online, and everything should work on a real-time basis.

The semiconductor industry has been a model for innovation over the last couple of decades. The complexity of integrated circuit (IC) designs has increased, and the process to produce them has become more challenging due to variable market demand. The increasing computational complexity of electronic design automation (EDA) has resulted in a tremendous increase in demand for computing resources (Man et al. 2014). Implementing cloud services could help in both the design and production use cases.

To optimize time-to-market while maintaining the highest quality, lowest cost, best service, cleanest environment, and greatest flexibility, cloud computing is the most reasonable infrastructure choice (Tao et al. 2013). It is emerging as a technology for EDA applications and assembling. Web-based processing application services provide highly scalable hardware and software resources. These scalability and adaptability properties are quite strong. EDA software licenses can easily be added or removed as requirements shift (Ranjan 2011). Successfully implemented cloud services can also be helpful for processing and to ensure maximum utilization of computational tools.

However, the adoption of cloud services in the semiconductor industry can involve some serious challenges. Success requires attention to the factors that are required for running the industry smoothly. Adoption of third-party cloud services can be even riskier, because the organization's information assets must be managed by some outside agent. In this article, the authors explore and identify success factors for cloud services in the semiconductor industry to help organizations reduce risks and ensure positive outcomes. Findings will be useful to organizations in this industry that are considering cloud services, particularly top management who are responsible for making major decisions.

BACKGROUND AND MOTIVATION

During the last couple of decades, semiconductor industries have undergone remarkable changes. They have been able to reduce the sizes of many electronic devices to a remarkable extent, have expanded R&D capabilities, and have mobilized to address unpredictable market demand. New electronic devices showcasing improved execution, less power consumption, and better features have, however, given rise to greater complexities and unpredictability. Efforts are, of course, being made to reduce these – and adoption of cloud services has been of considerable help. Because of this enabling technology, semiconductor industries are able to grow and develop further. Several researchers have discussed these dynamics, including Kamath, Giri, and Muralidhar (2013) and Man et al. (2014), who explain the need for EDA applications on cloud-based architecture for semiconductor design. Misra et al. (2016) identified privacy issues that emerge in the context of distributed ERP systems. Chen (2014) noted that the largest semiconductor manufacturing organizations of the world are all investing heavily in implementing cloud services.

Supply chain management (SCM) has brought about several changes in semiconductor industry sectors over the past two decades. For example, information technologies (IT) and business services have been incorporated to improve performance. The integration of IT and information means of the cloud has further improved the performance of many organizations in this space as cloud-based services are adopted. Several researchers have studied challenges and other business aspects associated with adoption (Gen 2010; Leukel, Kim, and Schlegel 2011; Pearson and Benameur 2010; Lindner et al. 2010; Cheung, Cheung, and Kwok 2012; Morgan and Conboy 2013; Hsu, Chiu, and Chang 2012; Huang et al. 2014; Wang et al. 2015; and Khan 2016) of new technology that have been investigated in different contexts by Amritesh, Misra, and Chatterjee (2014), Misra et al. (2012), and Misra, Kumar, and Kumar (2010). Implementation of e-governance was discussed in (Amritesh, Misra, and Chatterjee 2014) in the context of e-counseling in India, while that of agile software development in different industries was covered in (Misra et al. 2012; Misra, Kumar, and Kumar 2010). It was found that the challenges faced during cloud adoption are multifold; they can be organizational, environmental, and technological. Challenges also can be related to maintaining security, privacy, and recoverability of data alongside compliance and network performance.

Opportunities presented by web-based services in the cloud in industrial organizations were discussed by Kalakota and Whinston (1996). These include consumer-oriented e-commerce, electronic payment systems, intra- and inter-organizational e-commerce, advertising and marketing on the internet, resource discovery, and consumer search. Singh and Rosin (2001) observed that information sharing has been greatly improved in many supply chain management projects that leverage cloud services. It is, however, important to note that risks and uncertainties increase when some services are adopted (Pereira 2009). Integrating web-based services may impact the ability of both buyers and suppliers to share data and information in real time (White 1996).

