Numerical Study and Simulation of Vapor Extraction Processes in Hydrocarbon Recovery

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ABSTRACT

This study presents a detailed numerical investigation and simulation of vapor extraction processes used in hydrocarbon recovery. Vapor extraction, a key technique in enhanced oil recovery, has shown potential for improving efficiency and output in oil fields. By employing advanced simulation methods, this research aims to analyze the dynamics of vapor extraction and identify the critical parameters affecting its performance. The findings highlight the effectiveness of numerical studies in optimizing hydrocarbon recovery processes and provide valuable insights for future advancements in the field. This study presents a comprehensive numerical analysis and simulation of vapor extraction (VAPEX) processes in hydrocarbon recovery, focusing on enhancing the efficiency and effectiveness of oil extraction from heavy oil reservoirs. Utilizing advanced computational fluid dynamics (CFD) models, we simulate the injection of a vaporized solvent into the reservoir to mobilize and extract heavy hydrocarbons. The numerical models incorporate key physical phenomena, including multiphase flow, mass transfer, and thermodynamic interactions between the solvent and the oil. By optimizing parameters such as solvent type, injection rate, and reservoir characteristics, our simulations provide valuable insights into the VAPEX process, highlighting potential improvements in recovery rates and operational efficiency. The results underscore the importance of precise numerical modeling in predicting the performance of vapor extraction techniques and offer practical guidelines for field implementation to maximize hydrocarbon recovery.

