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ORIGINAL ARTICLE

Steam Boiler Hazard Identification Using Analytical Network Process (Case Study: Farabi Hospital)

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ABSTRACT
Steam boiler is a common primary utility that creates steam by applying heat energy to water in a close system and poses different threats. The present study aimed to identify health, safety, and environmental hazards by implementing Hazard Identification (HAZID) method and Analytical Network Process (ANP). Therefore, the identified hazards were categorized and scored by HAZID method and then, prioritized using ANP. A total number of 58 hazards were identified in 4 categories; of which, 6 hazards were weighted by the super decisions software. According to the results, job stress and cooling system wastewater were recognized as the most and the least important hazards, respectively.

KEYWORDS: *Hazard identification, Analytical Network Process, Health, Safety and environment*

INTRODUCTION
Risk assessment is an essential procedure for organizations and hazard identification is its first step, which aids to decide preventive or reduction actions to decrease frequency and severity of incident consequences for proper risk management [1-4]. The literature review showed that in some countries, steam boilers cause high range of accidents amongst the other equipment [5]. Frequent accidents related to steam boilers have made them one of the most important concerns in England, especially because of the insurance costs of explosions [6]. In 19th century, boiler explosions caused a considerable amount of property damages and mortality that forced the government to take action [7]. Similar events happened in the U.S., which caused a tragic number of mortalities [8]. Steam boiler is a common primary utility, which uses fuel to produce steam in a close system for different purposes mostly energy production in healthcare facilities and industries [9-11]. Shortage of water and high pressure are failures, which can lead to the explosion in boilers [12-14].

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Therefore, it requires both boiler operator supervision and systematic control, particularly in the pressurized boilers that high pressure can result in catastrophic incidents [15]. Boiler, water level and quality should be measured and controlled, as the components of untreated water covers the interior parts of boilers, which eventually lowers their efficiency [16-18]. The variety of the consumed fuels, such as natural gas, oil, etc., has its own challenges [19]. The discharge of oily and heavy metal wastewater from boilers, bio-ethanol, polycyclic aromatic hydrocarbons, particulate matter, carbon dioxide, and other gas emissions cause environmental pollution [20-24].

The importance of the task and limited decision options not only affect boiler operators but also cause productivity losses [25-26]. Particularly, incidents in the steam boiler systems can be originated from the systematic fault of safety controls and operators' errors [27-28]. Therefore, boiler operators should always pay attention to system alarms and take action, if necessary. Consequently, operator–system interactions are robustly a key point in this utility [10, 29]. Boiler operation should be monitored around the clock; therefore, the operators work in heavy-duty shifts [30]. Studies showed that shift work has negative impacts on the operators' performance and safety [31-33]. Additionally, occupational health risks, like high noise, are common in most boilers [34]. Considering the possible incidents and consequences, it is important to identify the steam boiler hazards of each industry. This study investigated hazards related to health, safety, and environment that had significant roles in risk generation.

MATERIALS AND METHODS

This study was carried out in the steam boiler room of Farabi Hospital in October 2017. This hospital is one of the leading, highly equipped, and populated hospitals in Tehran City, and provides service to the patients from all over the country. There were three high-pressure boilers beneath the hospital building for energy and steam production. These boilers play an important role as a source of energy. However, they have various hazards, which could result in catastrophic consequences. Therefore, this unit was selected for analyses. Hazard is defined as physical or chemical threats that can affect human health, property, or environment. All possible hazards related to this unit were identified, analyzed, and categorized based on the literature reviews, interviews, field studies, meetings, procedures, hospital accidents, near misses, and risk assessment reports. HAZID method, as an applicable short time assessment tool, was used [35-38]. This method was conducted by the risk assessment team members, including the supervisor and operator of the steam boiler, as well as the health and safety officers and HSE manager of the hospital. All of the identified hazards were categorized based on HAZID and ranked with respect to the risk assessment matrix. Then, the ANP (Analytical Network Process) method, as a multi-criteria decision-making tool, was used to prioritize the hazards with respect to their importance. ANP was introduced by Satty to improve Analytical Hierarchy Process (AHP) [39] by making different interrelations and dependencies in a network [40-41].

