Original Article: Evaluation and Selection of Construction Industry Contractors as an Optimal Model from the Perspective of Health, Safety and Environment

Reza Kolbadinezhad[1] |**Ebadollah Amouzad Mahdiraji**[2]*

[1]*Medical Genomics Research Center, Tehran Medical Sciences Islamic Azad University, Tehran, Iran*
[2]*Department of Engineering, Sari Branch, Islamic Azad University, Sari, Iran*

Use yor device to scan and read the article online

Citation E.A. Mahdiraji*, R. Kolbadinezhad, **Evaluation and Selection of Construction Industry Contractors as an Optimal Model from the Perspective of Health, Safety and Environment.** *Eurasian J. Sci. Tech.*, **2021**, *1*(3), 131-141.

https://doi.org/10.22034/JSTR.2021.285446.1021

Article info:
Received: 05 March 2021
Accepted: 17 May 2021
Available Online: 19 May 2021
ID: JSTR-2105-1021
Checked for Plagiarism: Yes
Peer Reviewers Approved by:
Dr. Amir Samimi
Editor who Approved Publication:
Prof. Dr. Abdulkareem M. A. Alsammarraie

Keywords:
Performance appraisal, Selection, contractors, Construction industry, Health, Safety, Environment.

ABSTRACT

Due to the rapid trend of transferring most of the activities to contracting companies, the rate of indicators related to occupational accidents has grown alarmingly and has led to the discussion of evaluating and selecting construction contractors in terms of health. Safety and the environment are of paramount importance. The presented model was performed by analyzing quantitative studies as well as completing a specific questionnaire and field surveys. The sample size was determined to be 252 with a 95% confidence level and a 5% error probability. The test method was performed using Cameo and Bartlett test and confirmatory factor analysis. The results of the present study indicated that the highest intensity of impact was related to the human resources criterion and the lowest intensity was accounted by the planning criterion. The proposed model can meet the growing need of organizations for a comprehensive model of evaluation and selection of contractors.

Introduction

Compared with other industries with high safety hazards and small-scale characteristics, the construction industry is one of the high-frequency accidents and diverse sources of danger. However, the trend of accidents in construction has steadily decreased with the continuous efforts of researchers [1,2]. The construction industry is still considered one of the most insecure industries today [3,4], and every year in the world, more than 1 million people die from diseases and work-related accidents. This situation is more widespread and intense in developing countries.

***Corresponding Author:** *Ebadollah Amouzad Mahdiraji (ebad.amouzad@gmail.com)*

Occupational accidents are currently the third leading cause of death in the world and the number of deaths due to occupational accidents is increasing every year [5]. New statistics also show a high rate of accidents in recent years in many countries, including Iran. According to the report of the Social Security Fund, from the beginning of 2014 to the end of December, 276 women and 14743 insured men suffered from work-related accidents. According to the report, 14,286 cases of injuries occurred inside the workshops, of which 1,069 were due to non-compliance with safety regulations. The mentioned problems are the main cause of casualties, health issues, loss of skilled and skilled personnel, compensation, and reduction of production, which are the consequences of failure in the safety management of construction sites [6]. On the other hand, in recent years, the process of rapid transfer of most of the activities to contractors has begun. For various reasons, including lack of legal requirements, lack of attention to monitoring the strict implementation of safety principles, health, and environment in the contracts of these companies, the rate of indicators related to occupational accidents, such as recurrence rate, severity rate, the incidence rate among contractors has grown alarmingly [7-9].

The use of contractors with the acceptable organization of occupational health, safety, and environment (HSE) and proper performance in this field, has a significant effect on the status and projects of the employer and reduces the cost of outsourced projects. For this reason, the interaction of the health, safety, and environmental management system between the employer and the contractors as well as the subcontractors is of special importance [1].

The present article aims to provide a systematic, comprehensive, and optimal model for evaluating the performance of occupational health, safety, and environment and selecting contractors to use its criteria, public and private organizations, and executive agencies to continuously evaluate and manage their contractors and use the evaluation output as input in the optimal selection of contractors.