Yan et al. (2014) note that by adopting cloud services, organizations find it easier to share information in real time. According to Vickery et al. (2003), an organization can more easily integrate customers with suppliers via internet-based services. Cloud-based services also promote information sharing (Lenart 2011; Aleem and Sprott 2012). There are, however, challenges for adopting cloud services (Rimal and Choi 2012), for example, the issue of scalability. This poses challenges for the organization dealing with side channels, attacks via covert channels, and issues concerning authorization, identification, and authentication. Establishing security is another important facet of concern for the adoption of cloud services in an organization (Rimal and Choi 2012).

To address the issue of competition between cloud service providers in the cloud market, a non-cooperative stochastic game model was proposed by Truong-Huu and Tham (2014). Resorting to discrete choice, the probability of a user choosing a particular provider is evaluated and a game is modeled as a Markov decision process. There are, however, privacy protocols that need to be maintained while adopting cloud servers (Khan 2016). An intelligent economic approach for dynamic resource allocation (IEDA) has been suggested by Wang et al. (2015) to combat competition in the cloud market. It presents a combinatorial double auctioning protocol that facilitates simultaneous trading of resources between providers and users, and leads to effective task partitioning among multiple providers. A back propagation neural network algorithm for price prediction and formation was developed for the asking and bidding process, enabling eligible transactions among providers and customers.

The potential benefits of cloud computing have prompted many organizations to adopt cloud-based data sharing systems; however, there are several factors that are likely to hinder the successful adoption of cloud-based services in semiconductor industries. Risks and success factors from the literature are explored in the next section.

Determination of Success Measures

The semiconductor industry is developing rapidly, and firms fail or thrive under tremendous competitive pressure from their peers. Time-to-market and customer satisfaction are the main business success factors for these industries. To sustain their market position, semiconductor players must take utmost care to provide both of these things. This causes continuous pressure for engineers and researchers, who must develop and release new products quickly.

Sanchez, Savin, and Vasileva (2005) explained what is meant by "successful adoption" for any new technology. Dimensions of success may include effectiveness, efficiency, organizational attitude and commitment, and user satisfaction. The concept of success may change post-adoption after a period of usage, and stakeholders may have different opinions of what constitutes success, including cloud service providers, whose definition may be different from core players in the semiconductor industry (Sanchez, Savin, and Vasileva 2005; Markus et al. 2000). Project managers, however, typically consider three dimensions of success: time, cost, and quality (Schwaber and Beedle 2002). For the semiconductor industry, the authors select five criteria to examine the success of adopting cloud services:

- Electronic products are made available to the market in a timely manner (D1)
- Manufacturing cost is reduced (D2)
- Market globalization of services and electronic products (D3)
- Increase in productivity (D4)
- Improved coordination of design and manufacturing teams (D5)

Following is a brief discussion of each of these criteria.

Electronic products are made available to the market in a timely manner

Time-to-market is one of the most important parameters that aids in the success of any company. Customer satisfaction and quality also play a vital role. Time-to-market, product quality, and customer satisfaction depend on human resources, R&D facilities, and other capabilities. To reduce time-to-market, fast prototyping in product development is required, and this depends on the timely availability of computational capabilities and other resources (PMI 2004).

Manufacturing cost is reduced

Quality and cost are two of the predominant factors governing success in the semiconductor industry. Managing quality and controlling the cost of electronic products is a challenging task. Due to competitive pressures, the price of electronic products tends to rapidly decrease after release. At the same time, production costs rise over time, because new releases depend on research and development (R&D), skilled human resources, and computational resources. Reducing production cost is necessary for survival in this market (Singh and Rosin 2001; Stolbert et al. 2007). Some express that adopting cloud technology can help maintain the needed balance between quality and cost.

Market globalization of services and electronic products

Marketing refers to the management process by which services and products move from company to customer. It should include proper coordination of the following four points:

1. A product should be identified, selected, and developed properly.
2. The price of a product should be fixed, considering all relevant factors.
3. There should be a proper strategy for promoting the product.
4. A proper distribution channel should be chosen so a product can reach the customer quickly.

The requirement to reduce price while production costs rise is currently one of the biggest threats to the survival of organizations in this industry. Globalization of products and services is expected to combat this challenge (Calhoun 1993).

Increase in productivity

Semiconductor players are always particular in maintaining a balance between production costs and product costs to remain in the market (Davari 1999). By improving resource availability through proper integration and management, it is expected that cloud service adoption will help to increase productivity in this industry.