This method has widely been used in different fields and medical decisions and benefits group works to solve complicated problems [41-42]. The network of ANP consists of different elements, such as goal, criteria, sub-criteria, and alternatives [43-44]. In contrast to the AHP method, ANP can carry out multi relationship dependencies among the elements in a network, in which there are relations between the clusters (outer dependencies) and between the elements of a cluster (inner dependencies) [41, 45]. Group decision-making is an advantage to state the importance of elements in a network [36, 46-50]. ANP process describes problems and then, creates a model of all elements involved with relationships and dependencies based on the decision maker's points of view. Pair-wise comparisons based on Saaty's fundamental scale, as shown in Table 1, indicate the weights of the criteria and sub-criteria, obtaining from the supermatrix. Afterward, the measured alternatives were synthesized and prioritized. Simultaneously, the reliability of the results was controlled by the Consistency Ratio (CR) of the comparisons, which should be less than 0.01 [51-60].

RESULTS

Primarily, the hazards were categorized into four categories of health, fire and explosion, process, and environment, using HAZID method and totally, 11, 20, 12, and 15 hazards were identified in each category, respectively. In the next step, the risk assessment team ranked these hazards using the risk assessment matrix. Table 2 shows an example of this process. The assessment team considered "high pressure" as a guide world because of its great role in the boiler explosion. Boiler high pressure and torch spark can result in an explosion; therefore, photocell was used as a control mechanism, which its defect scored medium in terms of probability and severity. Among the 12 hazards identified in this category, only 2 hazards were scored medium and selected for ANP analysis. According to the scores, shift work and job stress as health hazards, photocell and thermostat defect as process hazards, boiler blow down and cooling system wastewater as environmental aspects, high pressure and high temperature as fire and explosion categories were selected for ANP analyses. The decision-making group of ANP shaped the structure of the ANP network. All possible clusters and nodes were found using the Delphi method the relations and dependencies were obtained, and the final structure of the problem was built in super decision software 2.4.0-RC1 version, as presented in Fig. 1. Subsequently, the comparisons were conducted based on the Saaty fundamental scale and by the questionnaires originated from the super decision software.

The decision-making team (risk assessment team) weighted the elements in groups with respect to each criterion. As shown in the first row of Fig. 2, boiler blow down was equally to moderately more important than the cooling system wastewater. The right part of the figure also depicts the inconsistency ratio of the comparisons (0.09723), which is less than 0.01 and shows that all comparisons are consistent. The results were imported to the super decision software to compute unweighted, weighted, and limit supermatrices. Moreover, the alternatives were prioritized and values were obtained from the limit supermatrix,

Table 1. Fundamental scale of the absolute numbers

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If the activity *i* has one of the above non-zero numbers assigned to it when compared with the activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
Rationales	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Table 2. Classified operating room hazards of the process

Guide word	Potential Hazards and Effects	Threats	Controls	Development Phase	Priority	Number
High pressure	Boiler explosion due to the spark of torch in the presence of accumulated gas.	Photocell defect	Weekly control and inspection	In operation phase	Medium	6
High temperature	Thermostat defect in the boiler output (responsible to alert when fuel is not burned well) causing the boiler to continue working, which results in explosion	Thermostat defect	daily control and inspection	In operation phase	Medium	11

as shown in Table 3. The super decisions software calculated the normal weights of job stress, shift work, boiler blow down, photocell failure, thermostat failure, and cooling system wastewater alternatives respectively as 0.27, 0.20, 0.18, 0.13, 0.10, and 0.09. Among which, job stress was found to be the most important alternative, while cooling system wastewater was given the least priority among all alternatives, as presented in Fig. 3.