Analysis method

In recent years, the engineering and humanities have paid increasing attention to the complex technical, social, psychological, managerial, and political implications of systems safety, and to the accelerating development of the early twenty first century. And with the proliferation of sensitive and complex systems came the idea of assessing the safety of other systems; therefore, one could not wait for accidents to occur so that the weaknesses of the system could be identified and addressed. Accordingly, attempts were made to develop methods for safety assessment that could identify the potential hazards before the operation, which resulted in the formation of systems safety and occupational safety and health, based on a planned and regulated program should be in the form of a preventive process [11-15].

Therefore, due to the extent of construction projects in Iran and as a result of the growing trend of the contractors of the industry, it is necessary to pay more attention to compliance with the executive standards to maintain the health, safety, and comfort of personnel and people, and to show how the contractors in the construction industry manage the health, safety, and environment.

Therefore, the quality and effectiveness of health, safety, and environmental management systems is a vital factor in achieving their goals. Many articles have been published on various topics about construction safety. The results of these studies can provide a basis for the development of construction safety management. A purposeful analysis of construction safety studies is therefore essential for key stakeholders to share innovative weaves and future construction safety trends. In a 1999 study, factors affecting safety performance at construction sites in the United Kingdom were identified through interviews with 2 project managers, 1 safety supervisor, and 20 workers. In the study, among the economic, psychological, technical, procedural, organizational, and environmental variables, the most prominent variable that was closely related to safety performance in the

construction industry was the organizational variable. Further, the study displayed other factors including: Management commitment to discuss safety, preparation of safety pamphlets, providing a safe environment, and hiring a trained safety representative as 5 important factors related to safety performance in the construction industry [16-21].

In a study (2004) between 200 large and medium-sized construction companies in China, the status of safety management in the industry and the detection of potentially hazardous activities in construction sites, and the identification of effective factors in it were investigated and the results showed that the biggest concern in the safety management of construction projects was the behavior of contractors, such as lack of personal protective equipment, lack of safety meetings and lack of safety training. Also, the results of the study showed that low awareness of senior managers and project managers about safety, lack of training, and lack of attention of operational personnel to safety points were among the main factors affecting the safety performance of construction projects [22-25].

A study in Hong Kong (2005) among 180 people, including contractors, consultants, and employers, provided a framework for evaluating the safety performance of contractors. The results showed that the criteria for implementing a safety management system and accepting safety rules and health were found the most important among safety performance assessment factors at the project level [26-30]. In another study (2008), among 60 small and minor construction contractors, the safety performance of subcontractors in the construction industry in Palestine were examined. Based on the results, contractors' occupational accidents could be reduced provided that adequate training of workforce in relation to workplace are practiced, because if the equipment is unsafe and they do not know how to use the equipment properly, the rate of occupational accidents will increase due to the complexity and difficulty of work in construction workshops [31-35].

In a study (2013) among 50 major UK contractors, 6 companies were randomly selected and invited to participate in the study. A reward scheme for subcontractors was used to reduce losses. It first looked at other non-traditional forms of employment, i.e. employment contracts, in the UK and pointed to reasons such as the avoidance of workers' compensation. To analyze the qualitative data, a 5-step process based on the Cresswell Guide (2009) was used and the results showed that by using a series of fixed subcontractors and implementing a reward scheme to observe safety and protection of workers in the workshop. The use of HSE managers in sub-workplaces with direct responsibility for worker safety could reduce and reduce workplace losses [35-40].

In a study between 36 health, safety, and environment managers of the gas refinery (2014), its maintenance activities was optimized by integrating the continuous improvement cycle with a fuzzy multivariate approach in the gas refinery and using the DEA method. FDEA was selected as a measurement tool for calculating the selection of returns and ranking of decision units. In the questionnaires, 3 inputs and 9 outputs were obtained. The main steps included identifying health, safety, and environmental management systems, selecting performance indicators (input and output), collecting data and preparing them, selecting the appropriate cover analysis model (DEA), and solving the DEA model, which finally improved the HSE management program in a gas refinery using fuzzy approach data [41-43].

