Research Journal for Societal Issues

Vol 5 No 2 (2023): 409-427

Cloud Inspired Human Resource Management Empowered with Fuzzy Inference System

Shama Sadaqat*[1], Safiullah Junejo[2], Saba Anwar[3]

[1*]Lecturer, Management Sciences Department, University of South Asia, Raiwind Campus, Lahore, Punjab, Pakistan.

[2]MA Scholar, Faculty of Economics and Business, Universitas Islam International Indonesia, Indonesia.

[3]MA Scholar, International Business and Management, University of Bradford, UK.

Corresponding author: safiullah.junejo@uiii.ac.id

Keywords: *Human Resource Management, Cloud Inspired Human Resource Management Information System, Cloud Computing, Fuzzy Logic.*

Article History

Date of Submission: 07-03-2023

Date of Acceptance: 21-06-2023

Date of Publication: 30-06-2023

DOI No: 10.56976/rjsi.v5i3.65

Traditional Human Resource Management (HRM) systems face complications in managing various issues related to personnel, organization, salary, attendance, etc. Cloud Computing (CC) provides help in these business applications. This research proposes a Cloud-Inspired Human Resource Management Information System (CIHRMIS) employing a fuzzy logic system. The proposed CIHRMIS, in view of Fuzzy Logic, may help companies accomplish their HRM tasks proficiently, which in turn reduces the cost and increases managerial efficiency. Further, the Fuzzy Logic System performs adaptive activities, which can be used with multiterminal platforms operation, which supplements the application value of the system as well.

1. Introduction

The NIST defined Cloud Computing (CC) as a "Model for enabling adequate, on-demand network access to a shared pool of configurable computing sources (e.g., networks, storage, applications, servers, and services) that can be precipitously provisioned and released with negligible management exertion or service provider interaction." "The term' cloud computing' refers to resources that are shared, rather than controlled by individual servers and devices" (Iqbal, 2015). The main purpose of CC is to let distant on request setting for widespread delivery of services. Cloud services include virtual networks, data storage, application hosting, etc., as numerous users share these, so they offer economies of scale & assist companies in cutting capital expenditure & operating costs.

Virtualization brings abundant revolt in Cloud computing through some of its unique features, including scalability, availability, and elasticity. Despite being a leading platform today, industries are also questioning clouds' security issues as well. It is serving as a barrier to the adoption of cloud-inspired systems (Choudhary et al., 2023). The movement from sequential to parallel computing opens a new epoch. Computing shifts from a centralized to a de-centralized distribution model. Such progress and modification in the model open new research avenues (Tabassam, 2017).

Pakistan is a developing country with a populace figure of 156 million. The country's GDP growth rate is 2.8% (p.a.). Pakistan has invested significantly in the industrial sector to compact with the digital world. The government of Pakistan announced action plan 2000 for Information Technology to validate digital breaks. They are also focusing on foreign commitments in this field now (Moomal & Masrom, 2015). Currently, the number of large-scale companies in Pakistan is growing daily; hundreds plus multinational companies are also working (See Annexure A). Each of these comprises a staff of approximately 500 people. Further, these companies have a large scale of data information (Asghar, 2018). Human Resource Management (HRM) is the essential work of any organization's management. Cloud Computing (CC) is a prevalent technology; with its enormous data management and processing superiority attributes, it is extensively used in large-scale organizations. Processing and storing massive data in the field of HRM is considered a good solution and enhances efficiency up to the adequate level of management (Vinay , 2018).

Based on a meta-analysis conducted by (Brekis et al., 2014) In the field of Information Technology (IT), one may say that in Pakistan growth and application of Human Resource Management Information System is still lagging behind while comparing this to other developed and even developing countries. Like in China, this has entered the maturity stage (Lv et al., 2018). The situation is far better in India as well (Singh et al., 2018). Human resource management tactics are virtually changed and significantly affected by Information Technology ranging from paperless offices, hand scan attendance, databanks, automated working practices, teleworking, processing of transactions, reporting applications, e-recruiting, staffing via the internet, and employee development (Abied et al., 2022). In general, IT intervention in modern organizations has seriously

influenced human resource management within organizations. Several problems occur in human resource management, including the absence of performance management, a weak sense of belonging among employees, and an evaluation of the enterprise's human resource management system is found to be good (Yao & Azma, 2021). However, the enterprise's management system still needs to be improved.

IT is considered a major technological breakthrough for developed countries. There is very little research on IT usage in developing nations due to numerous legitimate, social, and governing issues. This limits technological aptitude and reduces research and development (R&D) and excessive use of overseas technology (Lv et al., 2018). Another study (Moomal & Masrom, 2015) explored the existing state of IT development & its effect on the country's business and human resource strategies.

According to Avram (2014), Cloud Computing is a rapidly adopted phenomenon for many organizations. There are two types of organizations; one wants to adopt cloud technology because it is a new trend; others do not want their sensitive information to go outside the company premises. So many factors influence the company's decision to adopt the cloud-based technology; initially, many companies thought to opt for this technology by assuming that it would be cheap, but after or at the time of actual adoption, it is seen that the cost is far more than estimated by companies. This is also one of the critical reasons for non-compliance with this technology. Due to these adoption decisions, cloud technology must be based upon a well-informed analysis.

An exploratory study suggested that competitive pressure does not always compel a company to adopt cloud technology. Nevertheless, the main factors influencing this decision were: relative benefit, geographic limitations, compatibility, size, managerial support, industry, and market scope. Fuzzy Logic is an essential soft tool for efficient decision support systems (Samuel, Omisore, & Ojokoh, 2013). The main objective of this study was to give a logic-obsessed Cloud-Inspired Human Resource Management for companies. The task of HRM may be completed through the internet, including employee portfolio management, reporting, organizational structure, payroll management, attendance Management and count for payroll preparation purposes, performance goal setting, and tracking. The application may be connected via desk computers, laptops, tablets, or android phones, as this is very trendy and user-friendly.

2. Literature Review

According to Moomal and Masrom (2015), the Government of Pakistan must work on lines to reduce the unemployment rate and allocate excessive budget to enhance awareness about information and communication technology (ICT). More IT Universities must be formed. Further, organizations to compete must hire employees with a great acquaintance of ICT and ensure employees' utilization of new and advanced technologies like HRMIS. Another study by Wang et al. (2016) shows that SMEs face technical challenges in managing human resources due to insufficient information, technologies, and managerial expertise. A possible solution to this problem is to benefit from emerging cloud computing technology.