DISCUSSION

The results of the ANP demonstrated that job-related stress had the highest degree of importance (0.27). Moreover, the boiler operators, who were responsible for the maintenance of the whole hospital, with their critical duties and work overload, lacked the required profession for the steam boiler. Shift work, with the degree of importance of 0.2, could cause illness, fatigue, and error in judgments among the boiler operators. The wastewater from the boiler blow down and cooling system, with importance degrees of respectively 0.18 and 0.09, is not treated by the hospital treatment plant. The discharge, containing oil, grease, iron and other pollutants, not only can cause environmental pollution but also decreases the efficiency of the boiler. Among the assessed process failures, photocell and thermostat were given the degrees of importance of 0.13 and 0.1, respectively. Photocell controls flame performance and thermostat controls incomplete burning, so, their failure could result in the explosion of the boiler. The boiler room is located underground and underneath the hospital building; therefore, if an explosion occurs, the consequence will have a high fatality and severe damage to the main parts or the whole structure of the hospital.

CONCLUSION

In this study, the HAZID and ANP methods were used to rank the operating phase hazards of a steam boiler. The findings indicated that not only there should be a set of proper criteria when hiring boiler operators but also they should have specific work scope. This reduces job stress and leads to human error reduction. The operators' shift schedules need to be revised. Moreover, practical emission reduction measures and wastewater discharge controls should be planned to reduce the environmental pollution.