Improved coordination of design and manufacturing teams

For the timely availability of products, adequate R&D facilities and strong coordination between design and manufacturing teams are highly important. Skilled human resources must be available. One of the main objectives of enterprise adoption of cloud services is to integrate workflows globally. Rimal and Choi (2012) report that cloud service adoption promises to considerably improve coordination between design and manufacturing teams.

Technology Organizational and Environmental Model

The technology, organizational, and environmental (TOE) model is a conceptual framework that describes the adoption of new technology in terms of technology development, organizational development, and environmental factors. Following Low, Chen, and Wu (2011) and Baker (2012), the authors use the TOE model to explore cloud services adoption in semiconductor industries. For this study, the authors select six technological predictors of success of cloud adoption in the industries: 1) improvement in organizational performance; 2) computational efficiency; 3) improved scalability; 4) better trading partner; 5) competition among partners; and 6) availability of service and product on demand. There are five organizational factors: 1) time to market; 2) customer satisfaction; 3) size of the organization 4) top management support; and 5) integration of design and manufacturing services. Under environmental factors, the authors consider three variables: 1) competitive pressure; 2) partner dependency; and 3) legal issues.

The TOE model provides the independent variables that will be considered as potential predictors for this analysis, and has been a cornerstone of other similar studies to date. Low, Chen, and Wu (2011), Huang et al. 2012, and Lee and Kim (2007) found that top management support plays a vital role in adoption by providing required resources. Low, Chen, and Wu (2011) also noted that for adopting any new technology, firm size and competitive pressure play vital roles. Integration of design and manufacturing services was found to be most significant by Oliveira and Martins (Oliveira and Martins 2010). These factors are described in the following sections.

Technological Factors

1. **Improvement in organizational performance (Tech1):** The complexity of this industry comes less from the

complex processes involved in design and manufacturing, and more from the huge amount of confidential information that is generated during those processes. Fan (Cheng, Chen, and Chang 2012) introduced the concept of e-manufacturing, which advocates moving those processes to the cloud. This concept is used in integrated circuit (IC) design to reduce the failure rate and design complexity of electronic products.

2. **Computational efficiency (Tech2):** The success of a firm in the semiconductor industry is highly dependent on the availability of adequate and efficient computational resources. Stable demand of bandwidth is needed for progress, for example, to perform complex simulations to verify device characteristics and circuit design. Man et al. (2014) observed that adopting cloud services can provide precisely what is needed for this industry.
3. **Better scalability (Tech3):** Larger organizations can afford to bear the cost of high-speed servers for Big Data and providing improved computing facilities. Small and medium-sized companies may not have this budgetary flexibility, and may also have more pressing time and resource constraints. They may be compelled to expand EDA software, servers, storage, and/or networking unexpectedly in the final phases of a project. Ranjan (2011) observed that adoption of cloud services can render flexibility and scalability for cases like this.
4. **Competitive advantage (Tech4)*:*** As indicated earlier, semiconductor firms face strong competition and must launch products very quickly without sacrificing customer satisfaction. Improved features, smaller form factors, faster releases, and lower costs are all requirements based on this pressure.
5. **Better trading partners (Tech5):** Smaller players have recently developed partnerships with larger firms to secure and gain competitive advantage, including Samsung, Global Foundries, TSMC, and Intel (2013). The quality of established trading partners can influence decisions to adopt technologies such as cloud.
6. **On-demand product and service availability (Tech6):** The semiconductor industry relies on partnerships for research and development. Most universities, R&D labs, and small and medium-sized firms lack the funding for dedicated high-performance computing equipment. Man et al. (2014) suggested that if cloud services are adopted, these resources can be shared, ensuring availability of products and services on demand (Ranjan 2011).

