# Exploring research trends in information technology in Pakistan: A meta-analysis

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## ABSTRACT

*The objective of this study is to explore trends of research publications in Information Technology (IT) in Pakistan and to identify sectors where IT has been implemented and applied during twelve years (2000-2012). The present study has investigated different research methodologies adopted in IT in Country. The results show steady growth in number of publications in twelve years. The meta analysis results suggests that there were significant differences among different research methodologies adopted for research in IT in Pakistan. The mostly adopted research methods are experiments and simulations. This study also shows that applications of IT has mostly been found in the directly IT related sectors (system engineering, networking, software, telecommunication) and researchers in Pakistan have not utilized IT much for the indirectly IT related applications (Education, health, business, energy, agriculture).*

**Keywords:** Information Technology, Pakistan, Meta-Analysis, Direct and Indirect applications

## INTRODUCTION

Information Technology (IT) because of the progress of movable-type printing system and industrial revolution is broadly believed as the vital riot humankind has experienced (Dhanavandan, 2012). There has been a revolution in computing and communications, and all signs show the use of information technology is progressing in various technological disciplines at a fast rate. Supporting the utilization of information technologies and stunning boost in its power and diminishing cost of communications is a result of equally increased rivalry and technological improvements (Ammari, 2013). A country's development depends on the level of use, rate of access, and skilful use of IT systems. The exploitation of information technology has become marker of the intensity of a nation's possessions. Countries, which fails to arrange IT and do not implement it, are likely to be beaten their global competitiveness (Ramzan, 2004).

IT has reached to both in software and hardware industries of Pakistan. In 1957 "Packages limited" has begun the progression of computerization in Pakistan and it is believed as the foremost firm in Pakistan, which initiate using computers. Government of Pakistan was unwilling to take on for IT while commencing to implement IT, but now in all private and government organizations computer is at front position.

IT Ministry in Pakistan is now supervising IT related issues in country. To heighten IT in the country, other departments like Electronic Government Directorate (EGD), Pakistan Computer Bureau (PCB), Pakistan Software Export Board (PSEB), Pakistan



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Telecommunication Authority (PTA) and Computer Society of Pakistan are also functioning side by side with IT Ministry (Shaukat, 2010).

Since information technology commences to have the crucial impact on the firms' management, therefore researchers have examined various technological sectors where implementations of computing, telecommunications technologies or robotics have occurred. The publications in various research journals can be used to examine the implementation of IT in various sectors.

In Pakistan, research in IT is not published as much as it is being implemented in organizations. Publications are one of the indicators to measure the scientific progress of particular domain in any country.

According to Pakistan Council for Science and Technology (PCST) data book (2009), publications in the international journals by Pakistani scientists have increased during the year 2001 to 2008, amongst them only 38 are in the field of computer science/Information Technology (PCST, 2009). Pakistan Council for Science and Technology (PCST) is established to give opinions to the Government on the improvement of Science and Technology at the state level. The Council is concerned in carrying out strategies for S&T Policy making, planning, implementation of those policies. As the national repository for S&T statistics, PCST provides data to international and regional agencies such as UNESCO, SAARC etc. Periodically, the Council publishes reports on S&T indicators of Pakistan. The S&T Data presented in the PCST data book is the result of a comprehensive survey conducted by the PCST during August – September 2008 and is giving figures for 2007-08. It covers 98% of public sector research organizations (excluding the strategic organizations) and 89% of the higher education institutions in the public and private sector that respond to the survey.

However, neither PCST nor any other has done research so far to examine the implementation of IT with respect to different technological sectors. Therefore, this study examines the implementation of IT in different sectors through the review of research papers published in the international journals from 2000-2012.

## RESEARCH OBJECTIVES AND HYPOTHESIS

Many studies are conducted in field of IT in Pakistan within various sectors by the Pakistani researchers. They were published in scientific journals and also reported by PCST. However the as discussed the area being focused for IT research has not been analyzed to access the IT orientation and development in Pakistan by visualizing the recent research trends.

Therefore, in order to observe the publications of IT the following research objectives are investigated in this research.

1. The trend exploration of the IT research in Pakistan.
2. The investigation of different research methodologies adopted in IT Research in Pakistan.
3. The identification of sectors where IT has been implemented in Pakistan.
4. The determination of services in different sectors where IT has been applied in Pakistan.



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Based on observation and discussion, the following hypotheses are formulated:

H1: In Pakistan research in IT has increased over past twelve years (2000-2012).

H2: Experimental research methodology is dominated in the IT research in Pakistan.