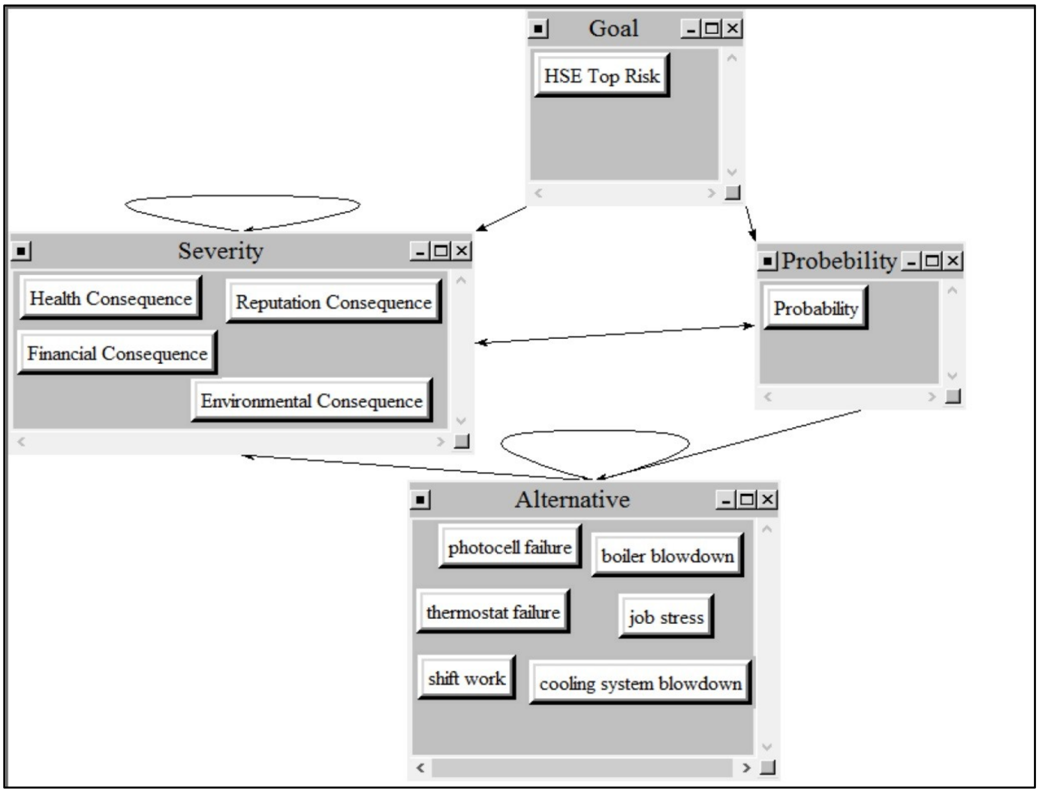

Fig. 1. Super decision main window: Boiler.sdmod

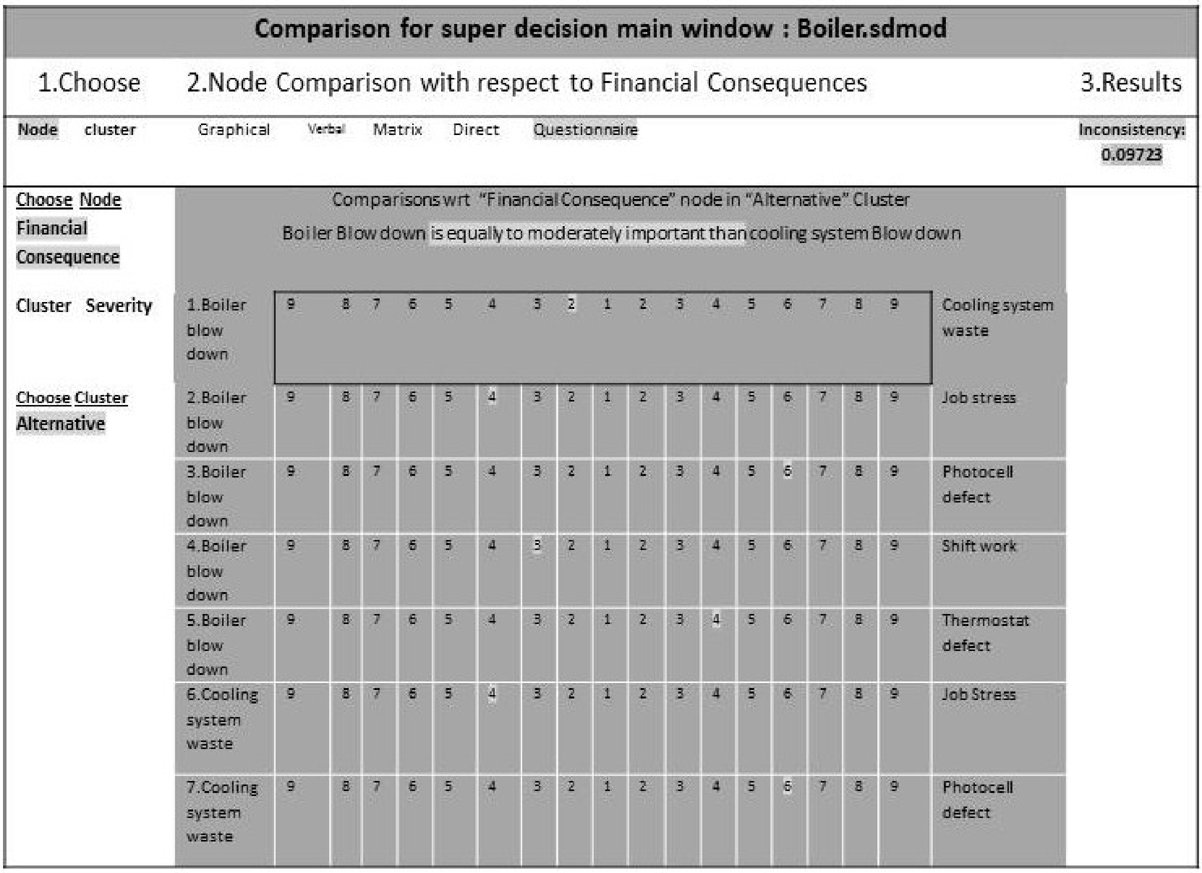

Fig.2. Comparison for super decision main window: Boiler.sdmod

Table 3. Limit supermatrix of the decision-making model developed for the steam boiler

		Goal	Probability	Environmental Consequence	Financial Consequence	Health Consequence	Reputation Consequence	Job Stress	Thermostat Failure	Photocell Failure	Shift Work	Cooling System Waste	Boiler Blow Down
Goal	HSE top risk	0	0	0	0	0	0	0	0	0	0	0	0
Probability	Probability	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616	0.183616
Severity	Environmental consequence	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168	0.139168
	Financial consequence	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173	0.144173
	Health consequence	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343	0.230343
	Reputation consequence	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631	0.104631
Alternative	Job stress	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071	0.054071
	Thermostat failure	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532	0.021532
	Photocell failure	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098	0.027098
	Shift work	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568	0.040568
	Cooling system waste	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948	0.018948
	Boiler blow down	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854	0.035854