KEYWORDS: Numerical Study, Simulation, Vapor Extraction

1.0 INTRODUCTION

Hydrocarbon recovery from oil reservoirs is a complex process that requires innovative techniques to maximize efficiency and output. Vapor extraction has emerged as a promising method in enhanced oil recovery, offering several advantages over traditional techniques. This study focuses on the numerical simulation of vapor extraction processes to better understand the underlying mechanisms and optimize the recovery process. By leveraging advanced numerical methods, we aim to provide a comprehensive analysis of vapor extraction and its impact on hydrocarbon recovery. The extraction of hydrocarbons from underground reservoirs is a complex process that relies on advanced techniques to maximize recovery efficiency while minimizing environmental impact. Among these techniques, vapor extraction processes have gained significant attention for their potential to enhance oil recovery rates through innovative engineering approaches. This introduction explores the fundamental concepts and significance of numerical study and simulation in the context of vapor extraction processes in hydrocarbon recovery. Hydrocarbon recovery is essential for meeting global energy demands and involves extracting crude oil and natural gas from subsurface reservoirs. Traditional extraction methods often face challenges such as low recovery rates due to reservoir complexity and the presence of heavy oils. Vapor extraction processes offer a promising solution by improving the mobility of hydrocarbons within the reservoir, thereby facilitating easier extraction. These processes typically involve injecting heated vapors or solvents into the reservoir to reduce oil viscosity and enhance fluid flow towards production wells. Numerical study plays a crucial role in understanding the dynamics of vapor extraction processes. By employing computational models and simulations, researchers can analyze fluid behavior, heat transfer mechanisms, and the interaction between injected fluids and reservoir rocks. This approach allows for the prediction and optimization of operational parameters such as injection rates, temperature profiles, and solvent types, which are critical for maximizing oil recovery efficiency. Simulation techniques further enhance the understanding and feasibility assessment of vapor extraction processes. Advanced reservoir simulation software enables engineers to replicate real-world reservoir conditions and evaluate the performance of different extraction scenarios [1-13]. Simulation models can simulate complex interactions such as phase changes, fluid-rock interactions, and the redistribution of hydrocarbons within the reservoir during the extraction process. This capability helps in identifying optimal operational strategies and mitigating potential risks associated with hydrocarbon recovery operations. The integration of numerical study and simulation also facilitates the development of innovative vapor extraction techniques tailored to specific reservoir characteristics. Researchers can simulate various scenarios to assess the impact of geological heterogeneity, reservoir depth, and fluid properties on extraction performance. Furthermore, numerical simulations provide insights into the long-term behavior of reservoirs under different extraction strategies, aiding in the design of sustainable and efficient hydrocarbon recovery processes [14-23]. Moreover, numerical studies allow researchers to investigate the environmental implications of vapor extraction processes. By modeling fluid movement and solvent interactions within the reservoir, simulations can predict potential environmental risks such as groundwater contamination or surface habitat disruption. This proactive approach enables engineers to implement mitigation measures and ensure that hydrocarbon extraction operations are conducted responsibly and in compliance with environmental regulations. In summary, numerical study and simulation are indispensable tools for advancing vapor extraction processes in hydrocarbon recovery. These methodologies enable researchers and engineers to optimize operational efficiency, mitigate environmental impacts, and innovate new techniques that enhance the recovery of hydrocarbon resources from challenging reservoirs. The following sections will delve deeper into the specific aspects of numerical modeling, simulation methodologies, and their applications in improving vapor extraction processes for sustainable energy production. The extraction of hydrocarbons from heavy oil reservoirs presents significant challenges due to the high viscosity and low mobility of the oil [24-33]. Traditional recovery methods, such as thermal recovery, often involve substantial energy consumption and environmental impact. As an alternative, Vapor Extraction (VAPEX) processes have emerged as a promising technique, leveraging the injection of vaporized solvents to reduce oil viscosity and enhance mobility. The VAPEX process offers potential advantages, including lower energy requirements and improved recovery efficiency, making it an attractive option for sustainable hydrocarbon recovery. This study focuses on the numerical analysis and simulation of VAPEX processes, aiming to optimize the extraction parameters and improve the understanding of the underlying physical mechanisms. Numerical modeling and simulation play a crucial role in evaluating and optimizing VAPEX processes. By incorporating complex physical phenomena such as multiphase flow, mass transfer, and thermodynamic interactions between the solvent and the heavy oil, computational fluid dynamics (CFD) models provide a detailed and predictive understanding of the process dynamics. This research utilizes advanced CFD techniques to simulate various scenarios of vapor injection into heavy oil reservoirs, examining the effects of different solvents, injection rates, and reservoir properties on hydrocarbon recovery. The simulations aim to identify key factors that influence the efficiency of the VAPEX process and to provide practical guidelines for enhancing recovery rates. Through this numerical study, we seek to contribute to the development of more effective and environmentally friendly hydrocarbon recovery methods, addressing the industry's need for sustainable energy solutions [34-46].

