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RESEARCH ARTICLE

Identifying the moderating effect of trust on the adoption of cloud-based services

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Summary

Cloud computing provides a way to coordinate and share relevant information and data on real-time basis over an organization. The adoption of cloud services is one of the most emerging technological advances in the practice of current competitive business environment. The research done in this article is based on the analysis of the data obtained from the semiconductor sector. Cloud adoption would most likely be the best answer for them. However, because of various types of complexities, semiconductor industries may have to confront with a few trust issues while receiving cloud services. This article aims to identify the trust factors in the adoption of cloud services in semiconductor industries. Further, the moderating effect of these trust elements related to the technological, organizational, and environmental success factors has been discussed here. On the basis of literature survey, a hypothetical model has been developed, and the relationships among the latent variables have been studied by using structural equations. The study reveals that while trust factors moderate the technology and environment-related success factors, there is not much moderating effect of the trust issues on the organization-related success factors in the adoption of cloud services in semiconductor industries.

KEYWORDS

cloud computing, environmental factors, organizational factors, semiconductor industries, structural equation modeling, technological factors, trust issues

1 | INTRODUCTION

Information technology (IT) adoption, especially the adoption of cloud computing, is the steady boost for industries nowadays. One of the main segments that affect the investigation of cloud-based supply chain management is the incessant changes stood up to by the organization, which are required to oversee the present competitive environment. Perseveringly improving IT, particularly cloud services, had outfitted various relationships with additional up to date capacities and resources for updating and upgrading the organizational performance. Cloud-based technologies are reliably improving IT environment incorporating changes and modifications to the present business structure. Semiconductor industries are one of the tech giants in present business sector. They are additionally hoping to grow their business by receiving cloud computing and cloud-based services. Cloud services, which have the capability of integrating and sharing the data and information on a real-time basis, have been adopted by many industries. The models, inciting the ascent of the cloud adoption, rely upon the incorporation of failure of previous information and data integration services. Although several organizations have their own specific strategies for applying cloud services, Mehrsai et al[1] recommended that there should have a proper coordinated effort between the cloud service provider and client industry. Cloud computing resemble an application that is kept up at web servers, sometimes maintained from some other countries. Unlike the conventional information integration process, cloud services works in an integrated manner, where the information and data would be accessible online and everything will be on real-time basis.

The rapidly growing semiconductor industries are playing a critical role in the development of different nations. Even some small countries have built up their economy just by

concentrating on the advancement of semiconductor organizations. Since 1987, Unites States has a development rate of 9% in this area, whereas it is only 4% for other industries.[2] Currently, semiconductor organizations have gained excellent ground, so far as integrated circuit (IC) outline and process technology are concerned. The advancement of micro- and nanochip items has definitely taken the semiconductor industries into different paradigms. The complexity of IC design and process has increased quite significantly because of frequent variation in the market demand. This also causes growing computational complexity of electronic design automation (EDA), resulting in explosion of demand for computing resources.[3] The possibility of fragmenting this vast and industry into smaller teams and groups has also been thought over.[4] The blend of complexity in products, market forces, and advanced methodologies has led to a move for new chip generation by using new segments discovered in recent year. It has been a great challenge for scientists and semiconductor organizations to keep parity with new generation chips, keeping in view the time and cost constraints.[5] The adoption of cloud services is believed to overcome the challenges. The adoption of cloud services is likely to bring down the assembling time and cost of different items. To achieve the point of speediest time to market, highest quality, lowest cost, best service, cleanest environment, greatest flexibility,[6] cloud computing is being thought of as the choice. Cloud computing is likely to open a new window for EDA and assembling. Cloud technology, the web-based processing application service, provides highly scalable hardware and software resources. The properties of scalability and adaptability add to the convenience of adopting cloud services in different industries. As and when required, EDA software licenses can be added or removed.[7] The fruitful execution of cloud services is necessary for further processing. Then it can be used for use of computational tools that can be developed and scaled properly, although it may reduce the requirement for huge upfront investments that characterized IT enterprise networks setup. In that case, the personal data and processing methods may be leaked to outsiders.

However, the adoption of cloud services in semiconductor industries might involve various challenges and trust issues. The adoption of a third-party cloud service is likely to transfer the information of internal process of an organization to some external agent. This may affect the consumer trust negatively. Therefore, before the adoption of cloud services from a third-party agent, a semiconductor industry has taken care of the trust issues. The effect of these trust concerns may hinder the success of the organization. It may be maintained that it is important to examine the effect of trust in the Internet even to access its effect on the implementation of cloud services in various industries and that even the moderating effect of buyer-supplier trust has an important bearing on the relationship between delivery performance of a supplier and outsourcing. In the present study, an attempt has been made to identify the moderating effect of trust issues on the technology, organizational, and environmental (TOE)–related success factors associated with the adoption of the cloud services adoption in semiconductor industries.

2 | BACKGROUND AND MOTIVATION

Supply chain management has brought several changes in the field of management science. Several ITs have been used to improve business services. The integration of IT with information sciences (IS) enables the organization to manage the process involved in their business in a better manner. The development of Internet-based services especially cloud computing has taken the current business process of integration to a new technology-driven process. The integration of IT and IS with cloud computing has improved the performance of an organization. With the development of cloud-based services, many organizations have tried to adopt this new data management system with an aim to improve their performance. Several researchers have studied different issues related to the adoption, challenges, and various business aspects for adoption of cloud services in an organization. Some researchers, including Gens,[8] Leukel et al,[9] Pearson and Benameur,[10] Lindner et al,[11] Cheung et al,[12] Morgan and Conboy,[13] Hsu and Yang,[14] Huang et al,[15] Wang et al,[16] Misra et al,[17,18] and Khan[19] have given a comprehensive overview of cloud services and cloud computing.

Kalakota and Whinston[20] discussed the possibilities to broaden the ways for adoption of cloud computing. They illustrated the opportunities of web-based services in business activities. White[21] showed that integration with web-based services had enabled both buyer and supplier to share real-time basis data and information. The tremendous growth in the IT sector inspired other industries to adopt cloud technology-based services. Singh and Rosin[22] mentioned that adoption of cloud services has improved the process of information sharing for many supply chain projects. The implementation of Internet-based services enables the organizations to integrate the customers with suppliers.[23] However, Pereira[24] showed that with the increase in technology-based services, the chances of risks and uncertainties were on the rise. The adoption of cloud-based services was portrayed as a wonderful tool for sharing information in any organization by Lenart[25] as well as Aleem and Ryan Sprott.[26] Rimal and Choi[27] identified that there are several challenges in the adoption of cloud computing, although there are some advantages of the adoption of cloud computing. Collaboration between management practices and information sciences in the supply chain networks has been preferred in industrial sectors.

Yan et al[28] emphasized that the adoption of cloud computing would enable any organization to share the information on real-time basis. Using some case studies, they

showed that their model can be applied to solve some industrial problems. Truong-Huu and Tham[29] proposed a game theoretic model to help both cloud providers and user industries in integrating cloud computing in different organizations. Zhang et al[30] showed that there are several privacy protocols that need to be taken care of before adopting cloud computing. Wang et al[16] proposed a modified model with resource allocation in the cloud adoption in organization.