Organizational Factors

1. **Time-to-market (Org1):** Bringing products to market faster, with improved features, smaller form factors, and at lower costs, is the essence of the competitive game in this industry (Wu, Qiao, and Poon 2014). Fast prototyping is thus also essential, with the goal of becoming an "early mover" and gaining benefits in terms of image (Wu, Qiao, and Poon 2014). Effective partnerships and integration of technology between partners impacts this factor.
2. **Customer satisfaction (Org2):** Since customer satisfaction is essential, a balance between quality and cost is always in focus. Customer requirements, however, change over time. Adoption of industrial cloud services is expected to promote customer satisfaction; as satisfied customers increase, so will rate of adoption.
3. **Integration of design and manufacturing services (Org3):** Wu, Qiao, and Poon (2014), Man et al. (2014), and Chen (2014) state that the ability to integrate services related to design and manufacturing processes, particularly across supply chain partners, depends on the timely availability of resources and services, flexibility, and scalability, which are all facilitated by cloud services.
4. **Top management support (Org4):** Resistance to new technology can be

overcome if top management promotes its adoption. This is particularly pronounced in the semiconductor industry (Ramdani 2009).

5. **Size of organization (Org5):** Size of an organization is a major factor for adopting any new technology (Awa, Ojiabo, and Emecheta 2015), but as cloud services grow the virtual organization, this can hold back the rate of adoption (Low, Chen, and Wu 2011). Management experience suggests that adoption of cloud services in the semiconductor industry becomes difficult if organizational size becomes too large.

Environmental Factors

An industry may face several challenges due to rapid changes in the competitive environment. Chang, Huang, and Shyu (1998) observed that environmental policies must be given priority for proper product development in this line of business. There were three factors explored in this analysis:

1. **Legal issues (Env1):** Complexities in legal factors can potentially pose problems in the adoption of cloud technology. Privacy laws and regulations need to be in place to sort out problems at the national/international levels, and are likely to be the major challenge in implementing cloud services (Morgan and Conboy 2013). There should be provisions to reduce complexities of legal issues.
2. **Competitive pressure (Env2):** Competitive pressure forces semiconductor players to bring improved features to the market in a timely manner (Zhu, Kraemer, and Xu 2006). Kinuthia (2015) observed that successful implementation of cloud services enhances the opportunity to increase partnerships with other companies. At the same time, this increases competitive pressure.
3. **Partner dependency (Env3):** Partners play an important role in bringing success to a company in the current competitive environment. Due to limited time interval between new product releases, a rush between different competitors aiming to fulfill the same market need is quite likely (Zhu, Kraemer, and Xu 2006). This creates a constant and unrelenting competitive environment. Heiser and Nicolt (2008) remarked that partner dependencies and good relationships can be very helpful to ensure on-time delivery of new products. Adoption of cloud services can help support these relationships on a global basis.

Relationships between these technological, organizational, and environmental factors are summarized in Figure 1.

METHODOLOGY

Based on an extensive literature review, the authors identified 14 potential predictors for success in the adoption of cloud services in semiconductor industries, classified into three groups: technology-related success factors, organization-related success factors, and environment-related success factors. Perceived risk factors were also identified. Next, the authors designed a survey to capture the perceptions of people who work in and with the semiconductor industry to examine these relationships. Their survey form consisted of mostly closed-ended questions (see Appendix A) but also included one open-ended question asking the respondents for feedback on the survey design itself.

Multiple regression analysis was used to study the relationships between predictor variables and the five identified dependent variables: electronic products are made available to the market in a timely manner (D1), manufacturing cost is reduced (D2), market globalization of services and electronic products (D3), increase in productivity (D4), improved coordination of design and manufacturing teams (D5). From the results obtained, a consolidated regression model was constructed to determine the effect of the independent variables on the dependent variable to determine the effect of a specific independent variable when other variables are controlled. The dependent variable was converted to a continuous variable by considering the average of all the dependent parts (D1-D5) and, hence, multiple linear regression was viable. The major assumptions taken into account for conducting the multiple regression analysis is that the relationship between the independent and dependent variables is linear. The normal distribution of the population under consideration was verified by p-p plots.

The target population for this survey was cloud service providers who serve the semiconductor industry, semiconductor industry member organizations, and others with knowledge and experience in semiconductors and cloud services, including government, software, educational centers, and researchers. One thousand questionnaires were sent by email, LinkedIn, Facebook messaging, and paper-based surveying, out of which 188 complete responses were received.