However, Zhao et al. (2021b), suggest that cloud computing managers must ensure that new technologies are incorporated with organizational strategies to support business outcomes. Organizations need managers who have technical skills as well as business insight. Another study (Sandu & Gide, 2018) found that environmental factors affect more than the organizational or technological factors in adopting Cloud services. The study suggested a fuzzy-based method for optimizing HR vulnerabilities in cloud environments while reducing security expenses. According to the study results, this method can simulate dynamic and complex security issues in cloud computing (Li & Pahlevanzadeh, 2021).

Integrating cloud computing, FIS, and HRM has resulted in numerous benefits for organizations. Firstly, the cloud-inspired HRM system provides real-time access to HR data, which helps HR managers in making informed decisions (Lima-Junior & Carpinetti, 2020). Secondly, FIS provides intelligent decision-making capabilities, which helps HR managers in solving complex HR problems (Azadeh et al., 2016). Thirdly, the cloud-inspired HRM system reduces the cost of hardware and software maintenance and helps organizations to focus on their core activities (Zhang et al., 2019). The cloud model transforms government information technology and IT in the corporate sector. Though it will take a bit of time, CC is the best option to implement and improve the services in education and health. It also uplifts developing countries socially (Min & Rabiei, 2022)

SMEs can easily acquire cloud computing to increase productivity and increase work efficiency. Due to cloud computing, SMEs do not require huge capital expenditure (Domun & Bheemul, 2019). The extensive accessibility and implementation of cloud services craft new dares for enterprise and IT and stimuli the need for new practices and skill sets for handling a hybrid of these services (Erbes et al., 2012). In addition, organizations are progressively looking for possible benefits from their IT investments (Abied et al., 2022).

A meta-analysis by Hoberg et al. (2012) bent the current research on cloud computing from a business viewpoint. It considered 60 sources and integrated the results to propose an outline of the existing body of knowledge. It further tried to reveal the research gap. Research is moving from a technical perspective to business aspects of cloud computing. Customer-perspective of CC is not yet uncovered by research. Pragmatic research upon driven factors adoption of services of cloud is also limited. This might be so as cloud computing is an emerging topic for current research.

According to Ahmad (2015), cloud computing has drastically changed HRM in the past few years. No matter the organization's size, companies are flourishing and succeeding due to the emergence of cloud computing. To further improve the performance of an organization, the researcher proposed Evolving HRM System via cloud computing, enabling users to access HR effectively.

In a recent study, Wang et al., (2016) proposed using cloud computing to support advanced features such as on-demand payments as a sub-system of HRM. They also focused on its application in small & medium enterprises (SMEs). There were four parts of the research. The first part was about cloud computing and its characteristics and applications. The second part discussed game analysis on the CC of HRM in small & medium enterprises. Thirdly, researchers proposed a new cloud computing set-up for implementing human Resource Management in small & medium enterprises. Lastly, its applications were discussed.

Choudhary et al. (2023) identified opportunities, threats, strengths, and weaknesses of cloud computing. They further pinpoint various issues affecting the variety of shareholders of Cloud Computing. Finally, along with some recommendations to the experts providing and using cloud computing, the author also discusses some crucial issues government agencies face in regulating cloud computing. Another study found empirically that the manufacturing & service sectors both have different factors that influence the decision to use cloud computing adoption (Oliveira et al., 2014).

Yao & Azma, (2021) also focused on business facets of cloud computing rather than technological only. Mainly researchers contributed by giving a conceptual understanding of cloud players and their roles in new cloud computing value. Cloud Computing is not just an idea but has become an important segment of every industry. With the significant reliance on cloud computing regarding data storage, an emerging threat of data security arises, and companies are getting concerned about the safety of their sensitive data. Security is required at the multilevel of the service provision, and hence a sequential multilevel security design is required (Subashini & Kavitha, 2011).

Many enterprises, like Amazon, Google, IBM, and Microsoft, offer varying Cloud services to clients. Due to this diversity, it becomes difficult for clients to choose whose services must be used. This is because of the absence of any base available to them for selection. Presently, no framework is available that can allow customers to evaluate and rank Cloud offerings. A framework that measures the quality of Cloud services and ranks them out further may create healthy competition among service providers so that they can meet Service Level Agreement (SLA) and improve their service quality (Garg et al., 2013).

In today's competitive environment, a company must adopt the latest technology. The technological advancement might require minor changes in some of the business processes, or it might be significant enough to change the entire business. The managers of such an organization then have to be dynamic enough to make rational decisions in this regard. Such decision-making is quite difficult when one cannot monetize these benefits, as in the case of CC Technology. The researcher provides a tool to managers to help them monetize even such intangible benefits. In the long run, it will improve the managers' decision-making ability to make such decisions and assist them (Misra & Mondal, 2011).

Berman et al. (2012) also argued that CC technology is strong enough to surely add value to businesses and help them take a competitive edge over their rivals by bringing some procedural changes in their organizations. Furthermore, Heiser & Nicolett (2008) argued that the companies opting for CC technology must also have an eye on the risks associated. They further found that an independent third party must calculate this risk. They also recommended that the company understand the legislative policies and rules before adopting this technology to protect them against any risks associated with data security, recovery, the privacy of data, etc.

In this study, the researcher proposed a method that will enhance efficiency by controlling management jam issues and hence a contributor to Green IT, which addresses less energy depletion, reduces low productivity, and hence increases system operational efficiency in computer usage (Park & Jeong, 2013). Núñez et al. (2018) developed the Mobile Cloud Computing-based Knowledge Management (MCC-based KM) platform to manage SME construction projects. This repetitive and user-friendly methodology is quite a viable and intelligent option to address these issues in SMEs. Currently, diverse investigation questions are associated with officially existing evolutionary algorithms, namely Swarm Intelligence (Khan et al., 2015; Choudhry et al., 2014; Chaudhry et al., 2019). Neural Networks and fuzzy frameworks (Zubair et al., 2013) have just been decided to embrace, yet still some new methods (Asif et al., 2019). This gave the researchers a key at another time.