The past couple of decades have witnessed tremendous expansion of semiconductor industries, which have had the ability to offer products in business sectors without much more consideration of limit and cost effectiveness. Changes that have occurred in recent years include smaller versions of device size, hence, in cost of research and development, as well as unpredictability in the market because of a diminishing trend of prices of electronic products. The low cost and high performance devices are functioning well in semiconductor industries, and they are able to meet the market demand. The new electronic devices with better execution, for instance, quicker with lower power requirement, have caused more complexity and more unpredictability. The financial issues are exacerbated by complexities and difficulties in keeping up the dynamic changes in semiconductor industries. The changing plans are being worked out with an aim to drive more associations to extend the research and development of semiconductor industries to reduce the cost of production and also to bring down the complexities. Cloud computing has brought about the additional advantages in semiconductor industries, due to which there can be potential development. Several researchers have discussed the needs and advantages of cloud computing in semiconductor industries.[3,7,31] They have also explained the need of EDA applications in semiconductor industries. These articles described the cloud-based architecture for semiconductor design, namely, cloud EDA. The authors have also argued that the adoption of cloud-based technologies would enable the semiconductor industries to globalize its business. In previous communication, Misra et al[17,18] reported their study, in which they have identified the privacy issues for the distributed ERP systems. While adopting cloud-based technologies, these privacy issues would be very useful. Chen[32] and Wu et al[33] focused on the applications and implementation of cloud-based technology for semiconductor industries. Chen[32] has maintained that the largest semiconductor manufacturing industry (TSMC) of the world is focusing on the implementation of cloud services.

The potential benefits of cloud computing has led many organizations to adopt the cloud-based data sharing system. Semiconductor industries are still lagging behind in adopting cloud computing in its existing structure. As mentioned earlier in this communication, there are several challenges in the adoption of cloud-based services in semiconductor industries. Several trust issues also are associated with the adoption. These trust issues could moderate the success of the adoption of cloud-based services in semiconductor industries. In this study, we have tried to identify the trust issues associated in this adoption. The present study is motivated toward identifying the moderating effects of these trust factors in technology, organization, and environment-related success factors in the adoption of cloud in semiconductor industries. The analysis that follows is based on the application of various advanced methods of statistics. The reliability analysis has also been conducted. The results have been adequately discussed. The findings of the present research study would enable a semiconductor industry to take care of the trust issues for the successful adoption of cloud services.

3 | THEORETICAL BACKGROUND AND SUCCESS MEASURE FORMULATION

As mentioned already, semiconductor industries are growing fast. There exists a spirit of competition among the top industries. They try to come forward with more and more advanced features. Customer satisfaction is considered to be yardstick for the measure of success of any company. Customer satisfaction and timely launching of products in the market constitute 2 serious challenges that every company should look into. The said factors induce constant pressure of work because timely completion of any project is very important for any company. Success of any project depends upon the technical, economic, and quality parameters. Sánchez et al[34] gave an explanation of successful adoption for any new technology. According to him, dynamic concept of success may change after a certain period of adoption and usage. It depends largely on customer requirement, production management, and organization. There are several dimensions of success of an organization. The dimensions may be classified according to effectiveness, efficiency, organizational attitude, and commitment as well as users' satisfaction. Different stakeholders of the adoption of any new services may have different viewpoints of the success for semiconductor industries. Success for the cloud service providers may be different from that in the case of semiconductor industries and consumers.[34,35] However, any project manager would like to have 3 dimensions in their success measures, viz, time, cost, and quality.[36,37] Here we use the following 5 criteria to determine the success of the adoption of cloud services in semiconductor industries:

- Electronic products are timely available in the market
- Manufacturing cost is reduced
- Market globalization of the services and electronic products
- Increase in productivity of semiconductor industries
- Improved coordination between the design and manufacturing team

3.1 | Electronic products are timely available in the market

For a semiconductor company, timely display of their products (such as mobiles, computers, and laptops) in the market before their competitors can do it plays a crucial role for success. Time to market, customer satisfaction, and product quality of a company mainly depend on some important factors like human resource, R&D facility, etc. Moreover, fast prototyping for developing the technological process and execution of design should be done, well in advance for the next technology node. These constitute the major issues for the industry.[38]

3.2 | Manufacturing cost is reduced

Quality and cost are 2 main factors, which gives measure of success for a semiconductor organization. These 2 parameters are complementary to each other. It is a very difficult task to manage these 2 parameters together. Nowadays, because of competitive pressure, product cost reduces day by day, but cost of production increases. Production cost depends on various parameters, such as R&D, skilled human resource, production equipment, etc. It has always been challenging to reduce cost of electronic gadgets. However, it is highly necessary for the success of a semiconductor industry because the market has become highly competitive. Maintaining a balance between quality and cost can be made possible by scaling the physical dimensions of various devices. This leads to the adoption of next generation technology, keeping in view of the competitive market and consumer demand. However, aggressive scaling of a device leads to increase in complexity for design and manufacturing both. Also, smaller node technology always requires much more sophisticated tools and manufacturing resources. To meet all these requirements with reduced time to market is the key success in today's consumer electronics.[22,39] Smart semiconductor players feel that the adoption of cloud technology is very helpful in reducing the design cycles of different products and also cost of the resources.

3.3 | Market globalization of the services and electronic products

The cost of electronic products is reducing gradually, but the cost of production (both design and manufacturing of equipment) is always increasing. This is one of the biggest threats for future growth of an industry. Semiconductor designers and manufacturers are always very much concerned about the cost. Resource availability and cost have always been challenging for semiconductor players. Calhoun,[40] while discussing a model of a semiconductor manufacturing company, added that the trend of increasing cost of a semiconductor device is a serious threat for the growth of semiconductor industries. He also tried to explain different aspects of the viability of semiconductor business.

3.4 | Increase in productivity of semiconductor industries

As discussed earlier, quality and cost are the 2 main success factors for a semiconductor organization. These 2 variables have direct effect on customer satisfaction. Cost maintenance, ie, parity between the cost of a product and the cost of its production, is one of the biggest challenges for modern semiconductor industry. Semiconductor players have always been serious to maintain parity between the production cost and product cost to stay in the market.[41] Because of better resource integration and management, it is expected that cloud service adoption will be much more useful for productivity improvement for modern semiconductor industries.

3.5 | Improved coordination of the design and manufacturing teams

For faster R&D, it is very important to maintain a healthy coordination between various laboratories and design team, and research organization is very important. Skilled human resource is the key to success for a semiconductor industry. The main objective of adopting of cloud services is to integrate the services across the semiconductor industries. Being a large and complex industry, semiconductor industries are expected to improve their business practice by coordinating all their divisions and providing the whole team with necessary data and information in real-time basis.[27] The purpose of the adoption of cloud services is to solve these issues. Therefore, if the cloud computing be able to stand with the expectation and can improve the coordination of the design and manufacturing teams, the adoption can be considered to be successful.

4 | TECHNOLOGY-ORGANIZATIONAL AND ENVIRONMENTAL MODEL

The TOE model was developed by Tornatzky and Fleisher,[42] who discussed the factors that influence new technology adoption. In the present work, we have adopted the TOE model for the promotion of cloud technology in semiconductor industry. The TOE model contains 3 context groups named technological, organizational, and environmental. The technological context covers the internal and external effects of technologies that are relevant for an organization. Organizational context covers several characteristics and resources of an organization that could affect the technology adoption, and lastly the environmental context covers the size and structure of the organization, the competitors of the firm, and regulatory environment.[42]

In our current work, we have used a TOE model developed by Low et al.[43] The model used in this research suggests 6 technological predictors of cloud services adoption in semiconductor industries—improvement in organizational

performance, computational efficiency, better scalability, competitive advantage, and better trading partner, as well as on demand product and service availability. Organizational context proposes another 5 attributes—time to market, customer satisfaction, integration of design and manufacturing services, top management support, and size of the organization. To adopt new technology, top management support plays a crucial role in providing the required resources.[43–45] Low et al[43] discussed the effect of firm size on the adoption of any technology. The effect of integration of design and manufacturing was discussed by Zhu et al[46] as well as by Oliveira and Martins.[47] They also clarified the ability of IT resources for the adoption of new technology. Moreover Low et al[43] and Oliver[47] dwelt on the competitive pressure.