RESULTS

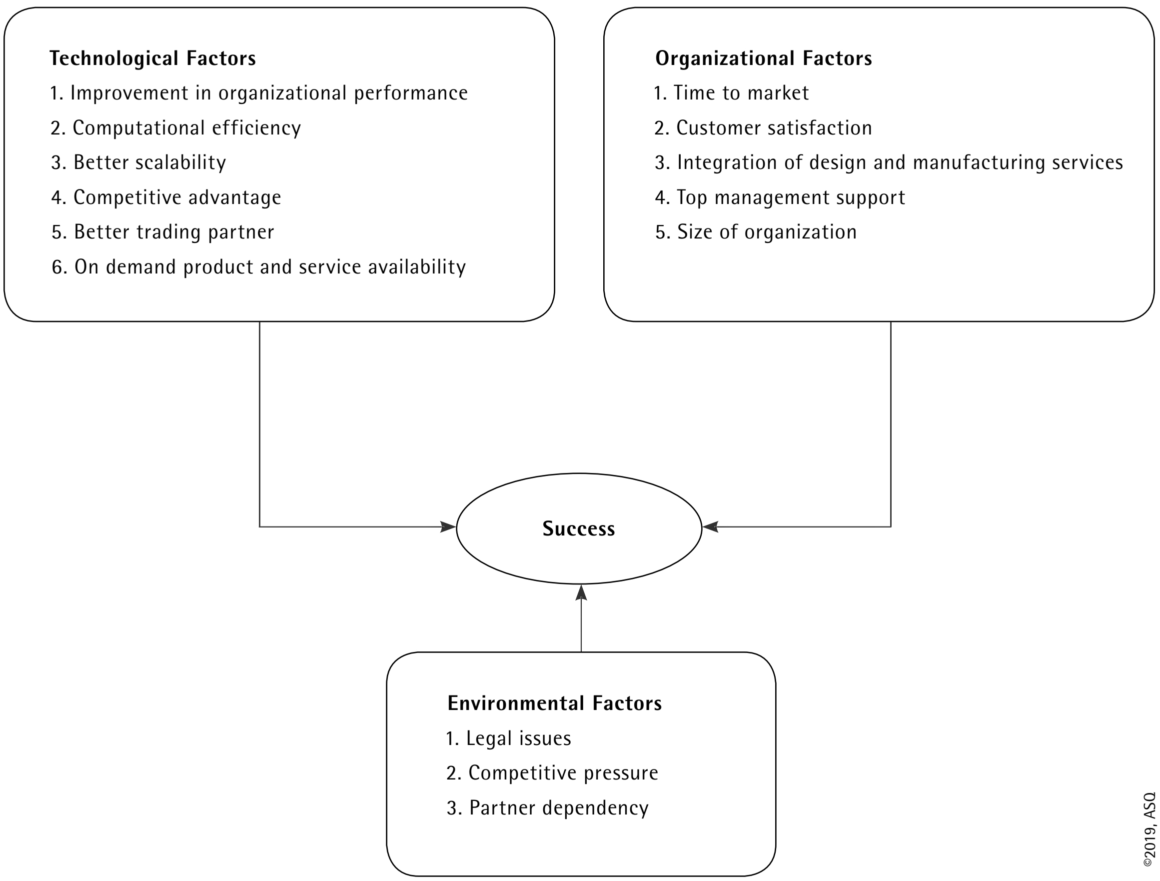
Out of 188 complete responses, 7 percent were responses from cloud service providers, 21 percent from stakeholders in the semiconductor industry, and 72 percent from the other affiliated areas previously described. Small and medium enterprises (SMEs) in the semiconductor industry with less than 300 employees (27 percent) were represented, as well as larger organizations in the industry (73 percent); these categories are broken down further in Figure 2.

Respondents came from all levels of experience: 20 percent were new to the industry, while 42 percent had spent between one and three years in it. Another 20 percent had three to five years of experience, while 13 percent reported five to 10 years, and 5 percent more than 10 years of experience in semiconductors. To ensure the data were not biased by the difficulty of completing the survey, respondents were asked to rate the ease of use of the survey form. The majority (70 percent) indicated the form was average, easy, or very easy.