H3: Implementation of IT is more in Directly IT related sectors than Indirectly IT related sectors in Pakistan.

H4: Services offered are more to Directly IT related sectors than Indirectly IT related sectors in Pakistan.

## RESEARCH METHODOLOGY

A review of literature regarding IT usage and implantation in Pakistan within different sectors was collected research publication adopted database including Science Direct, Scopus and other publishers. Help was also taken from documents generated by the government, which offered a preliminary background insight into the circumstances studied. Meta analysis was performed on research papers published by Pakistani authors in international journals in field of IT during the past twelve years (2000-2012); the research methodology is given in Figure 1.

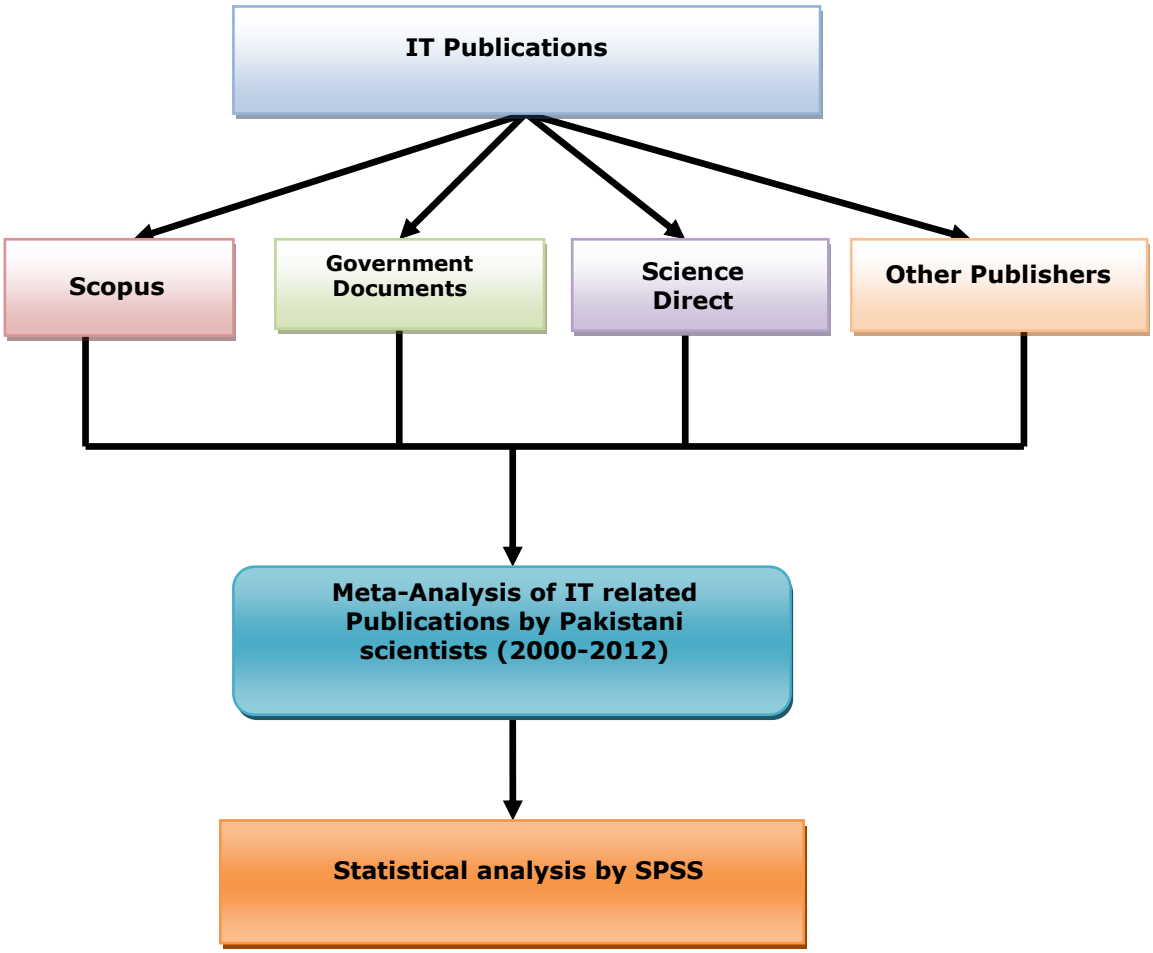


Figure 1. Flow chart of research methodology



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As the key constraint for a meaningful meta-analysis, a well-executed orderly review of articles was conducted and the coding strategy was decided. Using pre-designed format (appendix A) all the valid articles were coded. After coding, data was entered and analyzed using SPSS (Statistical Package for Social Sciences).