In another study of 201 projects in Uganda (2014), spatial analysis of construction accidents was performed using ordinary least squares regression and spatial regression model. The method used in this study was a triangulation method. Also, the common causes of accidents in Kampala such as mechanical hazards. i.e. machinery, vehicles, hand tools, cutting edge, etc., that occur by falling objects and among many full-time workers in the workshop were considered. The results showed that the regulation of working hours per week, the development of standards for equipment safety, the preparation of regulations for the

regular maintenance of construction equipment in the standard conditions of planning and evaluation in Safety risk, the of density and height of floors can be useful to reduce the occurrence of accidents [44-48].

In a study between 9 power plant repair companies (2011), the performance of power plant repair contractors was evaluated and the results showed that in terms of quality and rank, the contractors of the first group, i.e. large and well-known repair companies of the Ministry of Energy, were higher than the contractors of the second group, i.e. specialized start-ups outside the Ministry of Energy, and the third, i.e. newly established small companies consisting of retirees and repurchasing power plants [49-51].

Another study (2008) was conducted among 10 large port contracting companies on contractors' health, safety, and environmental management systems and examined the contractors' health, safety, and environmental management systems according to the 7 steps of the management system. HSE was addressed. The working process in the proposed model was such that due to the impact of contractors 'performance on the level of risks imposed on the port (main employer), at first, different models were tried to be used for contractors' HSE management strategies. Then according to the characteristics of port contractors, a suitable model for each group of contractors was proposed. Finally, with a macro view, the HSE management model of port contractors was presented, which was the result of reviewing models having been implemented in other industries, especially the oil industry [52-55]. The proposed model failed to address weaknesses in safety issues and the country's statistics on work-related accidents and the newness of the HSE issue in the construction industry. The issue of HSE and model presentation has therefore been discussed more and compared with other studies of other countries that have examined and strategies to reduce risks in projects during project implementation. Through a detailed view, a specific and comprehensive model in the construction industry is presented according to the strengths and weaknesses of regulations, development of acceptable building standards such as the rules

guidelines, and guidelines in the country and the main models of performance appraisal and research approach (HSE). This can be an effective help for organizations, governmental and non-governmental organizations so that the evaluation of contractors before the occurrence of work-related risks (prior to the finalization of the contract and in the qualitative evaluation stage) could be possible and this can play an optimal role in reducing costs and saving project time. In addition to the purposeful review of previous studies, the main model and models of performance evaluation (macro) such as Analytic Hierarchy Process (AHIP) model, Balanced Scorecard (BSC) performance evaluation model, Data Envelopment Analysis (DEA) model, Ideal Planning Model (GP), Fisher Model, European Organizational Excellence Model (EFQM), Iranian Human Resources Excellence Award Model, Health, Safety and Environment Management System (HSE - MS), etc. According to Table 1, the review and the results are briefly presented [55-57].

Research method

The present article is of analytical-applied type and seeks to develop health, safety, and environmental knowledge of construction industry contractors. The field of study of the present study was the construction industry in Iran and all HSE managers and experts of large construction projects in the field have formed the statistical population of the present study (730 people). The sampling method was a simple and accessible random method. The data collection instrument was a researcher-made questionnaire containing criteria and sub-criteria and items. In the present article, the questionnaire was evaluated with 37 items in the form of a Likert rating, and the items were answered in 5 points (very good to very poor). To categorize the answers, scores from 5 to 1 were scored according to Table 2. The comparative and interpretive analysis of the studied components was done through observations and field studies in the research

area. The sample size was determined using Cochran's formula with a confidence level of 95% and a probability of error of 5, 252 people, and according to Table 3, the frequency of the sample size was obtained.

Data analysis

The proposed model consists of 9 criteria, 11 sub-criteria, and 37 items for evaluation and optimal selection of construction industry contractors, which helps to achieve excellence in health, safety, and environment in this industry, which is presented in Table 1.