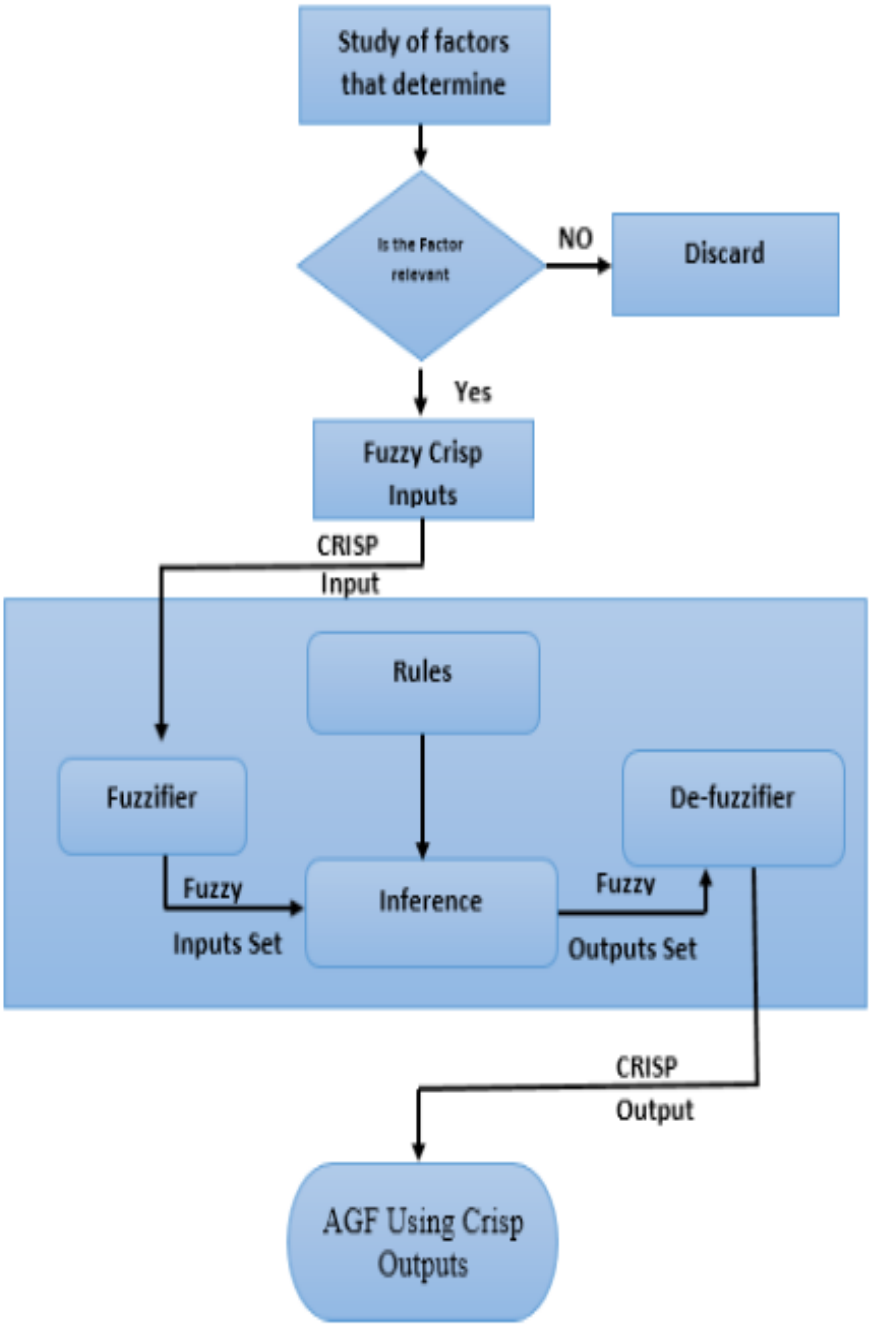
According to the analysis of Zhao et al. (2021), the management of human resources has some problems, including a lack of performance management, a lack of sense of belonging among employees, and a fuzzy comprehensive evaluation of the enterprise situation reveals that the enterprise's human resource management system is effective. However, the management system still needs to be improved further. Fuzzy logic provides a way to show and act on uncertainties by combining them with empirical knowledge and acuity. Besides handling uncertainties, Fuzzy Logic provides efficient and effective solutions to problems containing numerous decision variables (Oliveira, Thomas, & Espadanal, 2014). Various names are known as fuzzy Logicue to its multidisciplinary character, including fuzzy rule-based system, fuzzy expert system, fuzzy model fuzzy associative memory, fuzzy logic controller, and simply fuzzy system (Takagi & Sugen, 1985). Today's Information Technology, Production, and medical diagnostic decision-making and data analysis are fascinated by Fuzzy Logic (Samuel et al., 2013).

3. Proposed Methodology

3.1 Fuzzy Inference System Procedure

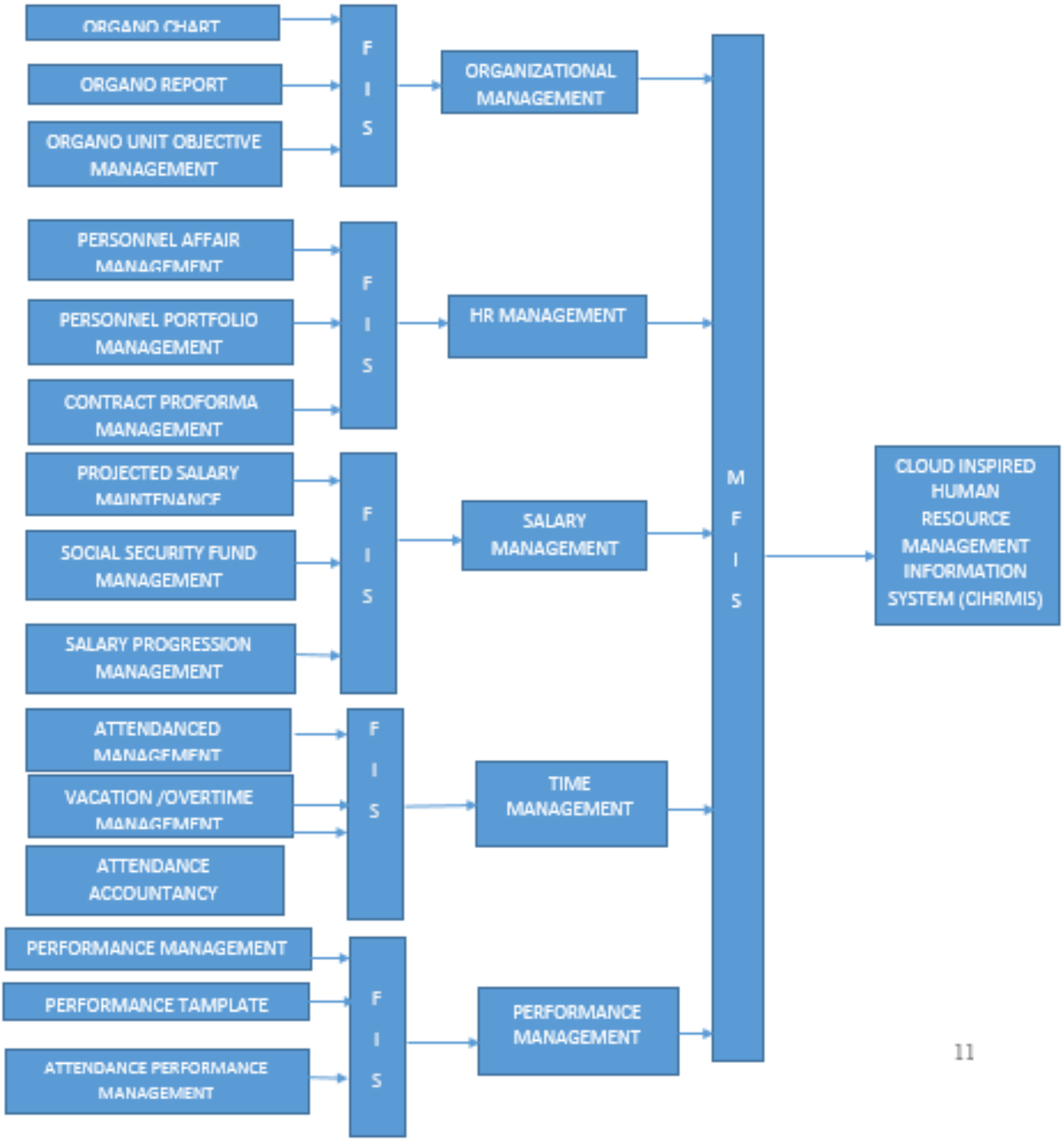
Fuzzy logic is beneficial for human resource management decision-making, such as selection and optimal staff design. This study introduces two fuzzy linear programming techniques for decision-making (Canos & Liern, 2004).