## DATA COLLECTION

The main purpose of this research is to investigate the research trends in Information Technology in Pakistan during last twelve years (2000-2012). A review of literature regarding information technology usage and implementation within different sectors was collected through Science Direct, Scopus, Google Scholar and other publishers. Document produced by Government of Pakistan such as Pakistan Council for Science and Technology (PCST) data book provided the initial background and insight into situation studied. The research methodology used is shown in Figure 1.

For ensuring the relevancy of articles to research all articles were read. For consistency and completeness list of articles were checked and complied. For capturing of all requisite information in the steady and reliable way the coding strategy was decided ,when the research articles were identified then all the articles were coded using pre –planned format (Appendix-A).

Once all articles were coded, then the data was entered and analyzed using Statistical Package for Social Science (SPSS).

Statistical method used for merging the findings from autonomous studies is meta-analysis. Meta-analysis suggests a helpful and rational means of dealing with a number of practical complexities that beset anyone trying to make sense of efficient research (Odette et al., 2011).

## RESULTS

A total 211 articles pertaining information technology usage were identified through search of literature from Science direct, Scopus, Elsevier, Springer and other publishers for the time period 2000-2012. To validate the hypotheses devised in this study, statistical analysis was performed at $P<0.05$ significance level on information obtained from these articles. The hypotheses are discussed in section below.

**H1: In Pakistan research in IT has increased over past twelve years (2000 – 2012)**.

In order to explore the trend in IT publications, yearly analysis was made. Figure 2 shows the trend of publications with respect to years. In total, 211 articles were published in the impact factor journals by the Pakistani authors. From 211 articles, 20 were published during 2000 to 2005, 23 were published during 2006 to 2007, and 163 were published during 2008 to 2012. Thus in the 5 years period from 2008 to 2012 it becomes visible that the trend in IT research is increasing progressively.

Science and Technology data book (2009) issued by Pakistan Council for Science and Technology (PCST) has also shown the increasing trend in the publications. Graph provided by Pakistan council for science and technology in their data book reflects that there is remarkable increase in the publications trend since year 2007 and onwards. The contribution of IT publications can be seen through this study. The trend of both the data collected for this research and data showed by the PCST are similar.



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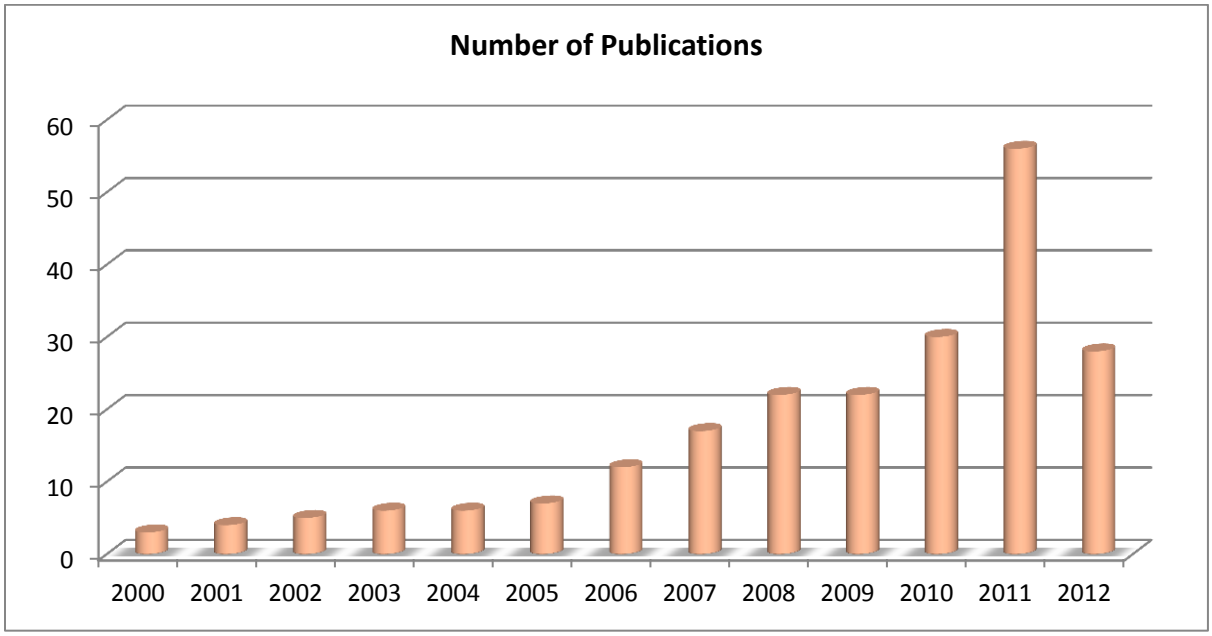