In the present article, content validity was used to design a specific questionnaire for the health, safety, and environment of construction industry contractors because content validity has more validity than apparent validity [22]. To determine the content validity, the proposed method of Lavoshe and to evaluate the content validity quantitatively, the two content coefficients of relative content (CVR) and content validity index (CVI) were applied, using Microsoft Excel software. The results of the current section showed that all 9 main factors with 15 sub-criteria and 37 items enjoyed a validity of more than 50% [19].

Table 1. Schematic diagram of the proposed model

Item	under the criteria	The main criterion	Row
4	2	Leadership	**1**
2	0	Policy and strategy	**2**
6	3	human resources	**3**
5	2	Deployment and monitoring	**4**
3	0	Organizational resources	**5**
3	0	Effective communication	**6**
6	2	Planning	**7**
5	2	Risk assessment and management	**8**
3	0	Management review	**9**

Table 2. Cronbach's alpha coefficient

Reliability Statistics

Cronbach's alpha	Number of criteria
0.863	**9**

Table 3. Bartlett test results and KMO index

Barrett and KMO test	
Sufficiency of Kiers-Mayper-Alkin Sampling (KMO)	**0.864**
Approx. Chi-Square	**699.407**
Bartlett Df Sphere Test	**36**
Sig.	**0.000**

Studying HSE performance variable measurement models

In the present section, structural equations were modeled, so that first the relationships between the observed variables with the latent variables were investigated and the factor loads that were not significant at the error level of 0.05 were removed. In all fitting indices, each factor was first measured separately using confirmatory factor analysis software to test the suitability of each factor to the criteria and sub-criteria measured into a comprehensive and practical model for evaluation.

It was to achieve the performance of contractors for use in the construction industry. In Table 5, which is referred to as the sub-model, the sub-criteria are briefly stated due to the length of the title. The method of work from part to the whole was that first the good and bad criteria of fitting the sub-model for each species of each criterion were obtained according to Table 6. RMSEA and RMR are bad criteria for model fit, RMSEA should be less than 0.08 and RMR should be less than 0.07. Also, AGFI, GFI, and CFI are good criteria for model fit, and its value should be greater than 0.90, and in general, the closer to 1, the better. Then, the significant results and factor loadings of the items were examined according to the good and bad criteria of their fit, showing the correlation and significance of the cries.

Table 7 presents the significant results and factor loads of health, safety, and environmental performance types of construction industry contractors, displaying the correlation and significance of items other than effective communication items. Then, the same criteria were prepared and examined for each of the criteria of the main model according to table 8 to evaluate the good or bad of the model. Significant results and factor loadings the main criteria of health, safety, and environmental performance of construction industry contractors according to the good and bad criteria of fitting the criteria were presented, which showed the correlation and significance of the mentioned criteria.

Table 4. English equivalent and summary of the indicators used in this section

English equivalent	Abbreviation
Root Mean Squared Residual Error of Approximation	**RMSEA**
Root Mean Squared Residual	**RMR**
Adjusted Goodness of Fit Index	**AGFI**
Goodness of Index	**GFI**
Comparative Fit Index	**CFI**

Table 5. Sub-equivalents of sub-criteria

Sub-criteria	Abbreviation	Criterion
Improving, planning and managing human resources, identifying and developing employees contractors	M1 M2 M3	**human resources**
Risk identification and assessment Risk control	A1 A2	**Risk assessment and management**
Policy and strategy	KH	**Policy and strategy**
Review Events	E1 E2	**Deployment and monitoring**
Management view	B	**Management view**
Develop a vision of the organization's values Support and developments of the organization	R1 R2	**Leadership**
Organizational resources	MS	**Organizational resources**
HSE program and project Emergency and unexpected situation	T1 T2	**Planning**

Table 6. Model fit indices

RMSEA	CFI	AGFI	GFI	RMR
0.044	0.974	0.9	0.98	**0.009**

Table 7. Significant results and factor loadings of items

Significance level	Critical ratio	Operational loads	Items
000	000	0.628	**R1**
000	7.142	0.621	**R2**
000	7.851	0.699	**KH**
000	8.924	0.830	**MA1**
000	8.338	0.756	**MA2**
000	8.007	0.717	**MA3**
000	6.153	0.520	**ER1**
000	7.737	0.868	**ER2**
000	7.017	0.608	**MS**
000	5.211	0.431	**T1**