Figure No 1: DFD of the Proposed methodology of CIHRMIS



Based on the above literature, this research proposed the Cloud-Inspired Human Resource Management Information System (ClHRIMS) Framework.

Figure No 2: Proposed CIHRMIS methodology of Multilayer Fuzzy Interface System



While implementing the Fuzzy, widely adopted procedure is Mamdani inference for depicting researchers' knowledge. It enables the description of knowledge in a more natural and human-friendly manner. Nonetheless, this fuzzy inference imposes a significant computing burden

(Ajith, 2009). Due to the nature of the subject under investigation, this research also utilized the Mamdani inference technique.

New processing strategies given fluffy rationale can be utilized to improve insightful frameworks for essential Organizational management, HR management, salary management, time management, and performance management. Fuzzy surmising guidelines will be an aid for giving the check to all components in large-scale companies. The plan is required to encourage well-being, economic framework, and other parental figures to choose wisely for a business organization. Prime HR management is a way to have a competitive edge over their rivals. In this manner, the cloud-based framework can be utilized more proficiently.

3.2 Inputs Variables

The membership function of this system provides a mathematical function offering statistical values for input and output variables, and the output values of the curve fall between 0 and 100. The first layer (Organizational management, HR management, salary management, time management, and performance management) is considered level 1; the rest is correspondence.

3.3 Rule-Based

I/O Rules are an integral component of FIS. These principles govern the development of a Fuzzy Inference System (FIS). In this article, I/O rules are generated using the lookup table shown in Table II. The proposed I/O regulation reliant on FIS has been listed below.

3.4 Inference Engine

Inference Engine is an essential part of a Fuzzy Inference System (FIS).

3.4.1 If (Organizational-Management is No) and (HR-Management is No) and (Salary-Management is No) and (Time-Management is No) and (Performance-Management is No), then (Cloud-Inspired-HRM-Info-System is No) (1)

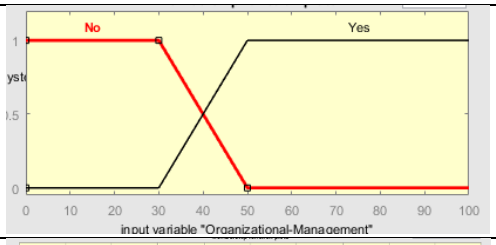
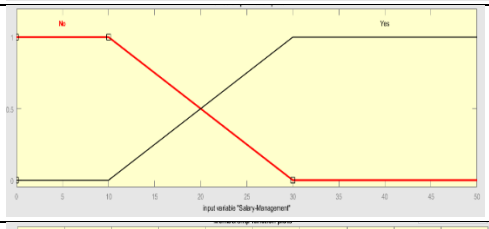
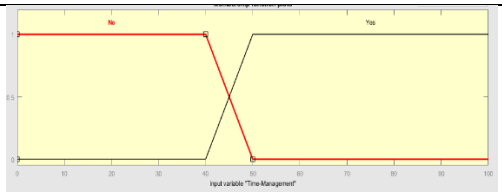
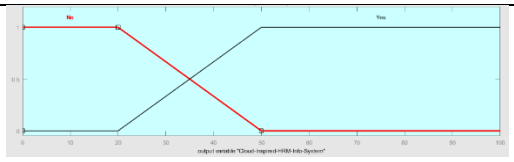
3.4.2 If (Organizational-Management is No) and (HR-Management is No) and (Salary-Management is No) and (Time-Management is No) and (Performance-Management is Yes), then (Cloud-Inspired-HRM-Info-System is No) (1)

3.4.3 If (Organizational-Management is No) and (HR-Management is No) and (Salary-Management is No) and (Time-Management is Yes) and (Performance-Management is No), then (Cloud-Inspired-HRM-Info-System is No) (1)

3.4.4 If (Organizational-Management is Yes) and (HR-Management is Yes) and (Salary-Management is Yes) and (Time-Management is Yes) and (Performance-Management is Yes), then (Cloud-Inspired-HRM-Info-System is Yes) (1)