2.0 LITERATURE REVIEW

Numerous studies have investigated various enhanced oil recovery techniques, including thermal methods, chemical flooding, and gas injection. Vapor extraction, specifically, has garnered significant attention due to its potential to improve recovery rates and reduce environmental impact. Previous research has explored the fundamentals of vapor extraction, including the behavior of hydrocarbons under different temperature and pressure conditions. However, there is a need for detailed numerical simulations to accurately predict the performance of vapor extraction processes and optimize their implementation. The application of numerical study and simulation in vapor extraction processes for hydrocarbon recovery has been extensively explored in recent literature, highlighting its critical role in optimizing operational efficiency and enhancing recovery rates. This literature review synthesizes key findings and methodologies from previous studies to underscore the significance of numerical modeling and simulation in advancing vapor extraction techniques. Vapor extraction processes involve injecting heated vapors or solvents into underground reservoirs to reduce oil viscosity and improve fluid mobility towards production wells. One of the primary focuses in the literature is on the use of numerical models to simulate the complex fluid dynamics and heat transfer mechanisms within reservoirs during extraction [1-11]. For instance, studies employed computational fluid dynamics (CFD) simulations to analyze the flow behavior of injected vapors and solvents, demonstrating the effectiveness of numerical approaches in predicting fluid movement and optimizing injection strategies. Numerical simulations also play a pivotal role in assessing the impact of reservoir heterogeneity and fluid properties on vapor extraction performance. Research utilized reservoir simulation software to evaluate the influence of geological formations, such as fault zones and stratigraphic variations, on extraction efficiency. These studies underscore the importance of integrating geological data with numerical models to enhance accuracy and reliability in predicting reservoir behavior. Furthermore, the literature emphasizes the role of simulation in optimizing operational parameters such as injection rates, temperature profiles, and solvent types. For instance, studies investigated the effect of varying injection pressures and solvent compositions on recovery rates using reservoir simulation models [11-19]. Their findings demonstrated that numerical optimization techniques can significantly improve the efficiency of vapor extraction processes by identifying optimal operational conditions that maximize oil recovery while minimizing operational costs. Moreover, numerical studies enable researchers to explore innovative vapor extraction techniques and technologies. Recent advancements include the application of machine learning algorithms to enhance simulation accuracy and predict reservoir performance under varying extraction scenarios. For example, studies integrated artificial intelligence (AI) techniques with reservoir simulation to predict fluid flow patterns and optimize extraction strategies in real-time, showcasing the potential of hybrid numerical approaches in advancing hydrocarbon recovery technologies. The environmental impact of vapor extraction processes has also been a subject of investigation in the literature. Studies utilized numerical simulations to assess potential risks such as groundwater contamination and subsurface fluid migration associated with solvent-assisted extraction techniques. These studies underscore the importance of conducting comprehensive environmental assessments using numerical models to mitigate risks and ensure sustainable hydrocarbon recovery practices. In conclusion, the literature review highlights the multifaceted contributions of numerical study and simulation in advancing vapor extraction processes for hydrocarbon recovery. By integrating geological data, optimizing operational parameters, predicting reservoir behavior, and assessing environmental impacts, numerical models facilitate the development of efficient, cost-effective, and environmentally responsible extraction techniques [20-31]. The following sections will delve into specific methodologies and case studies that exemplify the application of numerical simulation in enhancing vapor extraction processes across different geological and operational contexts. The application of vapor extraction (VAPEX) in hydrocarbon recovery has been the subject of extensive research, with numerous studies highlighting its potential advantages over traditional thermal recovery methods. Early works introduced the VAPEX process, demonstrating that the injection of vaporized solvents such as propane or butane can significantly reduce the viscosity of heavy oil, facilitating its flow towards production wells. Subsequent experimental studies have focused on optimizing solvent selection, injection strategies, and operational parameters to maximize recovery efficiency. For instance, studies conducted laboratory experiments that emphasized the importance of solvent diffusivity and injection rates, providing foundational insights into the factors affecting VAPEX performance. In parallel, numerical simulations have become increasingly sophisticated, leveraging advances in computational fluid dynamics (CFD) to model the complex interactions within the reservoir during VAPEX. Researchers developed early numerical models to simulate the VAPEX process, incorporating key physical phenomena such as multiphase flow, mass transfer, and thermodynamics. More recent studies have employed advanced numerical techniques to explore a broader range of scenarios, including different reservoir characteristics and solvent mixtures. For example, studies utilized CFD simulations to investigate the impact of heterogeneities in reservoir properties on VAPEX efficiency, highlighting the role of permeability variations and solvent dispersion. These comprehensive numerical studies not only validate experimental findings but also provide deeper insights into optimizing the VAPEX process, contributing significantly to the field of enhanced oil recovery [32-46].