4.1 | Technological factors

4.1.1 | Improvement in organizational performance

Semiconductor companies commonly generate huge amount of confidential data. The data are generated during design and manufacturing processes. The idea of e-manufacturing[48] is used in IC design to reduce the failure rate and design time of complex electronic products. In e-manufacturing and web service–based technology, there is need to engage a good service provider for supporting this technology and for providing satisfactory server storage and networking. It is our apprehension that cloud computing will play an increasingly significant role to improve the performance of semiconductor companies.

4.1.2 | Computational efficiency

Computational efficiency is the key to continuous progress of this technology. In this industry, major work is dependent on high computing facilities to perform computationally complex simulations to check the device characteristics, circuit testing, and verification of complex circuits/system level design. For design industry, electronics design tools are of various types and also very costly. Thus, small- and medium-sized organizations cannot afford to purchase. On the other hand, hardware and software purchased by big companies cannot be fully used. Some of the equipment are not used and thus there is wastage of resources. Cloud computing provides facilities to share hardware and software among different individuals or companies.[3] The successful implementation of cloud technology in semiconductor sectors will provide scalable and flexible computing platforms and will offer various ways to improve the computing efficiency and efficient human resource use. This can be archived only by proper training.

4.1.3 | Better scalability

Companies having huge turnover and large foot print could afford to the cost of high-speed servers required for big data and computational work and could effectively use them for efficient resource management practice. At the same time, medium and small companies having dedicated project could face financial problem for purchasing high-speed servers and costly advanced tools for verifications. Another issue is related to the workload variability and verification of project that comprises the individual block level and the subsystem level. In IC design, time to market is a critical factor to make it profitable; therefore, its design, testing, and verification need to be completed in short time span. Limited resources could bring the deadline to last stage and unexpected pressure buildup. Such a situation compels the management to increase number of EDA software licenses and server farm (such as servers, storage, networking, etc.) to complete the project in time. In similar situations, scalable and flexible computational facilities are very much required. The cloud-based services offer flexibility as well as scalability and so bear the advantage of providing thousands of servers quickly according to requirement, which could be scaled up or down.[7] The flexibility in cloud services is advantageous to small- and medium-level companies also because they pay for the facilities only for the period they use them. The factors of flexibility and scalability can be a boon for the semiconductor industry also.

4.1.4 | Competitive advantage

Competitive advantage is a business concept that describes attributes that allow an organization to better improve its own production scenario. The semiconductor industries are rapidly changing mainly because they have developed partnership with other big players such as Samsung, Global Foundries TSMC, Intel, etc.[49] This partnership has created pressure on them to come up with better products. Basically, for cloud-based services, the operation is conducted using the Internet. The expected benefits embedded in cloud services include collaboration with various organizations and speed of business communications.[43] Thus, the effective implementation of cloud services will be much more useful for present semiconductor players as well as for other companies, which are associated with them.

4.1.5 | Better trading partner

The semiconductor industry is basically a business oriented organization and is getting matured with the passage of time. There is much competition for timely product launching and for customer satisfaction. As indicated earlier, the semiconductor market always strives for better product with improved features. This trend of semiconductor organizations is also causing reduction in the life cycles of the products and is accompanied by shrinking of product size. The cost reduction of different products is one of the big challenges for companies. In view of all these issues, it has become a great challenge for the companies to stage in the market. So far, companies will have altered the traditional mind-set for business. Recent research studies report that trading partner

pressure is also important for adopting the new technology for staying in the market.[17,18] Cloud technology is becoming more and more popular for better trading support.

4.1.6 | On demand product and service availability

Lack of resource availability is one of the biggest issues for failure of any project. Usually, small- and medium-sized semiconductor companies often suffer from this difficulty. Review of exiting literature indicates that most of universities, companies, and R&D laboratories also suffer from lack of resources. The successful implementation of cloud technology especially for semiconductor sectors will help reduce these issues. Through cloud computing, all the resources, such as hardware and software, can be shared and offered to individuals or companies as and when required.[3] Cloud technology has also the capability to scale the resources according to requirement. There will be no possibility of any time lag. Moreover, the costumer will not be required to make any payment when they do not use the facility.[7]

On the basis of all the previously mentioned technological factors, we can hypothesize the following:

H1 *Technology-related factors have no effect in the adoption of cloud services in semiconductor industries.*

4.2 | Organizational factors

4.2.1 | Time to market

Semiconductor players always look for opportunities for launching new products. The timely launch of the products is the key component for any company's success. Speedy prototyping is required for developing any new process or design technology.[38] The industries also try to launch devices with advanced features to capture better market. It is always an advantage for the companies if they can launch the devices in the market, earlier than their competitors. Early movers begin building their image in the market as they launch new products. Being the key success factor, "time to market" plays an important role in being successful. Consequently, fast prototype design and process development are always welcome.[33,50] The successful implementation of cloud services in semiconductor organizations is always necessary for good collaboration with various universities and R&D centers for developing new prototype/model design.

4.2.2 | Customer satisfaction

In semiconductor industries, the success of launching any devices mainly depends on customer satisfaction. The customer satisfaction strongly depends on reliability of electronic product. Consumers of electronic gadgets today look for new product with advanced features. This demand of customers creates increase complexity for ICs. Thus, "customer satisfaction" is always challenging. The scaling size of different devices has always been considered important by customers. Increasing number of components, shrinking device size, and maintaining longer battery life with high speed are considered as critical challenges for circuit designers as well as manufacturers.[51]

4.2.3 | Integration of design and manufacturing services

The availability of service is the main factor for success in completing any project timely. Companies often face the problem of resources availability. This issue is very challenging for small- or medium-sized organizations. One of the important aspects of the successful implementation of cloud services in a semiconductor organization is that it should have the capability to integrate various services for design and manufacturing keeping an eye on the customer demand.[3,32,33]

4.2.4 | Top management support

Top management always plays the role of driver. It is an important key to the success of any project. Top management has definitely a positive influence on the adoption of technology in an organization. It decides all the policies and guidelines. Because of much more competitive environment, any semiconductor organization always needs such type of services. Commitment of top management plays a crucial role in the adoption of cloud-based services. Adopting cloud services may lead to some changes for the organization. A major or minor change at the execution level is of common occurrence. Such changes may be met with resistance within the organization. However, such a resistance can be reduced if the top management that has a positive attitude toward the technology adoption.[52]

4.2.5 | Size of organization

The size of an industry is a major factor affecting the adoption of a technology.[53] The size of the organization is also vital factor. The successful adoption of cloud services, with the help of the Internet, bears the potential to increase the size of an organization.[43] Their study shows that the adoption of cloud services in large industries may also exhibit some difficulties.