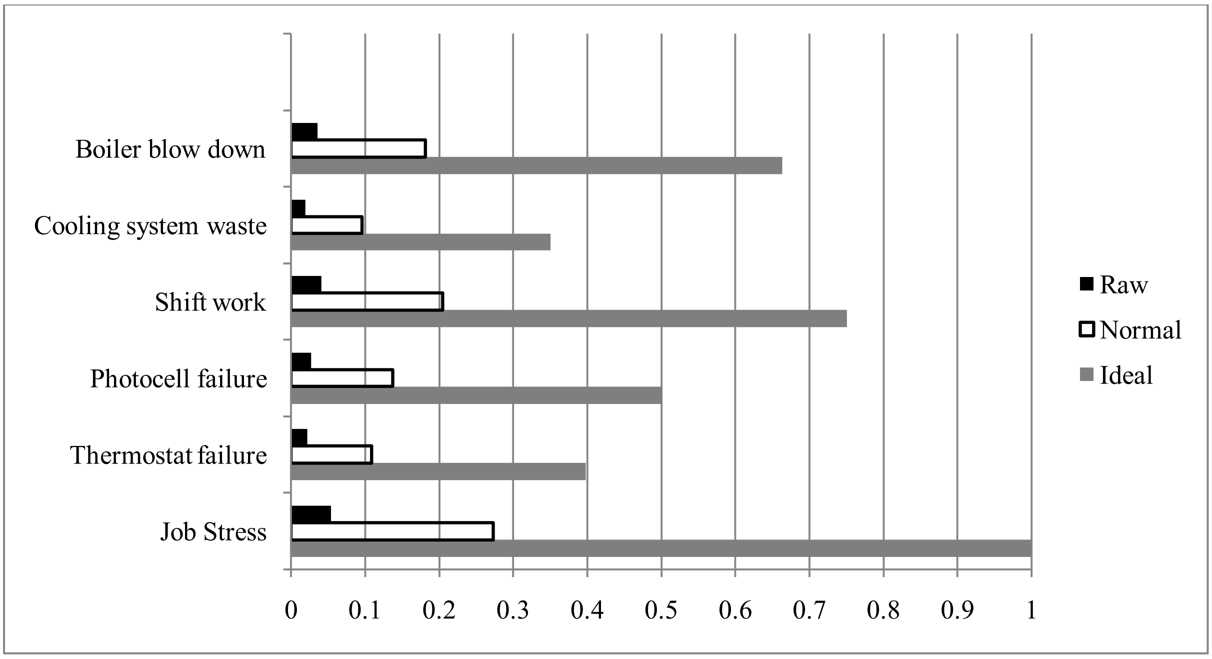

Fig. 3. Priorities of alternatives for steam boiler

In addition, periodic maintenance should be included in the system control measures. It is recommended to place boilers separated from the facility with proper protection arrangements to lower the consequences of the potential incidents.