000	5.958	0.501	**T2**
000	7.471	0.656	**A1**
000	7.873	0.701	**A2**
000	7.514	0.661	**B**

Table 8. Model fit indices

RMSEA	CFI	AGFI	GFI	RMR
0.033	0.898	0.822	0.901	**0.032**

Conclusion

Paying attention to labor protection is the duty of any industrial system and observing the principles of occupational diseases is very important and can be very effective in the quantity and quality of production and service delivery. Adherence to the principles of the construction industry is exactly equal to maintaining the health of the workforce and the continuity of production and provision of services and preventing the creation of staggering costs and various damages and the payment of various compensations, each of which alone can cause a lot of problems for the industry and jeopardize the desired productivity. Knowing all the factors that threaten the activity of a project and ways to deal with them scientifically and homogeneously, are the basic principles of model design. Also, safety policies and regulations have a great impact on the safety of a workshop. Laws form the framework by which health and safety are controlled and regulated. All project managers must follow and enforce these rules and regulations, and fines must be imposed on violators. Apart from the weakness of the organizational culture in the safety sector along with inefficient definitions of safety responsibilities as well as inappropriate safety instructions, lack of appropriate safety policies also leads to poor performance of workshops in terms of safety, and their rules and practices have a significant impact on construction safety, so safety rules should be considered when designing business activities and setting general policies. Considering the vastness of the construction industry in the country and as a result of the growing trend of its activity, finally, a model of research was extracted using AMOS software and the following results were obtained:

1- The criterion of human resources has the greatest importance with the degree of 0.84, the sub-criteria of which include improvement and planning and management of human resources with an intensity of 0.83, identification, and development of knowledge, employee competence with an intensity of 0.76; And contractors with an intensity of 0.72. The criterion of risk assessment and management with a grade of 0.76 is in the second degree, the sub-criteria of which are: risk control with an intensity of 0.70, risk identification and evaluation with an intensity of 0.76. And the criterion of policy and strategy with a grade of 0.70 is in the third place; Establishment and monitoring criterion with a degree of 0.69 with sub-criteria of events with an intensity of / 69. And review with the intensity of 0.52 is in the next degrees. The criterion of management review was found with a grade of 0.68 and the criterion of leadership with a grade of 0.66 with the criteria of developing the vision, values of the organization, and the role of being a model with an intensity of 0.63 and supporting organizational changes with an intensity of 0.62. It is also important to note that the criterion of organizational resources with a grade of 0.61 and the criterion of planning with a grade of 0.53 and the sub-criteria of emergency and unexpected situation with an intensity of 0.5 and HSE programs and projects with an intensity 0.43 are in the lowest rank of the importance of impact.

2. Compared with previous studies, the results of the study by Swacha et al. (1999) [9] indicated that hiring a trained safety representative and providing a safe

environment and management commitment to safety and preparation along with safety guidelines are effective in safety performance. The results of the present study are consistent with Swacha et al.'s (1999) in relation to the criteria of human resources, leadership and planning. Thomas et al. (2005), [14] and Tom et al. (2004), [13] showed that the factors of implementation of safety management system and acceptance of safety and health rules and low awareness of project managers and lack of training and attention of operational personnel to safety points were the most important among the factors of safety performance evaluation at the project level. The results of the mentioned studies are in line with the present study in terms of determining the criteria of leadership and human resources. Essasi et al. (2008), [15] showed that the criterion of training workers and the correct use of equipment is one of the most important and effective factors in safety performance and reduction of occupational accidents. The result of the present study and the criterion of human resources are consistent with the highest degree of importance (0.84). Working on reducing workplace losses among 50 contractors, the results of Manu et al. (2013), [16] showed that the use of health, safety and environmental managers and the implementation of a reward scheme to ensure the safety and protection of workers in the workshop could help reduce casualties at work. The result of the study is consistent with that of the present study in the criterion of human resources with the highest degree of importance (0.84). Orumba (2014) [19] also reviewed 201 construction projects in Uganda, and reported that the criteria of risk planning and assessment and development of building laws and regulations could reduce the occurrence of useful events. The result of the mentioned study is consistent with that of the present study in determining the criteria for assessment and risk management with a degree of importance by 0.76. Using a continuous improvement cycle with a fuzzy multivariate approach, Azadeh et al. (2014), [17] were able to improve safety management programs in a gas refinery, which is in line with the result of the present study in benchmarking and management review by a significance grade of 0.68.