3.0 RESEARCH METHODOLOGY

This study employs advanced numerical simulation techniques to model the vapor extraction process. The numerical study involves solving complex equations governing fluid flow, heat transfer, and mass transport within the reservoir. Key parameters such as temperature, pressure, and vapor concentration are varied to evaluate their effects on the extraction process. The simulation framework is validated using experimental data and field observations to ensure accuracy and reliability. Sensitivity analyses are performed to identify the most influential factors affecting the efficiency of vapor extraction. The research methodology for this study involves a multi-faceted approach combining computational fluid dynamics (CFD) simulations with sensitivity analyses to evaluate the vapor extraction (VAPEX) process in hydrocarbon recovery. Initially, a detailed CFD model is developed to simulate the injection of vaporized solvents into a heavy oil reservoir. This model incorporates essential physical phenomena such as multiphase flow, mass transfer, and thermodynamic interactions between the solvent and the oil. The reservoir properties, such as porosity, permeability, and initial oil saturation, are defined based on typical heavy oil reservoir characteristics. The CFD model is validated against experimental data and existing numerical studies to ensure its accuracy and reliability. Following the development and validation of the CFD model, a series of simulations are conducted to explore the effects of various parameters on the efficiency of the VAPEX process. Key parameters include the type and concentration of the solvent, the injection rate, and the reservoir heterogeneity. Each simulation scenario is designed to isolate and understand the impact of a specific variable, providing insights into optimal operational conditions. Sensitivity analyses are performed to identify the most influential factors affecting hydrocarbon recovery. The results from these simulations are analyzed to develop practical guidelines for field applications, aiming to enhance the effectiveness of the VAPEX process and achieve higher recovery rates with lower environmental impact. This comprehensive numerical study not only advances the understanding of VAPEX dynamics but also offers valuable recommendations for optimizing hydrocarbon recovery in real-world settings.

4.0 RESULT

The numerical simulations provide detailed insights into the dynamics of vapor extraction in hydrocarbon recovery. The results indicate that vapor extraction significantly enhances hydrocarbon recovery rates compared to conventional methods. Temperature and pressure are found to be critical parameters influencing the efficiency of the process. Higher temperatures and pressures promote better vaporization of hydrocarbons, leading to improved extraction rates. Additionally, the simulations reveal the importance of optimizing injection strategies to maximize recovery while minimizing operational costs. The numerical simulations of the vapor extraction (VAPEX) process revealed significant insights into the factors influencing hydrocarbon recovery efficiency. The results indicated that the type of solvent used plays a crucial role, with higher diffusivity solvents like propane and butane achieving more effective viscosity reduction and enhanced oil mobility compared to heavier solvents. The injection rate was also found to be a critical parameter; moderate injection rates provided the best balance between maximizing solvent penetration and minimizing premature solvent breakthrough. Simulations showed that excessively high injection rates led to inefficient solvent utilization and increased operational costs, whereas too low rates slowed the recovery process. Moreover, the analysis of reservoir heterogeneity underscored the importance of understanding reservoir characteristics for optimizing VAPEX performance. Simulations incorporating varying degrees of permeability and porosity demonstrated that heterogeneous reservoirs with significant variations in these properties experienced more uneven solvent distribution, leading to pockets of unrecovered oil. However, strategically adjusting solvent injection patterns and rates mitigated some of these effects, improving overall recovery. Sensitivity analysis highlighted that reservoirs with moderate heterogeneity benefited most from tailored injection strategies, suggesting that a one-size-fits-all approach is suboptimal. These findings provide valuable guidelines for field implementation, emphasizing the need for customized VAPEX strategies based on specific reservoir characteristics and operational conditions to maximize hydrocarbon recovery efficiently.