3.5 Membership Function

Table No 1. Layer 2 Input/output Variables Membership Functions Proposed CIHRMIS

Input/output	**Membership Function**	**Graphical Representation of MF**
$OM = O\mu_O(O)$	$\mu_{N,Y}(O) = \{\max(\min(1, \frac{50-o}{20}), 0)\}$ $\mu_{N,Y}(O) = \{\max(\min(\frac{O-30}{20}, 1), 0)\}$	
$HR = M\mu_H(H)$	$\mu_{NY}(H) = \{\max(\min(1, \frac{30-H}{30}), 0)\}$ $\mu_{N,Y}(H) = \{\max(\min(\frac{H-25}{30}, 1), 0)\}$	
$S = S\mu_S(S)$	$\mu_{N,Y}(S) = \{\max(\min(1, \frac{30-S}{20}), 0)\}$ $\mu_{C,G}(C) = \{\max(\min(\frac{S-10}{20}, 1), 0)\}$	
$T = T\mu_T(T)$	$\mu_{N,Y}(T) = \{\max(\min(1, \frac{50-T}{10}), 0)\}$ $\mu_{N,Y}(T) = \{\max(\min(\frac{T-40}{10}, 1), 0)\}$	
$P = P\mu_P(P)$	$\mu_{N,Y}(P) = \{\max(\min(1, \frac{35-P}{15}), 0)\}$ $\mu_{N,Y}(P) = \{\max(\min(\frac{P-20}{15}, 1), 0)\}$	
$CIS = O\mu_c(C)$	$\mu_{N,Y}(C) = \{\max(\min(1, \frac{50-C}{30}), 0)\}$ $\mu_{N,Y}(C) = \{\max(\min(\frac{C-20}{30}, 1), 0)\}$	

The values on the curve, which range from 0 to 100, are represented by the membership function. Input-output notation is a mathematical notation for describing the relationship between two variables. Table 1 shows the proposed CIHRMIS system's input/output variables from the FIS, both graphically and mathematically. Table 1 displays the proposed CIHRMIS system's input/output variables as defined by the FIS, together with graphical and numerical representations of the system. The functions of input members are shown in the first five rows of table 1, whereas the functions of output members are shown in row 6.

3.5 De-Fuzzifier

One of the most severe procedures of a fuzzy inference system is the de-fuzzifier. Multiple De-Fuzzifier variants exist. In this work, a De-Fuzzifier of the centroid variety was utilized. The fuzzy inference system's De-Fuzzifier is depicted graphically in Fig. 3.

Fig No 3: Rule Surface of Proposed CIHRMIS based on HR Management and Organizational Management

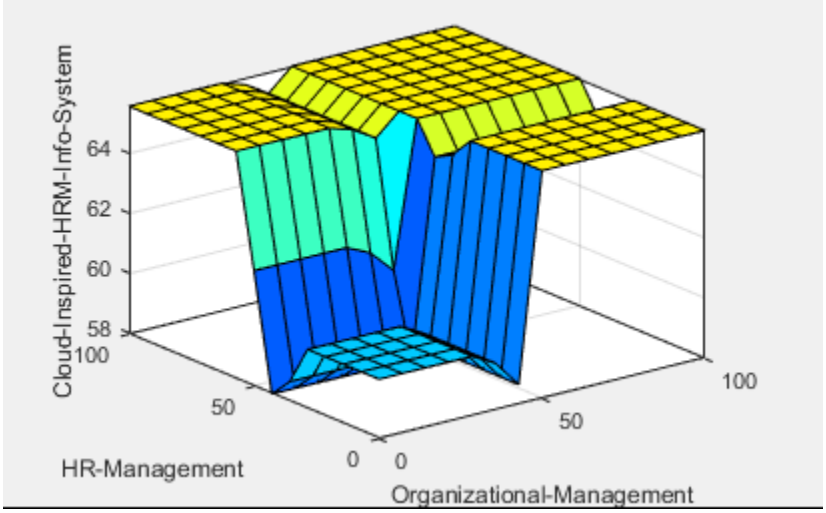


Fig. No 3 represents the 3D view of the ruled surface of the proposed CIHRMIS based on HR Management and Organizational Management. It observed that CIHRMIS weightage is Good (Yellow shade) and CIHRMIS weightage is Satisfied (Greenish Shade). Otherwise, CIHRMIS weightage is Weak or Poor (Bluish Shade).

Figure No 4: Rule Surface of Proposed CIHRMIS based on Organizational Management and Time management

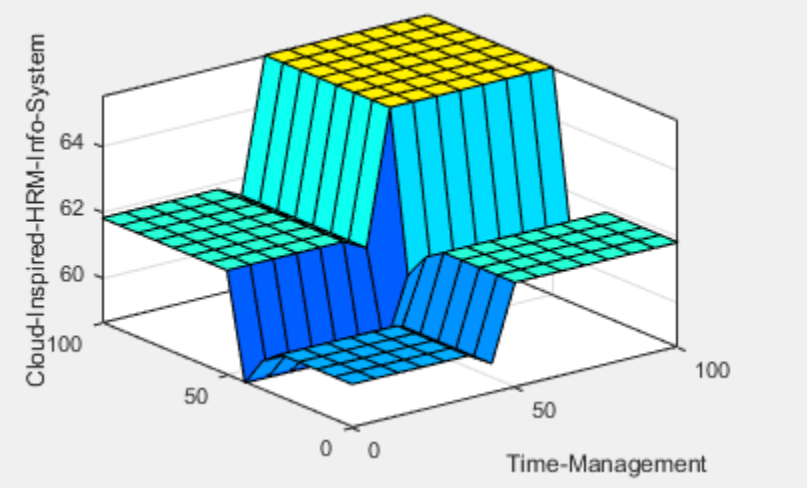


Fig. 4 represents the 3D view of the ruled surface of the proposed CIHRMIS based on Organizational Management and Time management. It observed that CIHRMIS weightage is Good (Yellow shade) and CIHRMIS weightage is Satisfied (Greenish Shade). Otherwise, CIHRMIS weightage is Weak or Poor (Bluish Shade).

Figure No 5: Rule Surface of Proposed CIHRMIS based on HR Management and Organizational Management

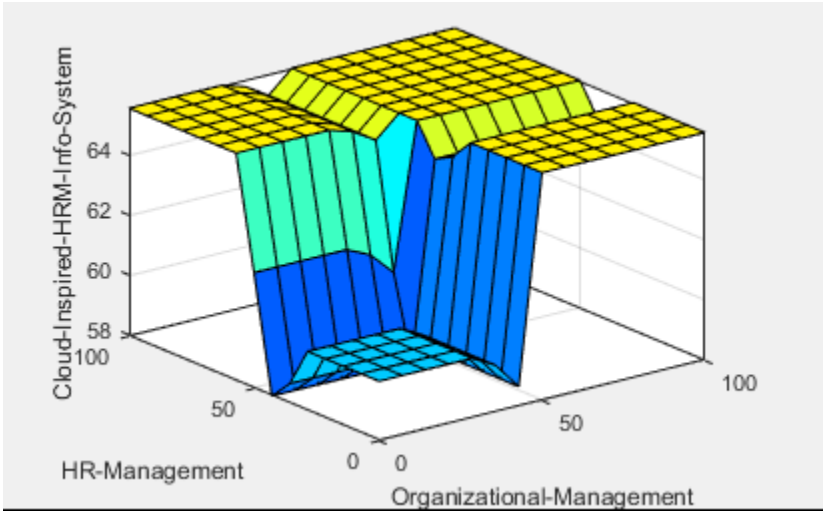


Fig. 5 represents the 3D view of the ruled surface of the proposed CIHRMIS based on HR Management and Organizational Management. It observed that CIHRMIS weightage is Good

(Yellow shade) and CIHRMIS weightage is Satisfied (Greenish Shade). Otherwise, CIHRMIS weightage is Weak or Poor (Bluish Shade).