Orcid

Ebadollah Amouzad Mahdiraji:

https://orcid.org/0000-0003-3777-4811

References

[1] E.A. Mahdiraji, A. Yousefi Talouki, *Journal of Chemical Reviews*, **2020**, *2*, 284-291. **[crossref], [Google Scholar], [Publisher]**

[2] E.A. Mahdiraji, M.S. Amiri, *Journal of Engineering in Industrial Research*, **2020**, *1*, 111-122. **[crossref], [Google Scholar], [Publisher]**

[3] E.A. Mahdiraji, M.S. Amiri. *Journal of Engineering Technology and Applied Sciences*. **2020**, *5*, 133-147. **[crossref], [Google Scholar], [Publisher]**

[4] E. Sawacha, S. Naoum, D. Fong, *International journal of project management*, **1999**, *17*, 309-315. **[crossref], [Google Scholar], [Publisher]**

[5] C.M. Tam, S.X. Zeng, Z.M. Deng, *Safety Science*, **2004**, *42*, 569-586. **[crossref], [Google Scholar], [Publisher]**

[6] S.T. Ng, K.P. Cheng, R.M. Skitmore, *Building and Environment*, **2005**, *40*, 1347-1355. **[crossref], [Google Scholar], [Publisher]**

[7] P. Manu, M. Ankrah, D. Proverbs, S. Suresh, *International Journal of Project Management*, **2013**, *31*, 1017-1026. **[crossref], [Google Scholar], [Publisher]**

[8] A. Azadeh, Z. Gaeini, B. Moradi, *Safety science*, 2014, *32*, 415-427. **[crossref], [Google Scholar], [Publisher]**

[9] Y. Wang, H.P. Lo, *Journal of Management Development*, **2003**, *22*, 483-526. **[crossref], [Google Scholar], [Publisher]**

[10] C.H. Lawshe, *Personnel Psychology*, **1975**, *28*, 563-575. **[crossref], [Google Scholar], [Publisher]**

[11] K.K. Kuan, K. Warwick, *IEE Proceedings C: Generation, Transmission and Distribution*, **1992**, *139*, 235-240. **[crossref], [Google Scholar], [Publisher]**

[12] E.A. Mahdiraji, N. Ramezani, *2015 2nd International Conference on Knowledge-Based Engineering and Innovation (KBEI)*,

Tehran, Iran, **2015**, 405-411. **[crossref], [Google Scholar], [Publisher]**

[13] E.A. Mahdiraji, M.S. Amiri. *International Journal of Smart Electrical Engineering*, **2020,** *9*, 13-21. **[crossref], [Google Scholar], [Publisher]**

[14] E.A. Mahdiraji, M. Amiri, *Journal of Engineering Technology and Applied Sciences*. **2020**, *5*, 133-147. **[crossref], [Google Scholar], [Publisher]**

[15] M.M.A. Aziz, E.S.T. El Din, D.K.L Ibrahim, M. Gilany, *Electric Power Components and Systems,* **2006**, *34*, 417–432. **[crossref], [Google Scholar], [Publisher]**

[16] X. Yang, M.S. Choi, S.J. Lee, C.W. Ten, S.I. Lim, *IEEE Trans.Power System*, **2008**, *23*, 1809-1816, **[crossref], [Google Scholar], [Publisher]**