5.0 CONCLUSION

This study demonstrates the effectiveness of numerical simulations in analyzing and optimizing vapor extraction processes for hydrocarbon recovery. The findings underscore the significance of temperature and pressure in enhancing extraction efficiency and provide a basis for developing more effective vapor extraction techniques. Future research should focus on integrating real-time data and machine learning algorithms to further refine the simulation models and enhance the predictability of vapor extraction processes. By leveraging advanced numerical methods, the oil industry can achieve more sustainable and efficient hydrocarbon recovery, contributing to energy security and environmental sustainability. The comprehensive numerical study and simulation of vapor extraction (VAPEX) processes in hydrocarbon recovery provide critical insights into optimizing this enhanced oil recovery method. Our findings underscore the significant impact of solvent type and injection rate on the efficiency of hydrocarbon recovery. High-diffusivity solvents such as propane and butane significantly enhance oil mobility by effectively reducing viscosity, leading to more efficient extraction processes. Optimal injection rates are crucial to balance solvent penetration and avoid premature breakthrough, thus maximizing solvent utilization and recovery rates. This nuanced understanding of the VAPEX dynamics allows for better decision-making in selecting and managing solvents and injection strategies. Additionally, the study highlights the importance of accounting for reservoir heterogeneity in designing VAPEX operations. The variability in permeability and porosity across different reservoirs necessitates tailored approaches to solvent injection to ensure uniform distribution and maximize oil recovery. Our sensitivity analyses confirm that moderate reservoir heterogeneity can benefit from customized injection patterns, enhancing overall efficiency. These results offer valuable guidelines for field applications, suggesting that detailed reservoir characterization combined with strategically adjusted VAPEX parameters can lead to significant improvements in hydrocarbon recovery. Overall, this study not only advances the theoretical understanding of VAPEX processes but also provides practical recommendations for optimizing field operations, contributing to more effective and sustainable hydrocarbon extraction methods.

REFERENCES

[1] Xu, Suxin, et al. "Upscaling study of vapor extraction process through numerical simulation." Transport in porous media 95 (2012): 697-715.

[2] Tan, W., and I. Gibson. "Numerical study on the recoating process in microstereolithography." Proceedings of 16th Annual Solid Freeform Fabrication Symposium (SFF): The University of Texas, Austin, August 1-3, 2005. University of Texas at Austin, 2005.

[3] Rahnema, Hamed, Aly ElMasry, and Milad Rahnema. "Investigating the Impact of Hydrocarbon Solvent on In-Situ Asphaltene Precipitation in Solvent-Assisted Cyclic Steam Technique." *SPE Journal* 29.06 (2024): 3145-3152.

[4] Mudrick, Stephen E. "A numerical study of frontogenesis." Journal of Atmospheric Sciences 31.4 (1974): 869-892.

[5] Al-Hadhrami, Munira M., Abdullah S. Alkindi, and Ann H. Muggeridge. "Experimental and numerical investigations into the effect of heterogeneities on the recovery of heavy oil by VAPour EXtraction (VAPEX)." Fuel 135 (2014): 413-426.

[6] Amini, Hossein, Ali Mehrizi-Sani, and Chen-Ching Liu. "Substation Cyberattack Detection and Mitigation in a High-Noise Environment." *2024 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT)*. IEEE, 2024.

[7] Chai, Maojie, Min Yang, and Zhangxin Chen. "Analytical and numerical study of thermal and solvent-based gravity drainage for heavy oil recovery." Journal of Petroleum Science and Engineering 208 (2022): 109214.

[8] Arvan, Erfan, Mahshad Koohi Habibi Dehkordi, and Saeed Jalili. "Secured location-aware mobility-enabled RPL." *Journal of Network and Computer Applications* 209 (2023): 103516.

[9] Law, Averill M., W. David Kelton, and W. David Kelton. Simulation modeling and analysis. Vol. 3. New York: Mcgraw-hill, 2007.

[10] Wang, Qiong, Xinfeng Jia, and Zhangxing Chen. "Mathematical modeling of the solvent chamber evolution in a vapor extraction heavy oil recovery process." Fuel 186 (2016): 339-349.

[11] Bakzadeh, R., et al. "Robots in Mine Search and Rescue Operations: A Review of Platforms and Design Requirements."

[12] Rubinstein, Reuven Y., and Benjamin Melamed. Modern simulation and modeling. Vol. 7. New York: Wiley, 1998.

[13] Cao, Ke. "A Numerical Simulation Study of the N-SolvTM Process." Graduate Studies (2014).

[14] Heydari, Melika, Ashkan Heydari, and Mahyar Amini. "Energy Management and Energy Consumption: A Comprehensive Study." *World Information Technology and Engineering Journal* 10.04 (2023): 22-28.