4. Simulation and Results

MATLAB R2017a is used for producing simulation output. Many other disciplines use MATLAB for modeling, simulation, algorithm extension, and prototyping. Software developers, data analysts, and mathematicians all benefit from using MATLAB. Three input data sources and a single output factor are used to reproduce the results. Cloud-based HRIS that is inspired by human resource management can produce several forms of output once the findings are visible. In this article, we suggest a fuzzy-based CIHRMIS that does more than identify output; it also showcases the many kinds of output that may be generated from a system like Cloud Inspired Human Resource Management Information System. The lookup rules diagram is built using Fuzzy Logic designer based on the rules stated in the lookup table.

The five-member function for layer-2 simulation results contains 32 inputs and outputs that correspond to layer-2s, and the outputs reveal the importance of CIHRMIS. Using a layer two analysis, fin al; reveals the true power and potential global variables for businesses.

Figure No 6: Layer 2 Lookup diagram for proposed CIHRMIS (No)

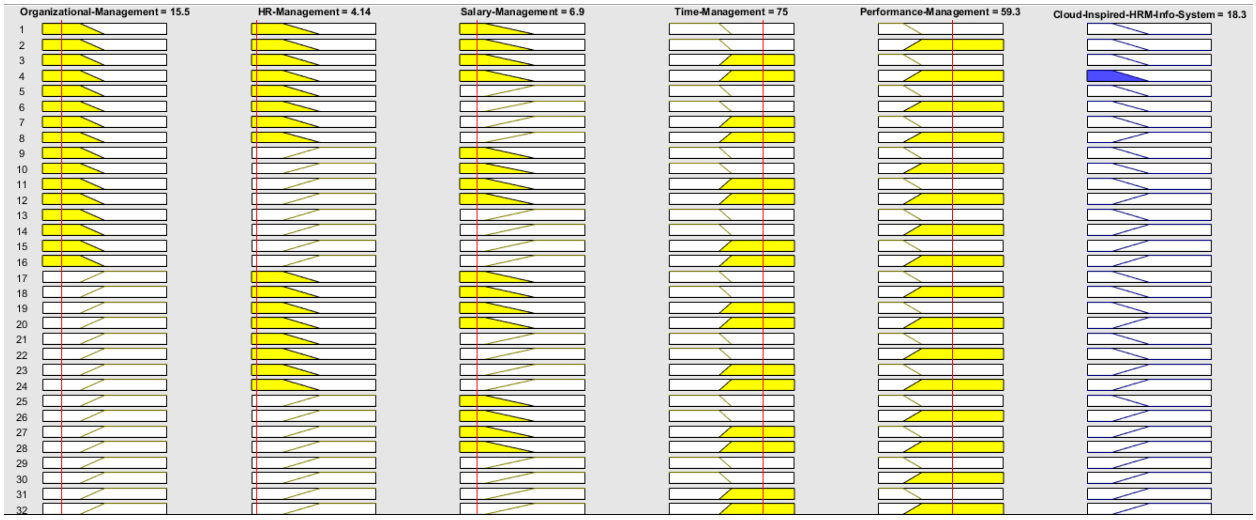


Fig 6 shows that if the values of Organizational-Management are No, HR-Management is No, Salary-Management is No, Time-Management is Yes, and Performance-Management is Yes, then Cloud-Inspired-HRM-Info-System is No.

Figure No 7: Layer 2 Lookup diagram for proposed CIHRMIS (No)

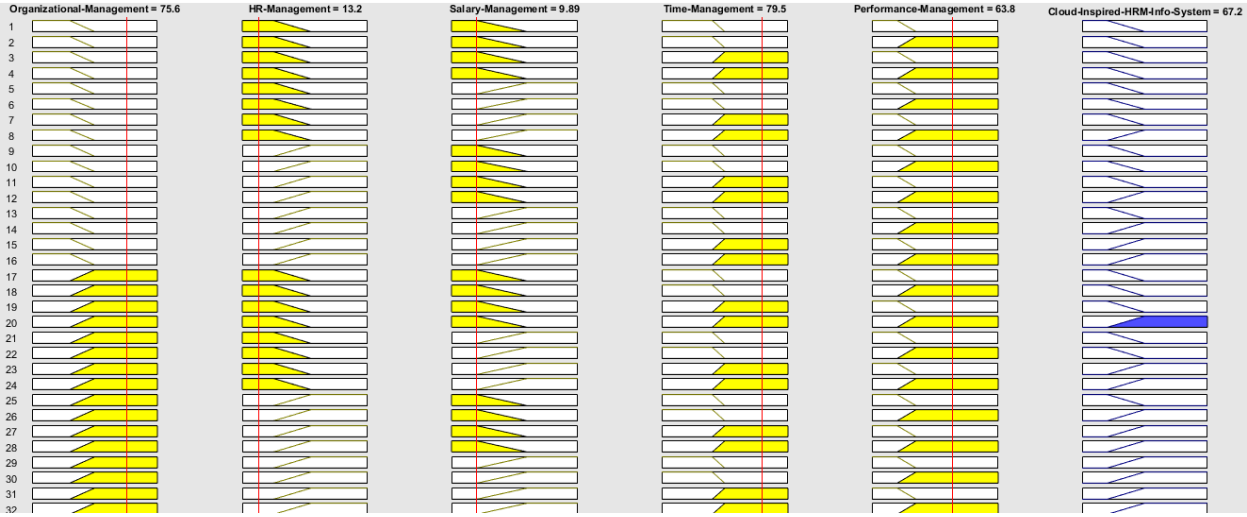


Fig 7 shows that if the values of Organizational-Management are Yes, HR-Management is No, Salary-Management is No, Time-Management is Yes, and Performance-Management is Yes, then Cloud-Inspired-HRM-Info-System is Yes.