Figure 2. Yearly publications trend in IT research since 2000 to 2012 year

**H2: Experimental research methodology is dominated in the IT research in Pakistan.**

During the review of 211 articles, it was observed that authors have used different research methodologies. The different types of research methods include case study, comparative analysis, experimentation, analysis etc. The details of different types of research methodology which have been adopted for performing the research are given in table 1. The table also presents the frequency and the percent of these research methodologies.

A total of 54 out of 211 studies used experiment as a research methodology and 52 articles used the simulation techniques. In addition, comparative analysis accounted for 32 articles while questionnaire was used in 29 studies. In 18 studies the use review article approach for their research is adopted.

The two research methods, simulation (24.6%) and experiment (25.6%) are mostly adopted in the IT research done by Pakistani authors. The paper reviewed shows that for research within organizations the computer simulation methodology is in more practice. Ranges of supposition are made by other research methods about the accurate cause and effect nature of the system under study. For instance, in order to learn from the data monitored through survey research; one must identify content of cause and effect a priori and its form. To assume the intrinsic complexity of organizational systems, researchers use simulation because other methods can answer questions like what, how and when but the simulation method can answer questions in more depth like what if. This is studied that simulation methodology facilitates studies of more complex systems. According to Dooley (2002) the research method strives to look backwards into history to determine how and what happened, while by looking into the future is simulation method which can produce observations as “moving forward”.



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**Table 1. Research Methods**

| | *Frequencies* | *Percentage* |
|---|---|---|
| Case Study | 11 | 5.2 |
| Comparative Analysis | 32 | 15.2 |
| Simulation | 52 | 24.6 |
| Empirical | 3 | 1.4 |
| Observation | 6 | 2.8 |
| Experiment | 54 | 25.6 |
| Review Article | 18 | 8.5 |
| Questionnaire | 29 | 13.7 |
| Interview | 6 | 2.8 |
| Total | 211 | 100 |

To assess new solutions for problems in computer science and IT the experimental methodologies are mostly used. The experimental assessment is characterized into exploratory phase and an evaluation phase. The measurements are being carried out by researchers in an exploratory phase to recognize what are the questions that should be asked about the system under estimation. The later phase of evaluation is then used to answer those questions. A quality planned experiment will initiate with a list of questions that the experiment is projected to answer (Jose, 2002).

In order to check is there any difference amongst different research methodologies particularly with the experiment and simulation methods as mostly adopted research methodologies; the Chi-square test was performed. The Chi-square test checked for the most popular research methodologies adopted by Pakistani IT researchers. Among the non parametric tests in statistics, Chi-Square ($X_2$) test is the most significant and most used statistical test. In categorical variables the chi-square test is used to observe differences in categories. We can describe social world features with help of categorical variables for instance political preference, religion, etc. The hypothesis in which such variables are used can be examined using chi-square test (Serban, 2003). Table 1 presents the frequency and percentage of different research methodologies adopted. The statisctaical difference between them is shown in table 2.

**Table 2. Test Statistics of Chi-square**

| | *Research Methodology* |
|---|---|
| Chi-Square | 130.701 |
| Degree of Freedom | 8 |
| Significance | 0.00 |



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The Table 2 shows, value for Chi-Square (130.701), the degrees of freedom (8), and possibility of gaining the value of Chi-Square by chance. The Chi-Square value shows significance of 0.00: which is less than 0.05. The significance value shows that there is significance difference amongst several categories of research methodologies and the null hypothesis can be rejected. As it is evident from data that simulation (N=52) and experiment (N=54) are the most popular research methodologies adopted, followed by comparative analysis (N= 32) and questionnaire (N=29), it proves the second hypothesis (H2).

**H3: Implementation of IT is more in Directly IT related sectors than Indirectly IT related sectors in Pakistan.**

After reviewing the 211 articles it is found that IT studies are conducted in different disciplines. Some of the papers produced are completely related to IT sector and some of the papers are produced for other sectors. The papers which are produced in the IT sectors are in the fields of telecommunication, software, networking, web security etc. The group of such papers is titled as **Directly IT related.** The papers which are produced other than the IT sectors are in the fields of education, government, business, health, agriculture etc. The group of such papers is titled as **Indirectly IT related.** The classification of these groups is shown in table 3. The table also shows the frequency of these publications with respect to different fields of studies. From this table it can be seen that so far published research is more in the field of systems engineering followed by networking and education sector.

