CHAPTER-6
CONCLUSION AND FURTHER RESEARCH

The reasoning draws conclusions, but does not make the conclusions certain, unless the mind discovers it by the path of experience which provides the reasoning that will defend the conclusions made. Therefore, as a result of this extensive literature survey, research on use of cloud computing, the interviews conducted with experts from the academicians and industry, and the result of the analysis of online questionnaire filled by employees of technical educational intuitions, the following conclusions were drawn on the current state and future scope of cloud computing in technical educational institutions.

6.1   CONCLUSION

In the literature, many definitions of the "Cloud Computing" and its phases of evolution and application were documented as illustrated in chapter – 2.   Further this chapter described about IT-diffusion and cloud computing in general and then defined some related terms like automatic computing, utility computing, grid computing and service oriented architecture. The specific usage of cloud computing in the higher educational environment was also explained in the same chapter where the main problems with the legacy systems in higher education were presented and furthermore the opportunities and issues using cloud computing in higher education were discussed. It also includes the literary review of development life cycle of cloud computing and current state of its use in higher and technical education. Subsequently, hype cycle of emerging technologies given by Gartner and technology adoption curve given by Moore helped to understand the present state of cloud computing and its future.

Concepts of research methods, and the methodology used in the desk research, formulation of online questionnaire and expert's interviews and basic sample selection technique, and steps taken into consideration to carry out the research were described in chapter-3.

Work carried out and contributions of this thesis are summarized as follows.

- **Online Questionnaire:** An online questionnaire was designed and validated and also checked its reliability as a tool. Further this tool was used to verify whether technical educational institutions currently use cloud computing or not. Pros and cons of using cloud services were also evaluated at length.

   The online questionnaire comprised of 6 primary blocks starting with a welcoming text followed by its subject and a brief definition of cloud computing. At the end, an acknowledgement has been sent with thanking them for the participation. Each block tried to answer one major question.

- **Sample Selection:** Out of total 4153 institutions across India, a sample of 400 employees of technical educational institutions and data centers across country was selected and contacted through E-Mails(s), with a request to compete the online questionnaire. The survey has been completed in six month run time.

   On the basis of questionnaire the contacted sample of technical educational institutions was formed consisting of 31.7% respondents were from universities and 68.3% from colleges. Out of which 77.27% were form private institutions and 22.72% from public institutions.

   The sample selected was representative sample since the samples of participants in different categories were independent of each other as verified by the related Chi-Square tests applied for this purpose. Similarly, overall participation of public institutions/ private self financing institutions were also independent of each other which again supports the statement that sample was representative of the true population. In this survey Confidentiality of personal information of respondents was guarded.

- **Data Analysis and Results:** Analysis and results on the basis of collected data was discussed at length in Chapter-4. A null hypothesis was set to define the purpose of online questionnaire: "Technical Educational institutions in India are neither using cloud computing, nor currently studying the possibility of using it and are also not aware of its advantages".

   The answers collected were analyzed on the basis of graphs and statistical analysis using suitable tools. The statistics presented in chapter-4 affirms that the study and results for adoption of cloud computing are authentic since the survey conducted was constituted from the right prospective users of cloud technology.

It was concluded that "future is of Cloud computing only", since 62.7% are already using software as a service (SaaS) in their organization and Platform as a service (PaaS) and Infrastructure as a service (IaaS) was already used by 22.78% and 20.00% respondents respectively. There is a significant difference in the current use of different service models of cloud i.e. Software as a service, Platform as a service, and Infrastructure as a service.

Majority of organizations considered the following factors in favor of cloud computing. Which are ranked from high to low in the following order "better functionality", "advanced technology", "cost saving", "improved security", "green IT", "better scalability" and "more flexibility", "switch from CapEx to OpEx", and "More (core) business focus". Which is against the general perception of cloud service providers as they have been highlighting the lowest ranked factors such as "switch from CapEx to OpEx", and "More (core) business focus" as the top most advantages and opportunities for adoption of cloud computing.