Thus, the following can be hypothesized:

H2 *Organization-related factors have no effect in the adoption of cloud services in semiconductor industries.*

4.3 | Environmental factors

Because of rapid change in the environment of high-tech companies, it faces several challenges. For most of semiconductor industries, in order that there can be continuous growth of operation, it is necessary that the policies of the industries are good. Environmental protection policy is also a key to the success in the design and manufacturing of an industry. In cloud technology, cloud servers should be

capable of improving recycling operation, lowering carbon and gas emission, and minimizing water usage in the cooling of different machines in the industry. Environment protection policy should be given due importance, alongside product development of business[54]

4.3.1 | Legal issues

In cloud-based semiconductor industries, because of mutual dependency between cloud service provider and semiconductor organization, various types of privacy laws and regulations exist. The privacy issues may be local or international. The proper handling of legal issues is one of the biggest challenges in the implementation of cloud services.[13] Highest priority should be given to reduce the complication of the legal issues. Because cloud service providers and partners have to work together with the semiconductor industry, there can be several legal and security issues related to infrastructure, access control, risk management, regulatory and legislative complains, auditing and logging, integrity control, and cloud computing provider dependency risks. For the effective and successful implementation of cloud services, there should be proper guidelines and transparent laws for resolving various legal issues.

4.3.2 | Competitive pressure

The quality improvement in a product from one generation to next generation largely depends on the competitive pressure along with trading partners.[46] Kinuthia[55] mentioned that the successful implementation of cloud technology increases the partnership semiconductor market and also the competitive pressure of which the partners have an urge to display their products with some new features, timely in the market.

4.3.3 | Partner dependency

To be successful in the present competitive environment combined with constant market pressure, partner dependency is also a very important factor. It creates continuous pressure for the companies. A study shows that for any big project or chip design, partner's dependency and deep relationship are very useful for successful and timely completion.[56] The successful implementation of cloud services will provide good opportunities for developing healthy deep relationship among semiconductor industries, partners, and cloud service providers.

On the basis of all the above technological factors, we can hypothesize the following:

H3 *Environmental factors have no effect in the adoption of cloud services in semiconductor industries.*

5 | TRUST ISSUES

The key barrier to cloud adoption in semiconductor sectors is trust. According to Rotter,[57] "trust" is an important variable, which can affect human relationship at all levels. "Trust" depends on parties involved in any a transaction. Because cloud services is an Internet-based application and semiconductor organizations have a lot of confidential information, transmission of data via Internet mainly depends on "trust" between service user and provider. However, security issues arise mainly when privacy level goes down. Some people are of the opinion that the adoption of cloud technology mainly depends on "trust" between service provider and user.

5.1 | Correctness

Correctness is a variable parameter, which depends on data governance model of any service provider. Because cloud technology is a completely new concept, for matured semiconductor players, this service adoption mainly depends on trust and information correctness.[45] Any wrong information provided by cloud services provider is harmful for both the parties. Thus, correctness is very important for the adoption of any new service.

5.2 | Availability

Availability of a service is another important parameter for success of any company. Since cloud technology is Internet -based, the availability of service mainly depends on Internet. When speed of the Internet is weak or off-state, cloud services are greatly affected.[58] Internet interruption is one of the main causes for service interruption. In semiconductor industry, various processes need the availability of services without any interruption.

5.3 | Reliability

The reliability of a system refers to its capability to perform in a consistent and precise manner. It is another factor that can affect the adoption of any new technology. The success of any company largely depends on reliability. "Reliability" may turn out to be one of the biggest challenges for cloud services provider.

5.4 | Security

This is a parameter that assures its ability to resist attacks from any factor, so that the data and services are protected so that there is no possibility of being leaked. In a semiconductor industry, much of data connected to different operations, including production, need to be kept with a high degree of confidentiality so that there is no possibility of being leaked. It is known that during semiconductor design, manufacturing, simulation, and manufacturing process, huge amount of data are generated. The confidentiality level of these data is much higher than other sectors. The transmission of such types of data depends on liability between service provider and users. However, a semiconductor vendor

puts their IP on servers, which are outside their control, and liability issues open up if something goes wrong.

5.5 | Survivability

It refers to the capability of a system to provide a level of services to safeguard against any hostile condition.[59] In a semiconductor industry, survivability is an important factor for its success, particularly when cloud services are adopted.

On the basis of trust and its effect on the TOE model of cloud service adoption, the following hypotheses were formed:

H4 *Trust issues have no effect in the adoption of cloud services in semiconductor industries.*

H5 *Trust issues have no moderating effect in the technology-related factors for the successful adoption of cloud services in semiconductor industries.*

H6 *Trust issues have no moderating effect in the organization-related factors for the successful adoption of cloud services in semiconductor industries.*

H7 *Trust issues have no moderating effect in the environment-related factors for the successful adoption of cloud services in semiconductor industries.*

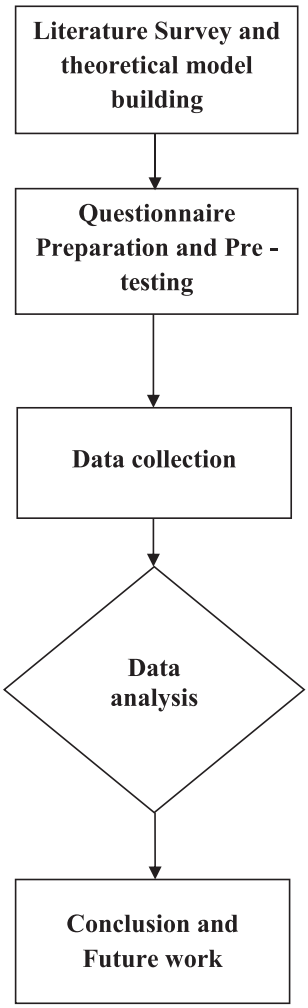

FIGURE 1 Flow chart

6 | QUESTIONNAIRE DESIGN

The flow chart depicts the flow of doing research in this article (Figure 1). On the basis of a review of existing literature published in the field of management sciences and industrial engineering, we have identified the indictor variables for different success factors related to technology, organization, and environment. Trust factors have also been identified along with the success measures of cloud adoption in semiconductor industries. In the next phase, we have prepared a survey questionnaire (see Appendix A) to collect the viewpoints of different people from semiconductor industries, cloud service providers, and others (researchers working in concerned areas). Our survey form consists of mostly closed ended questions. However, we had asked 1 open-ended question asking the respondents about any additional comments on the survey design and challenges. We received several feedbacks from different categories of people. Our survey form consists of 5 questions for measuring the success in a cloud-based semiconductor industry; 14 questions were related to TOE model (6 were technology related, 5 were for organization related, and 3 were environment related), whereas 5 questions were related to the trust issues. In all these questions, the respondents were required to mark their responses in a 5-point Likert scale. In addition, we also had some questions regarding some background information of the survey respondents. In the next section, we discuss the data collection process.

7 | DATA COLLECTION

It was a challenge to identify the sample population for our survey. The survey questionnaire was sent not only to cloud service providers and semiconductor industry members but also to educational sectors and researchers working in related areas. We had identified the respondent by checking their background and experience. We planned to collect around 200 responses. To achieve this target, we approached many people by using e-mails, LinkedIn, and related technologies. We also approached the respondents personally with a printed survey form. A total of 1000 questionnaires were sent (including e-mails, LinkedIn, and Facebook messaging and offline survey), out of which we received 188 duly filled in responses. Our statistical analysis has been performed based on these 188 responses. We have indicated backgrounds of our respondents in the next section. At the end section of our survey form, we also requested the respondents to indicate whether the survey questions were easy or difficult. Most

of them replied that they found "no difficulty" in responding to the questions. Eight respondents marked our questionnaire as "very difficult," and 25 said that it was somewhat difficult. Eighty-nine said, it was "average," whereas 53 marked as easy and 13 marked as "very easy."