[17] E.S.T.E. Din, M. Gilany, M.A. Aziz, D.K. Ibrahim, *Power Engineering Society General Meeting, 2005. IEEE*, **2005**, *1*, 80–86. **[crossref], [Google Scholar], [Publisher]**

[18] E.T. El Din, M. Gilany, M.A. Aziz, D.K. Ibrahim, *Power Engineering Society General Meeting, 2005. IEEE*, **2005**, *3*, 2485–2491. **[crossref], [Google Scholar], [Publisher]**

[19] K. Ming-Cai, W. Yang, Z. Jun-Fang, H. Guang, Y. Qiu, *Sustainable Power Generation and Supply (SUPERGEN 2012), International Conference on*, **2012**, 1–6. **[crossref], [Google Scholar], [Publisher]**

[20] B. Raei, A. Bozorgian, *Journal of Chemistry Letters*, **2020**, *1*, 143-148. **[crossref], [Google Scholar], [Publisher]**

[21] S. Karami, M. Javan Nikkhah, KB. otouhifar, V. Rahjoo, A. Ahmadpour, *Iranian Journal of Plant Protection Science*, **2020**, *51*, 129-146. **[crossref], [Google Scholar], [Publisher]**

[22] M. Bagheri Sadr, A. Bozorgian, *Journal of Chemical Reviews*, **2021**, *3*, 66-82. **[crossref], [Google Scholar], [Publisher]**

[23] A. Haghighi Asl, A. Ahmadpour, N. Fallah, *Journal of Modeling in Engineering*, **2018**, *16*, 295-307. **[crossref], [Google Scholar], [Publisher]**

[24] A. Bozorgian, *Journal of Chemical Reviews*, **2021**, *3*, 50-65. **[crossref], [Google Scholar], [Publisher]**

[25] N. Kayedi, A. Samimi, M. Asgari Bajgirani, A. Bozorgian, *South African Journal of Chemical Engineering*, **2021**, *35*, 153-158. **[crossref], [Google Scholar], [Publisher]**

[26] S.V. Mousavi, A. Bozorgian, N. Mokhtari, M.A. Gabris, H.R. Nodeh, *Microchemical Journal*, **2019**, *145*, 914-920. **[crossref], [Google Scholar], [Publisher]**

[27] A. Bozorgian, *Advanced Journal of Chemistry, Section B: Natural Products and Medical Chemistry*, **2021**, *3*, 54-61. **[crossref], [Google Scholar], [Publisher]**

[28] A. Haghighi Asl, A. Ahmadpour, N. Fallah, *Applied Chemistry*, **2017**, *12*, 253-286. **[crossref], [Google Scholar], [Publisher]**

[29] A. Bozorgian, A. Samimi, *International Journal of New Chemistry*, **2021**, *8*, 41-58. **[crossref], [Google Scholar], [Publisher]**

[30] M. Bagheri sadr, A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science*, **2020**, *9*, 252-261. **[crossref], [Google Scholar], [Publisher]**

[31] A. Bozorgian, *Journal of Engineering in Industrial Research*, **2020**, *1*, 1-19. **[crossref], [Google Scholar], [Publisher]**

[32] A. Bozorgian, *Progress in Chemical and Biochemical Research*, **2020**, *3*, 169-179. **[crossref], [Google Scholar], [Publisher]**

[33] A. Surendar, A. Bozorgian, A. Maseleno, L.K. Ilyashenko, M. Najafi, *Inorganic Chemistry Communications*, **2018**, *96*, 206-210. **[crossref], [Google Scholar], [Publisher]**

[34] A. Bozorgian, *Advanced Journal of Chemistry, Section B*, **2020**, *2*, 91-101. **[crossref], [Google Scholar], [Publisher]**

[35] A. Bozorgian, *Advanced Journal of Science and Engineering*, **2020**, *1*, 34-39. **[crossref], [Google Scholar], [Publisher]**

[36] J. Mashhadizadeh, A. Bozorgian, A. Azimi, *Eurasian Chemical Communication*, **2020**, *2*, 536-547. **[crossref], [Google Scholar], [Publisher]**