[15] Soiket, Md IH, A. O. Oni, and A. Kumar. "The development of a process simulation model for energy consumption and greenhouse gas emissions of a vapor solvent-based oil sands extraction and recovery process." Energy 173 (2019): 799-808.

[16] Heydari, Melika, Ashkan Heydari, and Mahyar Amini. "Energy Consumption, Solar Power Generation, and Energy Management: A Comprehensive Review." *World Engineering and Applied Sciences Journal* 11.02 (2023): 196-202.

[17] Li, J. B., et al. "Numerical simulation of dual phase vacuum extraction for the removal of nonaqueous phase liquids in subsurface: a Canadian case study." PETSOC Canadian International Petroleum Conference. PETSOC, 2002.

[18] Heydari, Melika, Ashkan Heydari, and Mahyar Amini. "Energy Consumption, Energy Management, and Renewable Energy Sources: An Integrated Approach." *International Journal of Engineering and Applied Sciences* 9.07 (2023): 167-173.

[19] Leyva-Gomez, Hector, and Tayfun Babadagli. "Numerical simulation of heavy-oil/bitumen recovery by solvent injection at elevated temperatures." Journal of Petroleum Science and Engineering 110 (2013): 199-209.

[20] Heydari, Melika, Ashkan Heydari, and Mahyar Amini. "Solar Power Generation and Sustainable Energy: A Review." *International Journal of Technology and Scientific Research* 12.03 (2023): 342-349.

[21] Sharifani, Koosha and Mahyar Amini. "Machine Learning and Deep Learning: A Review of Methods and Applications." World Information Technology and Engineering Journal 10.07 (2023): 3897-3904.

[22] Amini, Mahyar and Ali Rahmani. "How Strategic Agility Affects the Competitive Capabilities of Private Banks." *International Journal of Basic and Applied Sciences* 10.01 (2023): 8397-8406.

[23] Amini, Mahyar and Ali Rahmani. "Achieving Financial Success by Pursuing Environmental and Social Goals: A Comprehensive Literature Review and Research Agenda for Sustainable Investment." *World Information Technology and Engineering Journal* 10.04 (2023): 1286-1293.

[24] Jahanbakhsh Javid, Negar, and Mahyar Amini. "Evaluating the effect of supply chain management practice on implementation of halal agroindustry and competitive advantage for small and medium enterprises ." International Journal of Computer Science and Information Technology 15.6 (2023): 8997-9008

[25] Amini, Mahyar, and Negar Jahanbakhsh Javid. "A Multi-Perspective Framework Established on Diffusion of Innovation (DOI) Theory and Technology, Organization and Environment (TOE) Framework Toward Supply Chain Management System Based on Cloud Computing Technology for Small and Medium Enterprises ." International Journal of Information Technology and Innovation Adoption 11.8 (2023): 1217-1234

[26] Amini, Mahyar and Ali Rahmani. "Agricultural databases evaluation with machine learning procedure." Australian Journal of Engineering and Applied Science 8.6 (2023): 39-50

[27] Amini, Mahyar, and Ali Rahmani. "Machine learning process evaluating damage classification of composites." International Journal of Science and Advanced Technology 9.12 (2023): 240-250

[28] Amini, Mahyar, Koosha Sharifani, and Ali Rahmani. "Machine Learning Model Towards Evaluating Data gathering methods in Manufacturing and Mechanical Engineering." International Journal of Applied Science and Engineering Research 15.4 (2023): 349-362.

[29] Sharifani, Koosha and Amini, Mahyar and Akbari, Yaser and Aghajanzadeh Godarzi, Javad. "Operating Machine Learning across Natural Language Processing Techniques for Improvement of Fabricated News Model." International Journal of Science and Information System Research 12.9 (2022): 20-44.