8 | DEMOGRAPHIC BACKGROUND OF RESPONDENTS

In our survey form, we asked the respondents to write the type of organization they belong to. It was marked as mandatory. Therefore, we received 188 responses for this question. A pie chart (Figure 2) has been given to summarize the types of organization. Similarly, we have given pie charts (Figure 3 and Figure 4), which indicate the size of the organization the respondent belongs to and the number of years of experience of the respondent in the organization-related area.

From Figure 2, we may observe that there are 21% responses from respondents who work in semiconductor industries, 7% from cloud service providers, and 72% from other background people. In the "other" section, we had respondents from academic institutes and researchers in related areas, software industries, IT sector, and government employees having experience in related areas.

We got response from small and medium (SMEs) as well as large organizations. An organization consisting of employees less than 300 have been categorized as SMEs. We have 27% responses from SMEs and 73% from large organizations.

In our study, the survey respondents had diversified experiences. We got 20% responses from people who have less than 1 year of experience in the related area, 42% were in the experience zone of 1 to 3 years, 20% were with 3 to 5 years of experience, 13% of the respondents had an experience of 5 to 10 years, and 5% responses were from people with more than 10 years of experience.

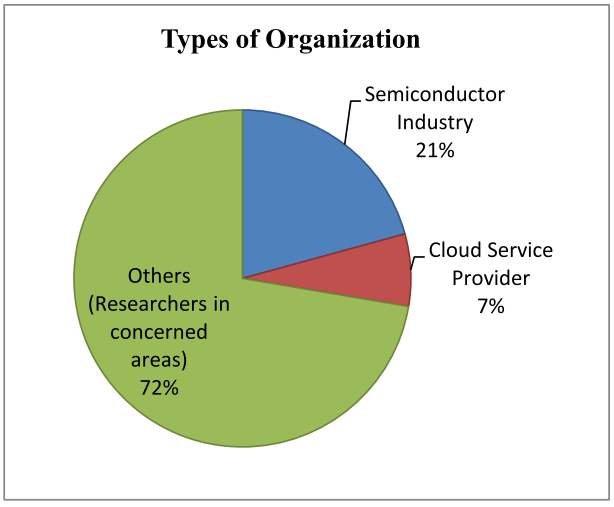

FIGURE 2 Types of organization

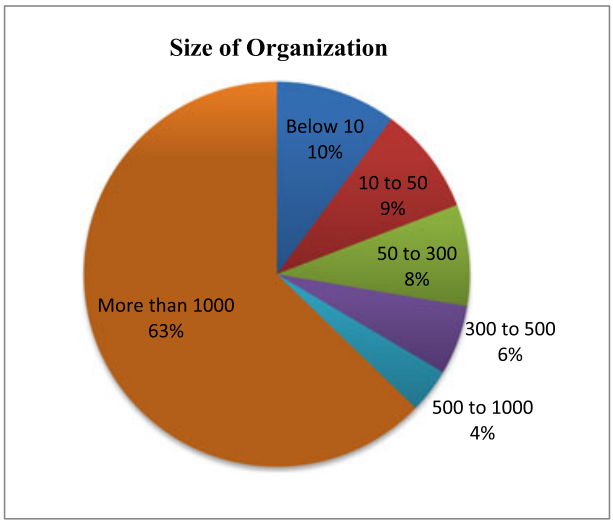

FIGURE 3 Size of organization

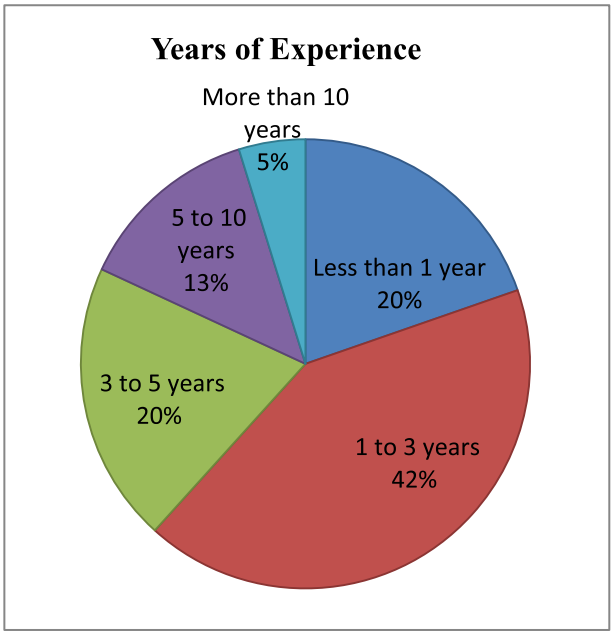

FIGURE 4 Years of experience

9 | STRUCTURAL EQUATION MODELING AND ANALYSIS

Warp PLS 5.0 has been used for the structural equation modeling by the use of our data set.[60–62] Respondents had written their opinion in a 5-point Likert scale, which were subsequently replaced by numeric values. We had replaced "strongly disagree" by 1, "disagree" by 2, "neutral" by 3, "agree" by 4, and "strongly agree" by 5. For the convenience in computation, we named the technological factors as "Techfact," which contains 6 indicator variables. These are 6 technology-related success factors. Similarly, the organizational-related factor has been renamed as "Orgfact" and environment-related factor has been renamed as "Envfact". Orgfact contains 5 and Envfact contains 3 indicator variables. After preparing our data set, we have preprocessed our data

set for missing value check. We found 1 missing value in our data set. It was taken care by the statistical software Warp PLS 5.0. We also checked the rank and variance problem for our data set, and we found no problem with the rank of the data matrix and variance. Finally, our data set has been standardized by using the said statistical software. For standardization purpose, we had subtracted the mean value from each entry and divided the check by the standard deviation. With this standardized data set, we made the final processing for performing the SEM analysis.

For the SEM analysis, we first conducted the reliability test of our data set. The reliability test was performed by using both the Cronbach alpha and the composite reliability test. The standard cutoff for the Cronbach alpha value was taken to be 0.7. Thus, a value greater value than 0.7 of the Cronbach alpha coefficient implies that our data set is reliable. For composite reliability test, the cutoff value was also taken to be 0.7. The results of our analysis are been presented in Table 1.

One may observe that for our study the composite reliability coefficients for all the latent variables are greater than 0.7. From this observation, it may be concluded that our data set is reliable for performing the SEM analysis. However, from the Cronbach alpha test, we observe that latent variables Envfact and Orgfact do not satisfy the minimum criteria for the Cronbach alpha value. As these values are close to 0.6, therefore, we may proceed for further analysis. Some researchers have taken 0.6 as the Cronbach value. On the basis of this observation, we have performed the SEM analysis for our data set. By applying our intuition, we have tried to justify the results of the SEM analysis.

After doing the reliability test, we have performed multicollinearity checking. Variance inflation factors (VIFs) have been calculated for each latent variable. Theoretically, a VIF value less than 5 implies that there is no problem of multicollinearity in a data set. From Table 2, we can observe that the VIF values for all the latent variables are less than 5. Thus, we may conclude that there is no problem of multicollinearity in our data set.

After checking multicollinearity, we have checked the inter correlations among the latent variables. Table 3 presents the correlation coefficients for all the latent variables. We may observe that no 2 latent variables pose correlation coefficient more than 0.9. Thus, it may be asserted that our data set is fine for further analysis.

Before performing SEM, we have performed factor analysis to cross check our latent variable formation. We have used principal component analysis to perform this check. Table 4 presents the combined loadings and cross loadings of the latent variables. An indicator with a component value greater than 0.5 is to be considered in that component.