Data Analysis

The data were analyzed using SPSS 16.0. By preparing the dataset from the survey response sheet, five-point Likert scale responses were replaced by numeric values (strongly disagree = 1, disagree = 2, neutral = 3, agree =

FIGURE 1 Hypothetical success factors model



APPENDIX A Success measure model for the adoption of cloud services in semiconductor industry

Mandatory

Please mark your type of organization. *

- ❍ Cloud service provider
- ❍ Semiconductor industry
- ❍ Other:_______________

Please mark the size of your organization. *

- ❍ Below 10
- ❍ 10 to 50
- ❍ 50 to 300
- ❍ 300 to 500
- ❍ 500 to 1000
- ❍ More than 1000

Please mark your experience in the above mentioned organization. *

- ❍ Less than 1 year
- ❍ 1 to 3 years
- ❍ 3 to 5 years
- ❍ 5 to 10 years
- ❍ More than 10 years

Kindly rate the success measures of cloud-based semiconductor industries. *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Electronic products are timely available in the market	❍	❍	❍	❍	❍
Manufacturing cost is reduced	❍	❍	❍	❍	❍
Market globalization of the services and electronic products	❍	❍	❍	❍	❍
Increase in productivity of the semiconductor industries	❍	❍	❍	❍	❍
Improved coordination of the design and manufacturing team	❍	❍	❍	❍	❍

Please indicate your level of agreement on the following factors for the successful adoption of cloud-based services in semiconductor industries. *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Improvement in organizational performance	❍	❍	❍	❍	❍
Computational efficiency	❍	❍	❍	❍	❍
Better scalability	❍	❍	❍	❍	❍
Competitive advantage	❍	❍	❍	❍	❍
Better trading partner	❍	❍	❍	❍	❍
On demand product and service availability	❍	❍	❍	❍	❍
Time to market	❍	❍	❍	❍	❍
Customer satisfaction	❍	❍	❍	❍	❍
Integration of design and manufacturing services	❍	❍	❍	❍	❍
Top management support	❍	❍	❍	❍	❍
Size of organization	❍	❍	❍	❍	❍
Legal issues	❍	❍	❍	❍	❍
Competitive pressure	❍	❍	❍	❍	❍
Partner dependency	❍	❍	❍	❍	❍

You are invited to specify any additional comments regarding this study. (Optional)

4, and strongly agree = 5). A check for missing values was done manually and none were found. To check reliability, the authors performed a Cronbach's alpha test and the test for composite reliability. A Cronbach's alpha value greater than or equal to 0.7 indicates the psychometric test is internally consistent; values greater than 0.6 are typically considered to be acceptable for further analysis (these are also the cut-offs for composite reliability). In the authors' analysis they found Cronbach's alpha value to be 0.77 for adoption success and composite reliability to be 0.85 (see Table 1) for the same variable, providing confidence in the internal consistency of the responses.

The authors also tested for multicollinearity. Multicollinearity can exist in a regression model if there are two or more predictor variables that are moderately or highly correlated. Existence of multicollinearity limits the conclusions that can be drawn from the research study. For each latent variable, the authors measured variance inflation factor (VIF), which gives them an idea of the severity of the multicollinearity, compared to a situation where the predictor variables have no linear relationship. When VIF is equal to one, the variables are not correlated. When VIF lies between 1 and 5, the variables are moderately correlated (but this is not problematic), and when it is between 5 and 10, the variables are highly correlated. Table 2 shows that the VIF values for the full set of variables are between 1 and 2, ensuring no problems due to multicollinearity.

Table 3 reveals the output of the multiple linear regression of the dependent variable D (which is the average of D1-D5 on all the predictor variables) for the initial model with all predictors included. Table 4 displays characteristics of the final model, with the four variables that were found to be statistically significant and excluding those that were insignificant. This was done to more clearly observe the effect of these variables on the dependent variable. The adjusted R-squared of this model was 0.328, indicating that nearly a third of the variation in the data is explained by the model. All predictors were significant with $p < 0.01$.

The final consolidated success (D) model equation is represented as:

$$D = 1.218 + 0.252*Tech1 + 0.128*Org1 + 0.158*Org3 + 0.127*Env3$$

The success factor D depends on Tech1 (improvement in organizational performance), Org1 (time-to-market), Org3 (integration of design and manufacturing services), and Env3 (partner dependency). The strength of dependency is indicated by the coefficients. The success of cloud technology adoption is largely dependent on improvement in organizational performance, but contributions from Env3, Org3, and Org1 are also reasonably high.