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REFERENCES

1. Blackhurst JV, Scheibe KP, Johnson DJ. Supplier risk assessment and monitoring for the automotive industry. *Int J Phys Distrib Logist Manag* 2008;38(2):143–65.
2. Cameron I, Mannan S, Németh E, Park S, Pasman H, Rogers W, Seligmann B. Process hazard analysis, hazard identification and scenario definition: are the conventional tools sufficient, or should and can we do much better? *Process SAF Env* 2017;110:53–70.
3. Othman SN. *A study on the compliance of manufacturing company to the factories and machinery act 1967 (Act 139): a case study.* Universiti Teknikal Malaysia Melaka, Melaka, 2011.
4. Willke TL, Shires TM, Cowgill RM, Selig BJ. US risk management can reduce regulation, enhance safety. *Oil Gas J* 1997;95(24):87.
5. Evtushenko O, Siryc A. Modern aspects of occupational safety at meat industry enterprises. *Ukr Food J* 2014;3(3):454–61.
6. Petroski H. Harnessing steam. *Amer Sci* 1996;84(1):15-19.
7. Bartrip P.W.J. The state and the steam-boiler in nineteenth-century Britain. *Int Rev Soc Hist* 1980;25(1):77–105.
8. Smith DJ. Regular maintenance, monitoring and operator training critical to boiler safety. *Power Eng* 2003;107(8):27–30.
9. Diaz LF, Savage GM, Eggerth LL. Alternatives for the treatment and disposal of healthcare wastes in developing countries. *Waste Manag* 2005;25(6):626–37.
10. Ramirez JC, Fecke M, Morrison DT, Martens JD. *Root cause analysis of an industrial boiler explosion (and how hazard analysis could have prevented it).* ASME 2010 International Mechanical Engineering Congress and Exposition, American Society of Mechanical Engineers, November 12–18 2010; Vancouver, British Columbia, Canada.
11. Darwish A, Morsi I, El Zawawi A. Complete combustion control for a steam boiler plant. *Balk J Elect Comput Eng* 2016;4(1):17–23.
12. Ferguson ES. *Risk and the American engineering profession: the ASME boiler code and American industrial safety standards*. The Social and Cultural Construction of Risk, Springer, 1987;pp. 301–16.
13. Robertson WS. *Boiler efficiency and safety: A Guide for Managers, Engineers and Operators responsible for Small Steam Boilers,* Springer, 1981; pp. 56–70.
14. Movafagpour M, Nezamodini Z, Shirali GA. Prediction and analysis of human errors on the boiler operator using PHEA method: a case study in dairy industry. *Jentashapir J Health Res* 2013;4(5):339–44.
15. Heselton KE. *Boiler operator's handbook.* 1st ed., Fairmont Press, Lilburn, Georgia, United