Table 4 confirms that our latent variable formation and indicator selection is correct. We found that all the indicators from technology-related factors are under the component Techfact. Also there is no deviation of indicators grouping for organization-related factors, environment-related factors,

TABLE 1 Reliability analysis

Techfact	Adoption	Trust	Orgfact	Envfact	Trust × Techfact	Trust × Orgfact	Trust × Envfact
Composite reliability coefficients							
0.845	0.845	0.865	0.781	0.78	0.935	0.852	0.866
Cronbach alpha coefficients							
0.78	0.77	0.803	0.65	0.577	0.927	0.828	0.834

TABLE 2 Multicollinearity checking

Techfact	Adoption	Trust	Orgfact	Envfact	Trust × Techfact	Trust × Orgfact	Trust × Envfact
Full collinearity VIFs							
2.257	1.504	1.581	2.384	1.447	1.919	2.067	1.507

TABLE 3 Correlation coefficients

	Techfact	Adoption	Trust	Orgfact	Envfact	Trust × Techfact	Trust × Orgfact	Trust × Envfact
Correlations among latent variables with square roots of AVEs								
Techfact	0.69	0.502	0.489	0.683	0.4	−0.154	−0.035	0.062
Adoption	0.502	0.722	0.33	0.471	0.284	−0.137	−0.183	−0.095
Trust	0.489	0.33	0.751	0.513	0.233	0.069	−0.041	0.205
Orgfact	0.683	0.471	0.513	0.647	0.504	−0.015	0.045	0.153
Envfact	0.4	0.284	0.233	0.504	0.737	0.056	0.167	0.246
Trust × Techfact	−0.154	−0.137	0.069	−0.015	0.056	0.577	0.643	0.432
Trust × Orgfact	−0.035	−0.183	−0.041	0.045	0.167	0.643	0.452	0.49
Trust × Envfact	0.062	−0.095	0.205	0.153	0.246	0.432	0.49	0.556

TABLE 4 Combined loadings and cross loadings

	Techfact	Adoption	Trust	Orgfact	Envfact
Tech1	**0.74**	0.198	0.169	−0.274	0.048
Tech2	**0.716**	−0.041	0.027	0.231	−0.152
Tech3	**0.644**	−0.006	−0.083	0.051	−0.087
Tech4	**0.663**	−0.108	0.052	−0.045	0.141
Tech5	**0.697**	−0.022	−0.088	0.178	−0.083
Tech6	**0.679**	−0.04	−0.095	−0.131	0.138
D1	0.131	**0.704**	0.108	−0.264	−0.075
D2	−0.21	**0.699**	0.231	−0.064	−0.122
D3	−0.032	**0.771**	−0.078	0.223	−0.044
D4	0.065	**0.725**	−0.044	−0.036	0.185
D5	0.045	**0.709**	−0.205	0.12	0.054
T1	0.021	0.205	**0.795**	−0.167	−0.048
T2	0.072	−0.019	**0.805**	−0.093	0.131
T3	−0.16	0.107	**0.809**	0.102	−0.094
T4	−0.107	−0.117	**0.71**	0.159	−0.048
T5	0.212	−0.245	**0.614**	0.02	0.07
Org1	0.098	0.08	0.108	**0.553**	0.095
Org2	0.11	−0.214	0.056	**0.675**	−0.039
Org3	0.077	0.198	−0.086	**0.641**	−0.072
Org4	−0.046	0.014	−0.016	**0.735**	−0.134
Org5	−0.231	−0.059	−0.05	**0.618**	0.191
Env1	0.003	−0.232	0.038	0.09	**0.741**
Env2	0.236	−0.045	−0.132	−0.103	**0.806**
Env3	−0.293	0.317	0.12	0.025	**0.657**

and trust issues. As expected, all moderating latent variables also follow the similar formation as it was expected.

10 | SEM MODEL AND DISCUSSION

The final result of the SEM model has been depicted in Figure 5. All the latent variables are presented as oval-shaped figure in the model. We considered the latent variables as reflexive in nature. The entire indicator variable in Figure 5 is marked "i." The line joining 2 latent variables represents each hypothesis. The dotted lines represent the moderating effect of the moderator. The value of the coefficient β signifies whether a relationship is significant or not. The significance level is indicated by *P* value. *P* value less than 0.05 indicates that the null hypothesis is rejected, ie, the relationship between 2 latent variables is significant. We have also calculated the model fit and quality indices. The average R^2 value of our model is 0.41. However, the average adjusted R^2 coefficient for our final model is 0.387. Both R^2 and adjusted R^2 value lies between 0 to 1. A value greater than adjusted R^2 value indicates better goodness of fit. For our model, the average block VIF value is 1.932, which is acceptable as the ideal value is less than 3.3.

On the basis of the β coefficient value and corresponding significance level *P* value, we can accept or reject our null hypothesis. Table 5 presents the acceptance/rejection of the

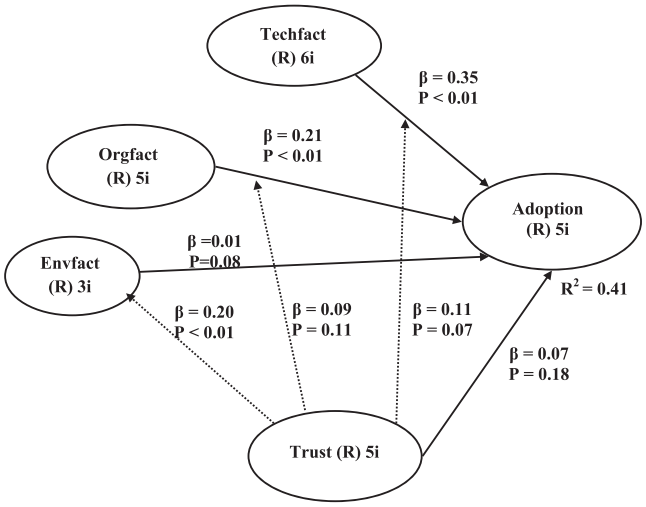

FIGURE 5 SEM model

null hypothesis. For 95% confidence interval, a *P* value less than .05 indicates that we can reject the null hypothesis and accept alternative hypothesis.

From Table 5, we observe that our null hypotheses H1, H2, and H7 have been rejected. Therefore, we can accept our alternate hypotheses $H1_A$, $H2_A$, and H7. For H5 and H3, we observe that the *P* values are .07 and .08, respectively. In this study, we also reject our null hypotheses H5 and H3 as the *P* value lies marginally in the rejection region. Hence, we will accept the alternate hypotheses $H5_A$ and $H3_A$.

The accepted alternative hypotheses are as follows:

$H1_A$ *Technology-related factors have significant effect on the adoption of cloud services in semiconductor industries.*

$H2_A$ *Organization-related factors have significant effect on the adoption of cloud services in semiconductor industries.*

H7 *Trust issues have moderating effect in the environment-related factors for the successful adoption of cloud services in semiconductor industries.*

$H5_A$ *Trust issues have moderating effect on the technology-related factors for the successful adoption of cloud services in semiconductor industries.*

$H3_A$ *Environmental factors have significant effect in the adoption of cloud services in semiconductor industries.*

To support our results, we have also plotted the graphs for the indicator variables against dependent variable adoption. The graphs (Figures 6–12) are presented below with proper reasoning of such curve.