1. Conclusion and Future Work

Cloud-inspired HRM models make an organization's HR function more effective and efficient. It adds value to the organization. The proposed system model optimizes organizational, HR, Salary, Time, and Performance Management operations. As for a business organization, prime HR management is a way to have a competitive edge over their rivals. This paper attempts to fill this gap in the literature by applying fuzzy to examine HR issues related to workers within organizations via Cloud computing tactics. The paper proposed a fuzzy logic driven Cloud inspired HR System aimed at providing human resource managers in organizations with a tool that would help them in various crucial organizational decision-making for its personnel. In the future, work on more business applications like production, costing, etc., based on Cloud can be done.

References

Abied, O., Ibrahim, O., Kamal, S. N. M., Alfadli, I., Binjumah, W. M., Ithnin, N., & Nasser, M. (2022). Probing determinants affecting intention to adopt cloud technology in E-Government systems. *Sustainability*, *14*(23), 15590. https://doi.org/10.3390/su142315590

Ahmad, N. (2015). MSc Project Title : Advancing HRMS with Cloud Computing (December).

Ajith, A. (2009). *Rule-Based Expert Systems. Handbook for Measurement System Design.* John Wiley and Sons.

Asghar, A. (2018). Key role of multinational companies in Pakistan. *Pakistan & Gulf Economist*.

Avram, M. G. (2014). Advantages and Challenges of Adopting Cloud Computing from an Enterprise Perspective. *Procedia Technology*, *12*, 529–534. https://doi.org/10.1016/j.protcy.2013.12.525

Berman, S. J., Kesterson-Townes, L., Marshall, A., & Srivathsa, R. (2012). How cloud computing enables process and business model innovation. *Strategy and Leadership*, *40*(4), 27–35. https://doi.org/10.1108/10878571211242920

Brekis, E., Rozite, K., & Zuka, R. (2014). Meta-Analysis of Advantages And Concerns of Cloud Computing in Small Companies. *the 8th International Days of Statistics and Economics*. Prague.

Canos, L., & Liern, V. (2004). Some Fuzzy Models for Human Resource Management. *International journal of Technology, Policy and Management*, 291-308.

Choudhary, H., Pandita, D., Vapiwala, F., & Rukadikar, A. (2023). *Determining the effectiveness of cloud computing on the payroll management system*. Retrieved from https://doi.org/10.1109/icbir57571.2023.10147457

Domun, V., & Bheemul, H. (2019). *Information Systems Design and Intelligent Applications* (Vol. 862). Springer Singapore. https://doi.org/10.1007/978-981-13-3329-3

Erbes, J., Motahari Nezhad, H. R., & Graupner, S. (2012). The future of enterprise IT in the cloud. *Computer*, *45*(5), 66–72. https://doi.org/10.1109/MC.2012.73

Garg, S. K., Versteeg, S., & Buyya, R. (2013). A framework for ranking of cloud computing services. *Future Generation Computer Systems*, *29*(4), 1012–1023. https://doi.org/10.1016/j.future.2012.06.006

Heiser, J., & Nicolett, M. (2008). Assessing the Security Risks of Cloud Computing. *Gartner Research*, (June), 1–6. Retrieved from http://www.gartner.com/DisplayDocument?id=685308

Hoberg, P., Wollersheim, J., & Krcmar, H. (2012). The business perspective on cloud computing - A literature review of research on cloud computing. *AMCIS 2012 Proceedings*, 1–12. Retrieved from https://aisel.aisnet.org/amcis2012/proceedings/EnterpriseSystems/5

Iqbal, N. (2015). Oracle HRMS E-Business Migration to the Cloud Environment.

Leimeister, S., Böhm, M., Riedl, C., & Krcmar, H. (2010). The Business Perspective of Cloud Computing: Actors, Roles and Value Networks. *18th European Conference on Information Systems*, 1–12. Retrieved from http://aisel.aisnet.org/ecis2010/56/

Li, L., & Pahlevanzadeh, B. (2021). Evaluation of the trust values among human resources in the enterprise cloud using an optimization algorithm and fuzzy logic. *Kybernetes*, *51*(6), 2008–2029. https://doi.org/10.1108/k-04-2021-0280

Lima-Junior, F. R., & Carpinetti, L. C. R. (2020). An adaptive network-based fuzzy inference system to supply chain performance evaluation based on SCOR® metrics. *Computers &Amp; Industrial Engineering*, *139*, 106191. https://doi.org/10.1016/j.cie.2019.106191

Lv, Z., Wang, Q., & Yang, Y. (2018). cloud computing management platform of Human Resource Based on Mobile Communication Technology.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing - The business perspective. *Decision Support Systems*, *51*(1), 176–189. https://doi.org/10.1016/j.dss.2010.12.006

Mell, P., & Grance, T. (2011). Certificate of registration - dried milk, why & whey protein. *National Institute of Standard AndTechnology*. https://doi.org/10.1136/emj.2010.096966

Min, Z., & Rabiei, K. (2022). Feasibility of implementing the human resource payroll management system based on cloud computing. *Kybernetes*, *52*(4), 1245–1268. https://doi.org/10.1108/k-07-2021-0554

Misra, S. C., & Mondal, A. (2011). Identification of a company's suitability for the adoption of cloud computing and modelling its corresponding Return on Investment. *Mathematical and Computer Modelling*, *53*(3–4), 504–521. https://doi.org/10.1016/j.mcm.2010.03.037

Moomal, A., & Masrom, M. (2015). ICT Development and Its Impact on e-Business and HRM Strategies in the Organizations of Pakistan. *Journal of Advanced Management Science*, *3*(4), 344–349. https://doi.org/10.12720/joams.3.4.344-349

Núñez, D., Ferrada, X., Neyem, A., Serpell, A., & Sepúlveda, M. (2018). A User-Centered Mobile Cloud Computing Platform for Improving Knowledge Management in Small-to-Medium Enterprises in the Chilean Construction Industry. *Applied Sciences*, *8*(4), 516. https://doi.org/10.3390/app8040516

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information and Management*, *51*(5), 497–510. https://doi.org/10.1016/j.im.2014.03.006

Park, J. H., & Jeong, H. Y. (2013). Cloud computing-based jam management for a manufacturing system in a Green IT environment. *Journal of Supercomputing*, *69*(3), 1054–1067. https://doi.org/10.1007/s11227-013-1007-7

Prasad, R. S. R., & Atukuri, V. R. (2012). Cloud Computing Technology for Effective e-Governance. *International Journal of Computer Science and Information Technologies*, *3*(1), 3241–3244. Retrieved from http://www.ijcsit.com/docs/Volume3/Vol3Issue1/ijcsit2012030159.pdf

Purohit, G. N., Jaiswal, M. P., & Pandey, S. (2012). Challenges Involved in Implementation of ERP on Demand Solution: Cloud Computing. *International Journal of Computer Science Issues*, *9*(4), 481–489.