For directly IT related sectors with 43 publications in Systems engineering has account for 20.37% in total publications in past twelve years. In total, 26 studies have focus on networking and are contributed for 12.32%. The software sector shows 9.95% share in publications in the directly IT related category. The overall contribution of "directly IT related" sector is of 66.82%. While in "indirectly IT related" sector the education contributed the most at 12.32%. The government and Business organizations accounted for 3.79% (for each sector). While with 6 articles health sector contributes 2.84% for the "indirectly IT related" category. The contribution as a whole of "indirectly IT related" in IT implementation is 33.15%. Figure 3 and Figure 4 show bar charts for number of publications in "Directly IT related" and "Indirectly IT related" categories. Finally, table 4 presents the chi-square value two categories.

**Table 3. Classification of Directly and Indirectly IT related fields**

| *Classification* | *Fields* | *Frequency* | *Percentage* |
|---|---|---|---|
| Directly IT related | System Engineering | 43 | 20.38 |
| | Intelligence | 10 | 4.74 |
| | Software | 21 | 9.95 |
| | Telecommunication | 17 | 8.06 |
| | Real Time System | 9 | 4.26 |
| | Networking | 27 | 12.8 |
| | Web Security | 11 | 5.21 |
| | Space Engineering | 3 | 1.42 |
| Total | | 141 | 66.82 |



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**Table 3. Classification of Indirectly IT related fields**

| *Classification* | *Fields* | *Frequency* | *Percentage* |
|---|---|---|---|
| Indirectly IT related | Education | 26 | 12.32 |
| | Agriculture | 3 | 1.42 |
| | Government | 8 | 3.79 |
| | Sports | 1 | 0.47 |
| | Business | 8 | 3.79 |
| | Banking | 5 | 2.37 |
| | Health | 7 | 3.32 |
| | Geology | 4 | 1.89 |
| | Military | 3 | 1.42 |
| | Energy | 4 | 1.89 |
| | Construction | 1 | 0.47 |
| Total | | 70 | 33.15 |