From Figure 6, we may observe that the technology-related success factors form a decreasing slope curve. This implies that technology-related factors affect the successful adoption of cloud services in semiconductor industries. Existing literature also reveals that advanced technology has

TABLE 5 Hypothesis testing

Hypothesis	β	*P* (95% confidence interval)	Accept/reject
H1: Technology-related factors have no effect in the adoption of cloud services in semiconductor industries.	0.35	<.01	Reject
H2: Organization-related factors have no effect in the adoption of cloud services in semiconductor industries.	0.21	<.01	Reject
H3: Environmental factors have no effect in the adoption of cloud services in semiconductor industries.	0.10	.08	Accept
H4: Trust issues have no effect in the adoption of cloud services in semiconductor industries.	0.07	.18	Accept
H5: Trust issues have no moderating effect in the technology-related factors for the successful adoption of cloud services in semiconductor industries.	0.11	.07	Accept
H6: Trust issues have no moderating effect in the organization-related factors for the successful adoption of cloud services in semiconductor industries.	0.09	.11	Accept
H7: Trust issues have no moderating effect in the environment-related factors for the successful adoption of cloud services in semiconductor industries.	0.20	<.01	Reject

a positive effect on success for of any technical adoption. The technical factors bring out improvement in organizational performance, computational efficiency, better scalability, competitive advantage, better trading partner, and on demand product and service availability. Clearly, these factors are helpful in the adoption of cloud computing for any industry. On the basis of the sudy, one may conclude that technical advancements are necessary for successful adoption of cloud services in a semiconductor industry.

Figure 7 explains the significance of organizational factors for the successful adoption of cloud services in semiconductor industries. Organization-related factors (time to market, customer satisfaction, integration of design and manufacturing services, top management support, and size of organization) form a decreasing slope curve with the adoption of cloud services. Therefore, one may conclude that these factors have considerable effect on the successful adoption of cloud services in semiconductor industries.