Ross, P., & Blumenstein, M. (2013). Cloud computing: The nexus of strategy and technology. *Journal of Business Strategy*, *34*(4), 39–47. https://doi.org/10.1108/JBS-10-2012-0061

Samuel, O. W., Omisore, M. O., & Ojokoh, B. A. (2013). A Web Based Decision Support System Driven by Fuzzy Logic for the Diagnosis of Typhoid Fever, Expert System with Applications (ESWA). *40*, pp. 4164-1-4171. Elsevier.

Sandu, R., & Gide, E. (2018). Technological, Organisational and Environmental (TOE) Factors that Influence the Adoption of Cloud Based Service SMEs in India. *IEEE International*

Conference on Cloud Computing, CLOUD, 2018–July, 866–870. https://doi.org/10.1109/CLOUD.2018.00123

Singh , M., Kuldeep , T. S., & Srivastava, V. M. (2018). Cloud Computing Adoption Challenges in the Banking Industry. *2018 International Conference on Advances in Big Data, Computing and Data Communication Systems, icABCD 2018*, (pp. 1-5).

Subashini, S., & Kavitha, V. (2011). A survey on security issues in service delivery models of cloud computing. *Journal of Network and Computer Applications*, *34*(1), 1–11. https://doi.org/10.1016/j.jnca.2010.07.006

Takagi, T., & Sugeno, M. (1985). Fuzzy identification of systems and its applications to modeling and control. *IEEE transactions on systems, man, and cybernetics*, (1), 116-132. Tabassam, S. (2017). Security and Privacy Issues in Cloud Computing Environment. *Journal of Information Technology & Software Engineering*, *7*(5), 216.

Vinay, P. (2018). The Impact of Cloud Computing in Human Resource Management. Retrieved from https://www.techprevue.com

Wang, X. L., Wang, L., Bi, Z., Li, Y. Y., & Xu, Y. (2016). Cloud computing in human resource management (HRM) systems for small and medium enterprises (SMEs). *International Journal of Advanced Manufacturing Technology*, *84*(1–4), 485–496. https://doi.org/10.1007/s00170-016-8493-8

Yao, X., & Azma, M. (2021). Do cloud-based enterprise resource planning systems affect the productivity of human resources in the COVID-19 era? *Kybernetes*, *51*(6), 1967–1990. https://doi.org/10.1108/k-03-2021-0243

Zhao, C., Xue, Y., & Niu, T. (2021). Enterprise human resource management index based on fuzzy system. *Journal of Intelligent &Amp; Fuzzy Systems*, *40*(2), 3137–3146. https://doi.org/10.3233/jifs-189352

Annexure A
List of Multinational Companies Businesses in Pakistan

1. Aass Foundation - Islamabad
2. Creative Packers And Movers Company In Pakistan – Faisalabad
3. Hascomb Business Solutions (Pvt) - Faisalabad
4. Shell Development & Offshore - Islamabad
5. The Attock Oil Company Limite - Islamabad
6. Crown Agents For Overseas Govt - Islamabad
7. Hinopak Motors Ltd – Islamabad
8. Mol Pakistan Oil & Gas Co. B.v - Islamabad
9. The General Tyre & Rubber Comp – Islamabad

10. Thomas Cook Travel Pakistan - Islamabad
11. Coca-cola Beverages Pakistan - Sialkot
12. Standard Chartered Bank (pakis - Sialkot
13. U.s. Publishers (Pvt) Ltd. - Sialkot
14. Bank Of Tokyo-mitsubishi Ltd. - Karachi
15. Blackwood Hodge Pakistan (Pvt) - Karachi
16. Bp Pakistan Exploration And Pr - Karachi
17. Bsn Medical (Pvt) Ltd. - Karachi
18. Burmah Castrol Company - Karachi
19. Cadbury Pakistan Ltd. - Karachi
20. Cdc Capital Partners - Karachi
21. Crescent Commercial Bank Ltd.
22. Karachi Crown Agents Ent, - Karachi
23. Cupola Pakistan Limited – Karachi
24. Dubai Islamic Bank Pakistan Lt - Karachi
25. Elixir Securities Pakistan (pvt) - Karachi
26. Ici Pakistan Powergen Ltd. - Karachi
27. Industrial Power Drives - Karachi
28. Industrial Promotion Services - Karachi
29. Itim Pakistan - Karachi
30. Jardine Fleming Pakistan (pvt) - Karachi
31. Lundbeck Pakistan (pvt) Ltd. - Karachi
32. Mitsubishi Corporation - Karachi
33. Mott Macdonald International - Karachi
34. P&o Containers Pakistan (pvt) - Karachi
35. Pak Arab Refinery Limited - Karachi
36. Pak-arab Refinery Limited (par - Karachi
37. Pakindia.net Free Classified Ads – Karachi
38. Pakistan Pta Limited - Karachi
39. Ray Shipping Enterprises Ltd. - Karachi Sgs Pakistan (pvt) Ltd. - Karachi
40. T.c. Ziraat Bankasi A.s. - Karachi
41. The Bank Of Tokyo-mitsubishi L - Karachi
42. The Hub Power Co. Ltd. (hubco) - Karachi
43. Merck (private) Limited - Pak - Quetta

44. Siemens Pakistan Engineering - Quetta
45. Nestle Pakistan Ltd. - Peshawar
46. Total Atlas Lubricants Pakist - Multan
47. Sanofi-aventis Pakistan Ltd. – Multan
48. Areva T&d Pakistan (pvt) Ltd. – Lahore
49. Atlas Investment Bank Ltd. - Lahore
50. Avery Scales (pvt) Ltd. - Lahore
51. Avery Scales (pvt) Ltd. - Lahore
52. Becton Dickinson Pakistan (pvt - Lahore
53. Berger Paints Pakistan Limited - Lahore
54. Citibank N.a. - Lahore
55. Coca-cola Beverages Pakistan L - Lahore
56. Euro Multico Import And Export - Lahore
57. Faysal Bank Limited (gulberg B - Lahore
58. Gestetner (pvt) Ltd. - Lahore
59. Getwptheme - Lahore
60. Haier Mobile Pakistan - Lahore
61. Ibm World Trade Corporation - Lahore
62. J & P Coats Pakistan (pvt) Ltd - Lahore
63. Meezan Bank Ltd. - Lahore
64. New Hampshire Insurance Company - Lahore
65. Oman International Bank SAO – Lahore
66. Pakistan Tobacco Company Ltd. - Lahore
67. Unilever Pakistan Foods Ltd. - Lahore