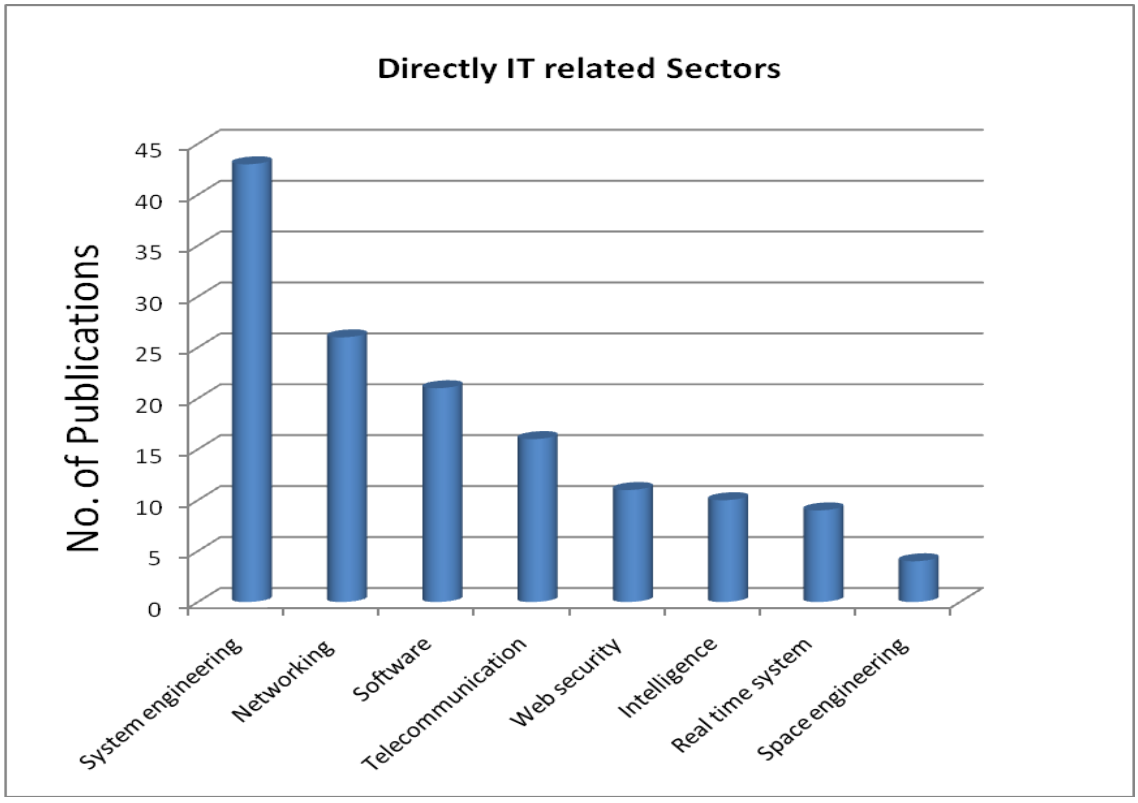


Figure 3. Publication trend by directly IT related sectors

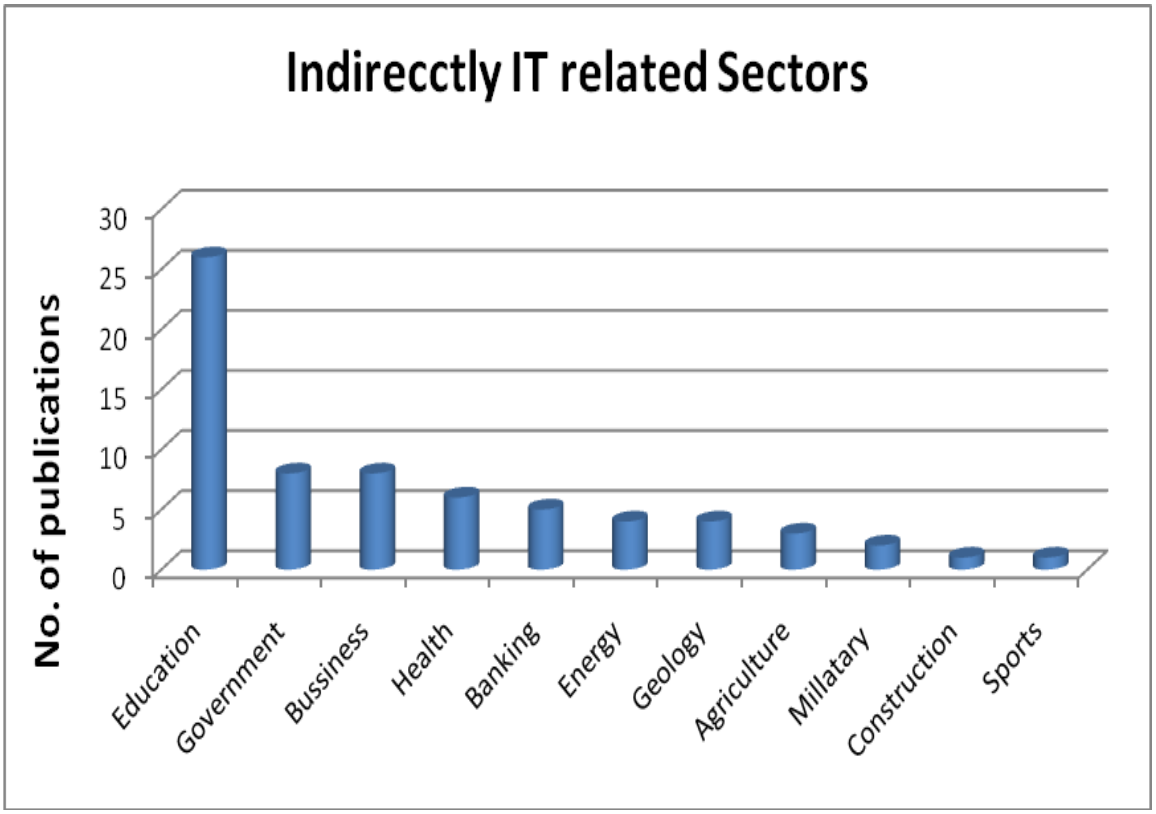


Figure 4. Publications trend in Indirectly IT related sectors during 2000-2012

**Table 4. Test Statistics of Chi-square for different sectors where IT implemented**

| | *Fields* |
|---|---|
| Chi-Square | 211.844 |
| Degree of Freedom | 18 |
| Significance | 0.00 |

The Table 4 shows the Chi-square value and statistics for different fields of studies where IT is implemented. At the probability of 0.00 level of significance there is enough evidence to conclude that numbers of publications by the Pakistani authors in fields which belong to the Directly IT related category are different from the number of publications in fields which belong to the Indirectly IT related category. The focus of Pakistani authors remained more on the directly IT related category in comparison to the Indirectly IT related category. Therefore, the hypothesis (H3) is accepted.