DISCUSSION

The findings of the empirical study were aligned with the literature in establishing the important factors for determining the successful adoption from the three realms: technology, organizational, and environmental. The authors were specifically able to elicit partner dependency as one novel factor that needs ample consideration. Industries should strive to maintain healthy relationships with partners and competitors

FIGURE 2 Size of organization (in terms of number of employees)

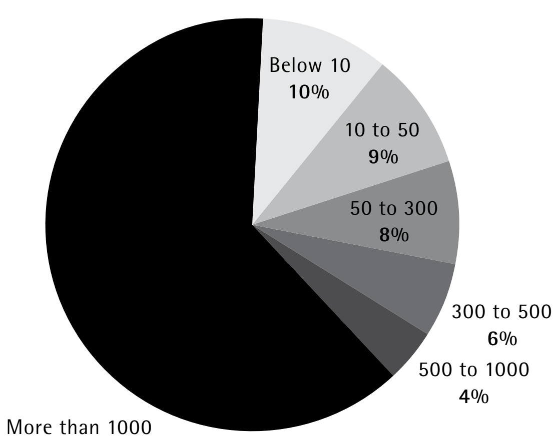


TABLE 1 Reliability analysis

Composite reliability coefficients			
Adoption (Success)	Techfact	Orgfact	Envfact
0.85	0.85	0.78	0.78
Cronbach's alpha coefficients			
Adoption (Success)	Techfact	Orgfact	Envfact
0.77	0.78	0.65	0.57

TABLE 2 Evaluation of multicollinearity

Model	Unstandardized coefficients		Standardized coefficients	t	Sig	Collinearity statistics	
	B	Std. Error		Beta		Tolerance	VIF
1 (Constant)	1.218	0.313		3.896	0.000		
Tech1	0.199	0.066	0.235	3.004	0.003	0.594	1.684
Org1	0.117	0.050	0.165	2.365	0.019	0.746	1.340
Org3	0.135	0.063	0.159	2.153	0.033	0.668	1.496
Env3	0.137	0.045	0.216	3.074	0.002	0.737	1.358
Tech2	0.013	0.067	0.016	0.201	0.841	0.576	1.735
Tech3	0.049	0.054	0.067	0.924	0.357	0.683	1.465
Tech4	0.018	0.053	0.025	0.333	0.739	0.646	1.549
Tech5	0.014	0.059	0.019	0.244	0.807	0.604	1.657
Tech6	0.029	0.062	0.036	0.468	0.640	0.631	1.584
Org2	0.021	0049	0.032	0.439	0.661	0.706	1.416
Org4	0.054	0.049	0.084	1.088	0.278	0.608	1.646
Org5	-0.018	0.054	-0.025	-0.342	0.733	0.689	1.451
Env1	-0.083	0.052	-0.113	-1.595	0.113	0.727	1.375
Env2	--0.014	0.057	-0.018	-0.243	0.808	0.686	1.458

so the overall sector benefits and continues to grow effectively. The success of cloud adoption as measured by the average of the five dependent variables was somewhat linearly dependent on improvement in organizational performance (Tech1), time-to-market (Org1), integration of design and manufacturing services (Org3), and partner dependency (Env3). The suggested determinants of success were statistically significant at $\alpha=0.05$ ($p < 0.02$ in all cases).

Overall, this suggests that adopting cloud technology invites growth and success for firms in this industry. Nonetheless, there are impediments that can possibly inhibit adoption, in particular, initial hesitation to invest in technology that is unfamiliar. Management should increase the awareness about the benefits of adoption, and help workers develop new skills and become comfortable with the new framework. Training should be considered a strategic investment. The "people" factor cannot be overlooked if the intention of adopting cloud technology is genuine.

The value in the regression model is not that it can be directly applied by practitioners, but that it reveals relationships between the factors that can assist in strategic decisions regarding direction and prioritization. For example, cloud adoption will be productive if the organization is agile enough to adapt to new processes, especially those that require critical review of confidentiality and accuracy when data are moved to the cloud. Time-to-market is yet another factor that should be directly addressed, along with support for fast prototyping, facilitated by connected design and development processes via the cloud. Integration of services related to design and manufacturing will ease the execution of tasks, allowing them to be completed in much less time and using fewer resources thus contributing to the bottom line. Having good relationships with partners will strengthen the chance of success particularly in a highly competitive industry when there is demand that could easily be met by other competitors.