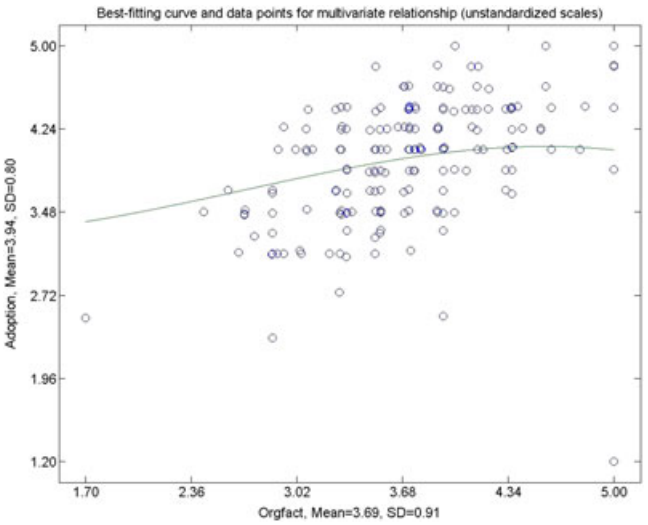

FIGURE 7 Adoption vs organization-related factors

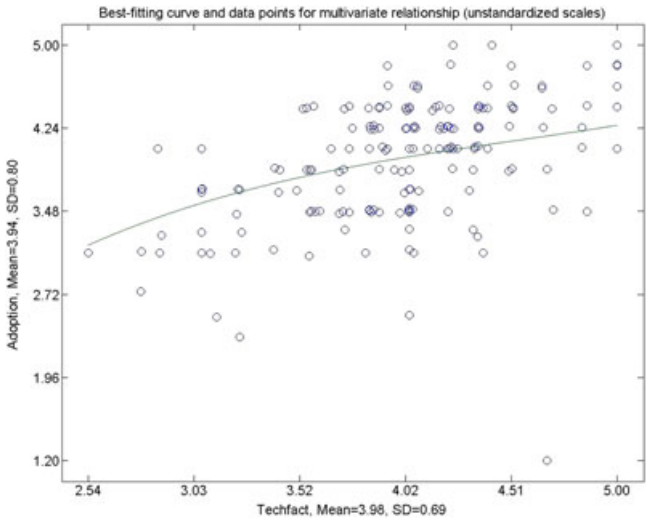

FIGURE 6 Adoption vs technology-related factors

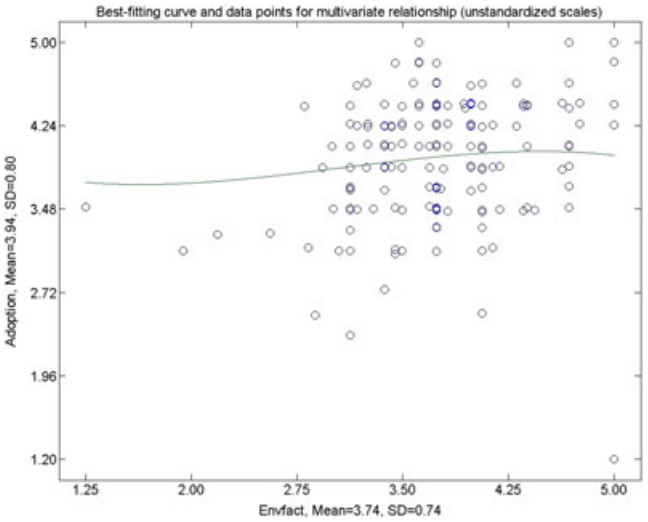

FIGURE 8 Adoption vs environment-related factors

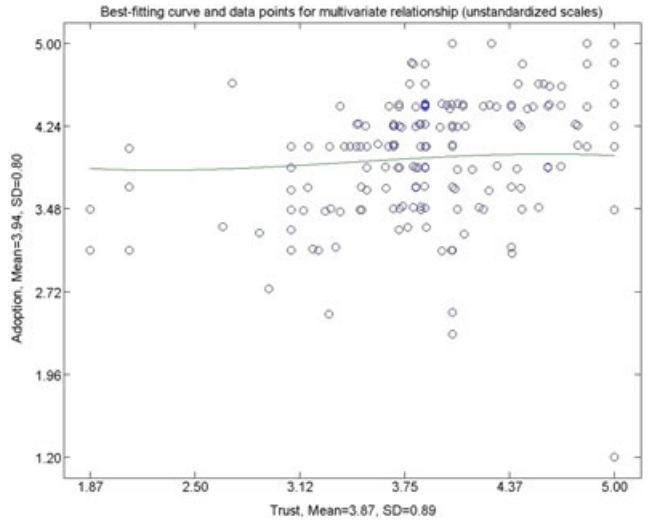

FIGURE 9 Adoption vs trust issues

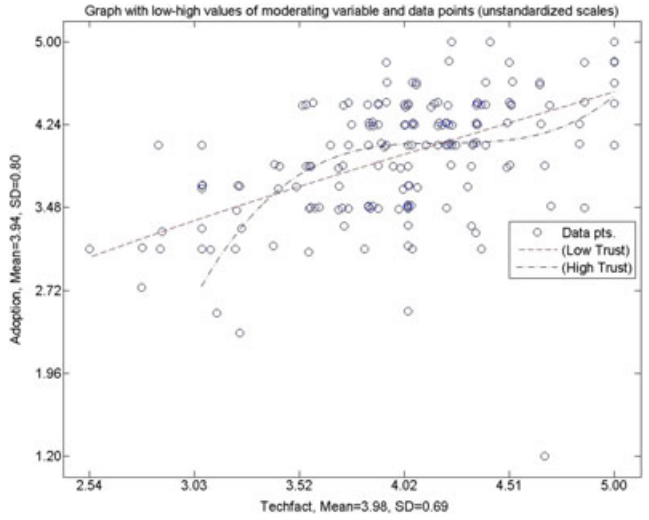

FIGURE 10 Adoption vs technology-related factors in the presence of trust

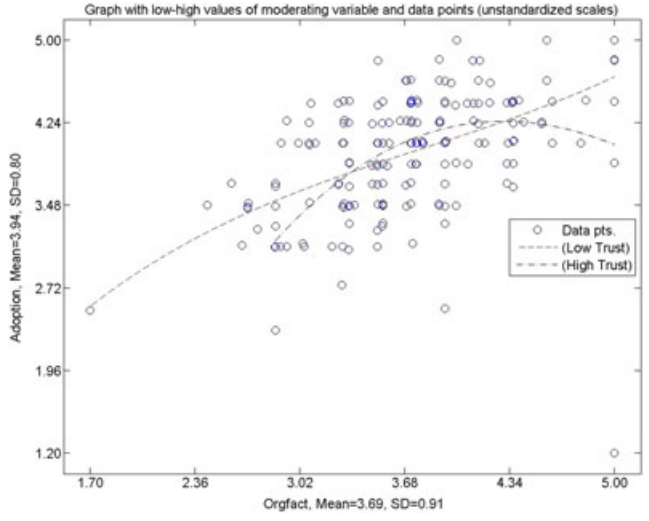

FIGURE 11 Adoption vs organization-related factors in the presence of trust

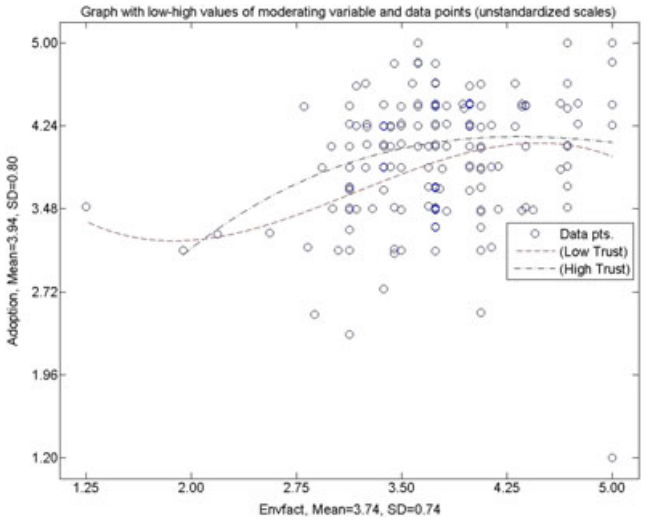

FIGURE 12 Adoption vs environment-related factors in the presence of trust

Figure 8 explains the relationship between the environment-related factors and the successful adoption of cloud services in semiconductor industries. In this graph, environmental factor forms a very low slope line. However, we observe that with increasing value of Envfact the graph starts deviating from zero slope line. Hence, we may conclude that the environment-related success factors (legal issues, competitive pressure, and partner dependency) have significant effect on the successful adoption of cloud services in semiconductor industries. However, the significance may not be very strong, as the path coefficient is very small.

The graph for trust issues factors versus the adoption does have a constant slope. It is rectilinear with zero slope. Therefore, we can conclude that trust issues factors (correctness, availability, reliability, security, and survivability) do not have any significant effect on the successful adoption of cloud-based services in semiconductor industries. This may be owing to the fact that our survey respondents feel that there will not be any significant effect of the trust factors alone in the adoption.

In Figure 10, the graph of technology-related factors in presence of trust against adoption has been plotted. This graph shows that both low trust (red dotted line) and high trust (black dotted line) do not have similar slope. Therefore, we may conclude that the trust factors (correctness, availability, reliability, security, and survivability) moderate the technology-related success factors (improvement in organizational performance, computational efficiency, better scalability, competitive advantage, better trading partner, on demand product, and service availability) for the successful adoption of cloud services in semiconductor industries.

Figure 11 shows a similar characteristic as Figure 10. In this plot, the organizational-related factors have been plotted against the adoption in presence of trust issues. The high trust (black dotted line) and the low trust (red dotted line) have similar slopes. Therefore, we may conclude that the trust factors (correctness, availability, reliability, security, and

survivability) do not have any moderating effect on the organizational-related success factors (time to market, customer satisfaction, integration of design and manufacturing services, top management support, and size of organization) for the successful adoption of cloud services in semiconductor industries.

In Figure 12, we have presented the graph between environment-related success factors in the presence of trusts against adoption. In this graph, we may observe that the high trust (black dotted line) and the low trust (red dotted line) have a deviation in slope. Therefore, we may conclude that trust factors (correctness, availability, reliability, security, and survivability) have a moderating effect on the environment-related success factors (legal issues, competitive pressure, and partner dependency). However, as the deviation is not too much; therefore, we may conclude that the moderating effect may be relatively low.

11 | CONCLUSION

According to Hair et al,[63] the primary evaluation criteria in a structural model are the adjusted R^2 coefficient and the significance of the path coefficient. In our study, we found that although the technology and organization-related success factors have significant relationship with the successful adoption of cloud services in semiconductor industries, environment-related factors do not have much significance with the cloud adoption in an industry. However, the research study conducted here reveals that environment-related factors have significant effect on the cloud service adoption in semiconductor industries as its significance value lies just above the cutoff region. While assessing the moderating effect of trust issues, we found that there is no moderating effect of trust on the technology and organization-related success factors. In our study, we have considered trust issues to have a moderating effect on the technology-related factors, as the P value lies just outside the cutoff range. Therefore, we have considered this to have a moderating effect on technology-related factors for the successful adoption of cloud services in semiconductor industries. We can also observe that trust issues moderate the environment-related factors for the adoption of cloud services in semiconductor industries. Trust issues alone do not have any effect on the successful adoption of cloud in semiconductor industries.

The purpose of this study is to identify whether trust issues have a moderating effect on the TOE model for the successful adoption of cloud services in semiconductor industries. The results presented here indicate that the factors related to technology and organization has strong effect on the adoption of cloud services in semiconductor industries. However, the effect of environment-related factors is not strong as that of technology and organization-related factors. The study further reveals that the trust issues have moderating effect on the factor related to technology and environmental for successful adoption of cloud services in semiconductor industries, but trust issues have no moderating effect on organization-related factors. However, trust issues have no effect on the process of adoption.

It is worthwhile to mention some of the limitations of the present study. As mentioned earlier, although we tried our best to collect data on a global basis, all the data were received only from India. Also, survey respondents for the research survey include practitioners from semiconductor industries and cloud survey providers and researchers in related areas. However, researchers are not expected to have adequate knowledge of the risks and security issues of semiconductor industries. Moreover, practitioners in semiconductor industries may not have sufficient knowledge of cloud technology infrastructure and vice versa. Because of the limitation, the interpretation of the data may not match very well with the global scenario. Further research is necessary for this purpose. Despite this, the present study definitely serves as a useful step toward identifying the moderating effect of trust on the adoption of cloud services in industries.

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APPENDIX A

A.1 | Adoption of Cloud Services in Semiconductor Industries

* Required

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	☐	☐	☐	☐	☐

Please indicate your level of agreement in the following trust issues for the adoption of cloud based services in semiconductor industries. *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Correctness	☐	☐	☐	☐	☐
Availability	☐	☐	☐	☐	☐
Reliability	☐	☐	☐	☐	☐
Security	☐	☐	☐	☐	☐
Survivability	☐	☐	☐	☐	☐

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

Kindly rate the ease of answering the questionnaire. *

- ☐ Very difficult
- ☐ Difficult
- ☐ Average
- ☐ Easy
- ☐ Very easy