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**H4: Services offered are more to the "Directly IT related" sector than "Indirectly IT related" sectors in Pakistan.**

The hypothesis H3 has already proved that IT is more implemented in the Directly IT related fields in comparison to the Indirectly IT related fields in Pakistan. In order to see that within these big categories which type of services have been studies, the research papers are reviewed at the level of service applications. In figure 5 different services are shown which were studied in 211 research articles. These services are then further allocated to different fields in two big categories of "Directly IT related" and "Indirectly IT related" sectors.

A Mann-Whitney U test was conducted to evaluate the hypothesis that services offered to "Directly IT related" sectors are more and significantly different from the Indirectly IT related sector. Table 5 shows the services in "Directly IT related" sector had sum of ranks of 14059.50, while services in "Indirectly IT related" sector had sum of ranks of 8306.50. This test rank the scores, take sum the ranks of the scores for each group. The sums of ranks for each group are used to make the statistical comparison.

**Table 7. Sector specific ranks of services**

| Sector | *N* | *Sum of Ranks* |
|---|---|---|
| Direct IT related | 141 | 14059.50 |
| InDirect IT related | 70 | 8306.50 |
| Total | 211 | |

**Table 8. Mann-Whitney Test Statistics**

| | *Services* |
|---|---|
| Mann-Whitney U | 4048.50 |
| Wilcoxon W | 14059.50 |
| Z | -2.128 |
| Significance | 0.033 |

Table 8 gives the Mann-Whitney test statistics. The results of the test are found to be significant at probability score of 0.033. The data provides statistically significant evidence of a difference between services offered for two wider categories of "Directly IT related" and "Indirectly IT related" sectors. The higher rank (14059.50) of services offered for "Directly IT related" in comparison to smaller rank (8306.50) of services offered for "Indirectly IT related" proves that services are offered more to the "Directly IT related" than "Indirectly IT related" sectors. Hence it proves the hypothesis H4.



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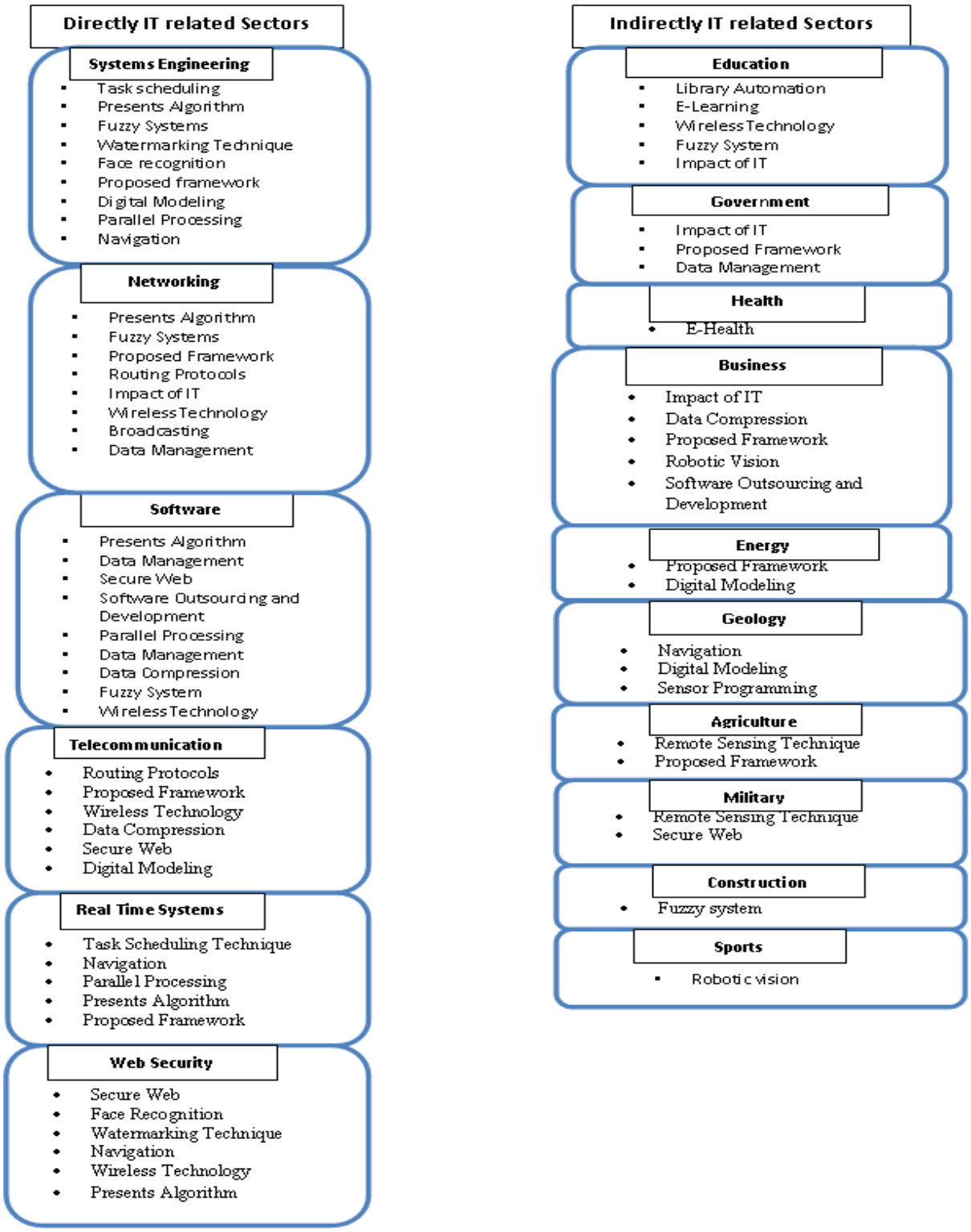
Fig. 5. Services offered to Directly IT related and Indirectly IT related Sectors