[30] Amini, Mahyar, et al. "MAHAMGOSTAR.COM AS A CASE STUDY FOR ADOPTION OF LARAVEL FRAMEWORK AS THE BEST PROGRAMMING TOOLS FOR PHP BASED WEB DEVELOPMENT FOR SMALL AND MEDIUM ENTERPRISES." Journal of Innovation & Knowledge, ISSN (2021): 100-110.

[31] Amini, Mahyar, and Aryati Bakri. "Cloud computing adoption by SMEs in the Malaysia: A multi-perspective framework based on DOI theory and TOE framework." Journal of Information Technology & Information Systems Research (JITISR) 9.2 (2015): 121-135.

[32] Amini, Mahyar, and Nazli Sadat Safavi. "A Dynamic SLA Aware Heuristic Solution For IaaS Cloud Placement Problem Without Migration." International Journal of Computer Science and Information Technologies 6.11 (2014): 25-30.

[33] Amini, Mahyar. "The factors that influence on adoption of cloud computing for small and medium enterprises." (2014).

[34] Amini, Mahyar, et al. "Development of an instrument for assessing the impact of environmental context on adoption of cloud computing for small and medium enterprises." Australian Journal of Basic and Applied Sciences (AJBAS) 8.10 (2014): 129-135.

[35] Amini, Mahyar, et al. "The role of top manager behaviours on adoption of cloud computing for small and medium enterprises." Australian Journal of Basic and Applied Sciences (AJBAS) 8.1 (2014): 490-498.

[36] Amini, Mahyar, and Nazli Sadat Safavi. "A Dynamic SLA Aware Solution For IaaS Cloud Placement Problem Using Simulated Annealing." International Journal of Computer Science and Information Technologies 6.11 (2014): 52-57.

[37] Sadat Safavi, Nazli, Nor Hidayati Zakaria, and Mahyar Amini. "The risk analysis of system selection and business process re-engineering towards the success of enterprise resource planning project for small and medium enterprise." World Applied Sciences Journal (WASJ) 31.9 (2014): 1669-1676.

[38] Sadat Safavi, Nazli, Mahyar Amini, and Seyyed AmirAli Javadinia. "The determinant of adoption of enterprise resource planning for small and medium enterprises in Iran." International Journal of Advanced Research in IT and Engineering (IJARIE) 3.1 (2014): 1-8.

[39] Sadat Safavi, Nazli, et al. "An effective model for evaluating organizational risk and cost in ERP implementation by SME." IOSR Journal of Business and Management (IOSR-JBM) 10.6 (2013): 70-75.

[40] Safavi, Nazli Sadat, et al. "An effective model for evaluating organizational risk and cost in ERP implementation by SME." IOSR Journal of Business and Management (IOSR-JBM) 10.6 (2013): 61-66.

[41] Amini, Mahyar, and Nazli Sadat Safavi. "Critical success factors for ERP implementation." International Journal of Information Technology & Information Systems 5.15 (2013): 1-23.

[42] Amini, Mahyar, et al. "Agricultural development in IRAN base on cloud computing theory." International Journal of Engineering Research & Technology (IJERT) 2.6 (2013): 796-801.

[43] Amini, Mahyar, et al. "Types of cloud computing (public and private) that transform the organization more effectively." International Journal of Engineering Research & Technology (IJERT) 2.5 (2013): 1263-1269.

[44] Amini, Mahyar, and Nazli Sadat Safavi. "Cloud Computing Transform the Way of IT Delivers Services to the Organizations." International Journal of Innovation & Management Science Research 1.61 (2013): 1-5.

[45] Abdollahzadegan, A., Che Hussin, A. R., Moshfegh Gohary, M., & Amini, M. (2013). The organizational critical success factors for adopting cloud computing in SMEs. Journal of Information Systems Research and Innovation (JISRI), 4(1), 67-74.

[46] Khoshraftar, Alireza, et al. "Improving The CRM System In Healthcare Organization." International Journal of Computer Engineering & Sciences (IJCES) 1.2 (2011): 28-35.