The limitations of the current study can be summarized under threats to internal and external validity. The threats to internal validity may be attributed to omitted variable bias (variables missing from the analysis, for example, educational levels of the respondents, which might improve the model), simultaneous causality (reverse causality observed between dependent and independent variable), misspecification of the functional form (inappropriate assumption of linearity), or sample selection bias (due to research design). Since the study respondents were from a small geographical unit and limited number of industries, the results may not be generalizable to other populations. Different perceptions of risks and challenges may present different results in other parts of the world. The study could be strengthened by incorporating results from semiconductor firms in other countries, as well as by considering other factors like privacy risks.

CONCLUSIONS

The overall goal of this work was to advance understanding in the semiconductor industry by identifying the critical success factors for the successful adoption of cloud services and technology. Market globalization of products and services plays a key role in bringing success to this industry, and information sharing has become easier due to globalization. Partners are absolutely essential for success in this arena. Results indicate that incorporating these success factors into strategic and operational planning will reduce risk and ease adoption of cloud technologies in the semiconductor industry:

1. Electronic products are made available to the market in a timely manner (D1): Timely availability of electronic product is a measure of success for semiconductor industrialist or player. The main target of adoption of cloud technology or service in the semiconductor industry is to ensure the timely availability of products with improved quality. Intuitively, time-to-market of electronic product is predicted by organizational performance, product demand in the market, and desired management support such as R&D section, laboratories, and various skilled human resources.
2. Manufacturing cost reduction (D2): Controlling the manufacturing cost of electronics is one of the biggest challenges for semiconductor players. The cost of production will decrease with fewer legal complexities and lower taxes. Additionally, because partners are frequently leveraged for design or fabrication, total costs are dependent upon manufacturing channels.
3. Market globalization of the services and electronic products (D3): The ability to sell and distribute to the global market depends on top management's vision and performance of all partners in supply and distribution channels. Market globalization also helps to ensure timely delivery of electronics to the market.
4. Increase in productivity of the semiconductor industries (D4): In this industry, productivity depends on quality of trading partners, involvement in basic and applied research (R&D), and capability of design and manufacturing teams.
5. Improved coordination of the design and manufacturing team (D5): Coordination of teams improves as integration between design and manufacturing services increases. Shared market requirements and the mutual desire for timely product launches also facilitates coordination among team members.

The main theme uncovered in this work was that enhancing productivity should be the primary goal, and this can be done by selecting high-quality partners and emphasizing integration of services across organizational boundaries to support more efficient and effective design and manufacturing. Adopting cloud services can also reduce the product costs and increase margins by addressing major success factors on technological, organizational, and environmental levels.

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TABLE 3 Regression coefficients for initial model

	Unstandardized coeffcients		Collinearity statistics		
Model	B	Std. Error	Beta	t	Sig.
1 (Constant)	1.218	0.313		3.896	0.000
Tech1	0.199	0.066	0.235	3.004	0.003
Tech2	0.013	0.067	0.016	0.201	0.841
Tech3	0.049	0.054	0.067	0.924	0.357
Tech4	0.018	0.053	0.025	0.333	0.739
Tech5	0.014	0.059	0.019	0.244	0.807
Tech6	0.029	0.062	0.036	0.468	0.640
Org1	0.117	0.050	0.165	2.365	0.019
Org2	0.021	0.049	0.032	0.439	0.661
Org3	0.135	0.063	0.159	2.153	0.033
Org4	0.054	0.049	0.084	1.088	0.278
Org5	-0.018	0.054	-0.025	-0.342	0.733
Env1	-0.083	0.052	-0.113	-1.595	0.113
Env2	-0.014	0.057	-0.018	-0.243	0.808
Env3	0.137	0.045	0.216	3.074	0.002

TABLE 4 Regression coefficients for final model

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	1.280	0.271		4.719	0.000
Tech1	-0.252	0.057	0.297	4.384	0.000
Org1	0.128	0.044	0.181	2.905	0.004
Org3	0.158	0.057	0.187	2.753	0.007
Env3	0.127	0.040	0.199	3.161	0.002

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