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## CONCLUSION

This study explores the development trend of Information Technology (IT) publications during past twelve years (2000-2012) in Pakistan. In total 211 articles pertaining information technology usage were identified through search of literature from Science direct, Scopus, Elsevier, Springer and other publishers. All articles related to IT published in international journals by the Pakistani researchers during past twelve years (2000-2012) were selected for meta-analysis. In the past twelve years this study found the rising trend in the number of research publications by Pakistani authors in IT.

The research proposed and proved various hypotheses. Through this research it was identified that Pakistani authors have adopted experiment and simulation as the mostly adopted research methodology for conducting their research. Since it produces observations by shifting onward into the future, simulation method permit studies of more complex systems. As the implementation of IT systems requires a heavy investment that is why before implementing it, researchers prefer simulations, to avoid errors in implementing technology at the higher scale. It helps in designing the technology that can be debugged and then can be preceded towards implementing the technology in real environment. The comparative analysis was also found as highly preferred research methodology for the IT research.

This study identified that applications of the IT research in Pakistan are focused towards two groups of sectors:

1. Directly IT related
2. Indirectly IT related

The directly IT related category includes system engineering, networking, telecommunication, real time system, web security, intelligence and space engineering and the indirectly IT related sectors include education, government, business, health, banking, agriculture, energy, military, construction, sports and geology.

The study results indicated that in Pakistan, IT applications are implemented more in directly IT related sectors than those of indirectly IT related sectors. The overall contribution of directly IT related sector was found 66.82%, while the whole contribution of indirectly IT related sector was found as 33.15%. The statistical analysis reveals that 17.68% of the IT research served in presenting different algorithms, while 12.92% of IT research was focused on the implementation of fuzzy systems in directly IT related sectors. In indirectly IT related sectors the service of E-learning accounted 16.90% followed by 15.49% on analyzing the impact of IT implementation, where as 14.08% of IT research was focused on the investigation of the level of library automation in Pakistan. Based on the study the following recommendations are proposed.

## RECOMMENDATIONS

The “indirectly IT related” sectors are less focused in terms of implementing IT applications in Pakistan. It is therefore recommended that in future health, energy and government may be given priority and IT based applications may be produced in order to improve their operations and performance. These less focused areas must be taken up by Higher Education Commission (HEC) by offering scholarships and other development funds for them. The study results will help HEC in realistic planning and resources allocations and may therefore



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be repeated for other fields of studies. Pakistan is an agricultural country and so far only 3 research studies have focused on this sector. While bringing IT based applications in this field can impose benefits and can generate more economic advantages from this sector.

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**APPENDIX-A**

Coding sheet for meta-analysis of IT implementation Research

1. Author (s) name (s)
2. Publishing Journal (name)
3. Year of publication
4. Brief summary of Article
5. I.T studied
6. Research Methodologies were coded such as

   Case study was given the code 1, Comparative analysis=2, Simulation =3……and so on.
7. Sector in which IT was used:

   The education sector was coded as 1, Agriculture as 2, Education as 3, System Engineering as 4 and so on.
8. For services for which IT was applied in identified sectors: Watermarking technique was given the code 0, presents algorithm =1, library automation=2…….. and so on.



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