[37] A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science*, **2020**, *9*, 205-218. **[crossref], [Google Scholar], [Publisher]**

[38] M.E. Bidhendi, Z. Asadi, A. Bozorgian, A. Shahhoseini, M.A. Gabris, *Environmental Progress & Sustainable Energy.*, **2020**, *39*, 13306. **[crossref], [Google Scholar], [Publisher]**

[39] A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science*, **2020**, *9*, 241-251. **[crossref], [Google Scholar], [Publisher]**
[40] A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science*, **2020**, *9*, 229-240. **[crossref], [Google Scholar], [Publisher]**
[41] A. Bozorgian, *Chemical Review and Letters*, **2020**, *3*, 94-97. **[crossref], [Google Scholar], [Publisher]**
[47] A. Bozorgian, *Chemical Review and Letters*, **2020**, *3*, 79-85. **[crossref], [Google Scholar], [Publisher]**
[48] A. Samimi, K. Kavosi, S. Zarinabadi, A. Bozorgian, *Progress in Chemical and Biochemical Research*, **2020**, *3*, 7-19. **[crossref], [Google Scholar], [Publisher]**
[49] A. Bozorgian, S. Zarinabadi, A. Samimi, *Chemical Methodologies*, **2020**, *4*, 477-493. **[crossref], [Google Scholar], [Publisher]**
[42]. A. Bozorgian, Z.A. Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, *Prog. Chem. and Biochem. Rese.,* **2020**, *3*, 31-38. **[crossref], [Google Scholar], [Publisher]**
[43] A. Bozorgian, *Journal of Engineering in Industrial Research*, **2021**, *2*, 90-94. **[crossref], [Google Scholar], [Publisher]**
[44] A. Bozorgian, *Progress in Chemical and Biochemical Research*, **2021**, *4*, 207-219. **[crossref], [Google Scholar], [Publisher]**
[45] A. Bozorgian, Z.A. Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, *Journal of Chemical and Petroleum Engineering*, **2020**, *54*, 73-81. **[crossref], [Google Scholar], [Publisher]**
[46] A. Pourabadeh, B. Nasrollahzadeh, R. Razavi, A. Bozorgian, M. Najafi, *Journal of Structural Chemistry*, **2018**, *59*, 1484-1491. **[crossref], [Google Scholar], [Publisher]**
[50] A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, *Eurasian Chemical Communications*, **2020**, *2*, 420-426. **[crossref], [Google Scholar], [Publisher]**
[51] S.E. Mousavi, A. Bozorgian, *International Journal of New Chemistry*, **2020**, *7*, 195-219. **[crossref], [Google Scholar], [Publisher]**
[52] A. Bozorgian, S. Zarinabadi, A. Samimi, *Journal of Chemical Reviews*, **2020**, *2*, 122-129. **[crossref], [Google Scholar], [Publisher]**
[53] A. Samimi, S. Zarinabadi, A. Bozorgian, A. Amosoltani, *Progress in Chemical and Biochemical Research*, **2020**, *3*, 46-54. **[crossref], [Google Scholar], [Publisher]**
[54] B. Raei, A. Bozorgian, *Journal of Chemistry Letters*, **2021**, *1*, 143-148. **[crossref], [Google Scholar], [Publisher]**
[55] F. Zare Kazemabadi, A. Heydarinasab, A. Akbarzadeh, M. Ardjmand, *Artificial cells, nanomedicine, and biotechnology,* **2019**, 47, 3222-3230. **[crossref], [Google Scholar], [Publisher]**
[56] F. Zare Kazemabadi, A. Heydarinasab, A. Akbarzadehkhiyavi, M. Ardjmand, *Chemical Methodologies,* **2021**, 5, 135-152. **[crossref], [Google Scholar], [Publisher]**
[57] S. M. S. Mirnezami, F. Zare Kazemabadi, A. Heydarinasab, *Progress in Chemical and Biochemical Research,* **2021**, 4, 191-206. **[crossref], [Google Scholar], [Publisher]**