In spite of a move towards cloud major constraints which are pulling down the interest of organizations in adopting cloud are "privacy issues" and "security issues" at the top. Other threats in the order of rank are "lack of functionalities", "lack of performances", "insecure availability", "and integration issues", "compliance issues", "legal issues". "Immature technology" and "insufficient financial benefits" are assigned lowest rank in the risk factors, therefore, it can also be concluded from this that cloud technology is now treated as a mature technology and also financially beneficial.

Importance was given to following criterions in the selection of service providers in the order of their ranking "high security" and "availability of cloud services" followed by "low cost". Other factors such a "scalability of cloud services", adaptability of cloud services", "strict privacy guidelines", "simplicity" have equal importance, and least importance is given to "reputation of service providers".

As per the responses received from the various participants in the study major SaaS products of various CSPs like Google apps, Microsoft 0ffice 365, Drop Box, IBM SPSS, and Likden are 67.1%,28.9%,18.4%,13.2%, and 13.2% respectively and all other service providers have a share of 22.4% in totality.

Majority of organizations considered the following factors in favor of adopting Software as a Services model of cloud computing. Top ranks given to "availability", "security" followed by marginally low priority to "Privacy", and "Cost Saving". Lowest ranked factor was "Outsourcing of warranty and Support".

PaaS has still not captured the market only few service provider like Google app engine, Microsoft window azure, and IBM bluemix have a share of 42.9%, 28.6%, and 14.3 % respectively and all other service providers have a share of 33.3% in totality.

The best open standard support is provided by Google followed by IBM, while Microsoft leads in Multi/single tenancy support and as far as third party support is concerned IBM and Microsoft are at par with each other and leads Google as well as Gigaspaces.

Following factors in favor of adopting Platform as a Service model of cloud computing. Top ranks are given to "Availability" and "Cost Saving", followed by marginally low priority to "Security" and "Privacy". Lowest ranked factor was "Outsourcing of warranty and Support".

Major disadvantages in the use of Platform as a Service in the educational Institutions are "Cost" is top ranked followed by "Risk related to Security" & "Risk related to availability" and least affecting factors are "Risk of Privacy" and "Dependency on support and maintenance".

Over all usage of IaaS is also at the same level as PaaS i.e.17.7%, and percentage adoption of these services is again significantly higher in private organizations as compared to public.

Major disadvantages in the use of IasS in the organizations are "Risk of privacy" is top ranked followed by "Risk related to security" and least affecting factor is "Dependency on support and maintenance".

- **Interviews with experts:** To supplementing the online questionnaire and to gather a deeper understanding of the views of selected cloud experts telephonic interviews with selected experts were conducted. Finally, nine contributors accorded consent and two of them reaffirmed their consent when they were personally contacted through e-mail. These were universities and already using cloud in one or the other form. Two corporate agreed to participate in this

activity. Total four companies were contacted and only two have consented upon. The corporate were selected based on their product portfolio and market share in cloud computing.

A deeper understanding of the current state of cloud computing in higher and technical institutions was gathered with the help of interviews and it also helped in the formation of a recommendation for technical educational institutions. Perspective of two distinct categories of participants in interview was presented in chapter -5.

- **Design of Proposed Model:** As an outcome of this research a suitable model for cloud computing solution for the technical educational institutions is proposed and illustrated through a schematic diagram.

6.2   SUGGESTIONS FOR FURTHER WORK

Since cloud is the technology of future as has been concluded in my research which is well supported by the waste literature available and a survey conducted among the prospect users from varied type of institutions across the country. There will be a large scope of further research in this area which may include following.

- Deployment of proposed model for evaluating the cost effectiveness for educational institutions in general.
- A deeper research in majored concerns like security and privacy which are considered as the main hesitations in the adoption of the cloud right now.
- To design an enhanced community cloud for all type of services.
- Similar model can be designed for other specific areas of application of cloud.