States, 2005; pp. 415.
16. McIver A, Morgan C, Troubitsyna E. *The probabilistic steam boiler: a case study in probabilistic datafire nement*. Turku Centre for Computer Science, TUCS Technical Report, No. 173, April 1998.
17. Wang Z, Wang J, Dong N. *Study and application on removal of silica by chemical coagulation process from the oil field produced water reused in boiler*. Asia-Pacific Power and Energy Engineering Conference, 28-31 Mar 2010; Chengdu, China.
18. Tuan C, Cheng Y, Yeh Y, Hsu L, Chen T. Performance assessment of a combined vacuum evaporator-Mechanical vapor re-compression technology to recover boiler blow-down wastewater and heat. *Sustain Env Res* 2013;23(2):129–39.
19. Fecke M, Martens J, Cowells J. A guide to developing and implementing safety checklists: plant steam utilities. *Process SAF PROG* 2011;30(3):240–50.
20. Lee SW. Source profiles of particulate matter emissions from a pilot-scale boiler burning north American coal blends. *J AIR WASTE Manag* 2001;51(11):1568–78.
21. Fang J, Li G, Aunan K, Vennemo H, Seip HM, Oye KA, Beer JM. A proposed industrial-boiler efficiency program in Shanxi: potential CO_2-mitigation, health benefits and associated costs. *Appl Energy* 2002;71(4):275–85.
22. Silalertruksa T, Gheewala SH. Environmental sustainability assessment of bio-ethanol production in Thailand. *Energy* 2009;34(11):1933–46.
23. Pongpiachan S. How to reduce Polycyclic Aromatic Hydrocarbons (PAHs) from industrial boilers under the context of Thailand. *J Appl Sci* 2014;14:2882–91.
24. Kumar S, Katoria D, Sehgal D. Environment impact assessment of thermal power plant for sustainable development. *Env ENG Manag J* 2013;4(6):567–72.
25. Yang T, Ma M, Zhu M, Liu Y, Chen Q, Zhang S, Deng J. Challenge or hindrance: does job stress affect presentism among Chinese healthcare workers? *J OCCUP Healt* 2018;60(2):163–71.
26. Chimpololo A. An analysis of the technical and vocational skills gaps in the manufacturing industry in Malawi. *Int J Voc Tech Educ* 2017; 9(2): 9–19.
27. Smith J. Sequel to workmen's compensation acts. *Harv L Rev* 1914;27(4):344–68.
28. Hansen T. Power plant safety. Power Eng 2005;109(6).
29. Musyafa A, Adiyagsa H. Hazard and operability study in boiler system of the steam power plant. *Int J Sci Technol* 2012;1(3):1–10.
30. Rodrigues VAJ, Braga CS, Campos JCC, de Souza AP, Minette LJ, Sensato GL, Demoraes AC, Da Silva EP. Assessment of physical workload in boiler operations. *Work* 2012;41(Supplement 1):406–13.
31. Ball J, Day T, Murrells T, Dall'Ora C, Rafferty AM, Griffiths P, Maben J. Cross-sectional examination of the association between shift length and hospital nurses job satisfaction and nurse reported quality measures. *BMC Nurs* 2017;16(1):26.
32. Hoboubi N, Choobineh A, Ghanavati FK, Keshavarzi S, Hosseini AA. The impact of job stress and job satisfaction on workforce productivity in an Iranian petrochemical industry. *Safe Health Work* 2017;8(1):67–71.
33. Grønli J, Meerlo P, Pedersen TT, Pallesen S, Skrede S, Marti AR, Wisor, Jonathan P, Murison R, Henriksen TEG, Rempe MJ. A rodent model of night-shift work induces short-term and enduring sleep and electroencephalographic disturbances. *J Biol Rhythms* 2017;32(1):48–63.
34. Kisku GC, Bhargava SK. Assessment of noise level of a medium scale thermal power plant. *Indian J Occup Environ Med* 2006;10(3):133-139.
35. Amirah NA, Asma WI, Muda MS, Amin WAAWM. Safety culture in combating occupational safety and health problems in the Malaysian manufacturing sectors. *Asian Soc Sci* 2013;9(3):182.
36. Baratchi M. Risk assessment and introduction of HSE knowledge management pattern in designated hospitals of Tehran. M.Sc. Thesis, Science and Research Branch, Islamic Azad University, Tehran, Iran; 2017.
37. Siddiquia NA, Nandana A, Sharmaa M, Srivastavaa A. Risk management techniques HAZOP and HAZID study. *Int J Occup Heal Safety, Fire Environ Sci* 2014;1(1): 5-8.
38. Mohammadfam I, Sajedi A, Mahmoudi S, Mohammadfam F. Application of hazard and operability study (HAZOP) in evaluation of health, safety and environmental (HSE) hazards. *Int J Occup Hyg* 2015;4(2):17–20.
39. Saaty TL. How to make a decision: the analytic hierarchy process. *Eur J Oper Res* 1990;48(1):9–26.
40. Ayağ Z, Özdemir RG. Evaluating machine tool alternatives through modified TOPSIS and alpha-cut based fuzzy ANP. *Int J Prod Econ* 2012;140(2):630–6.
41. Saaty TL. *Theory and applications of the analytic network process: decision making with benefits, opportunities, costs, and risks*. 3rd ed., RWS Publications, Pennsylvania, United States; 2005.
42. Sevkli M, Oztekin A, Uysal O, Torlak G, Turkyilmaz A, Delen D. Development of a fuzzy ANP based SWOT analysis for the airline industry in Turkey. *Expert Syst Appl* 2012;39(1):14–24.
43. Sakthivel G, Ilangkumaran M, Gaikwad A. A hybrid multi-criteria decision modeling approach

for the best biodiesel blend selection based on ANP-TOPSIS analysis. *Ain Shams Eng J* 2015;6(1):239-56.
44. Zamani M, Zolfaghari V, Valmohammadi C. An integrated QFD and ANP model for improving the quality of financial services in consulting engineering firms. *Int J Adv Manuf Tech* 2017;9(1):1–22.
45. Chang K-L, Liao S-K, Tseng T-W, Liao C-Y. An ANP based TOPSIS approach for Taiwanese service apartment location selection. *Asia Pac Manag Rev* 2015;20(2):49–55.
46. Xu Z, Elomri A, Pokharel S, Ming XG. Product-service supplier pre-evaluation with modified fuzzy ANP reducing decision information distortion. *Int J Comput Integ M* 2017;30(7):738–54.
47. Chen T, Wang L, Wang J. Transparent assessment of the supervision information in China’s food safety: a fuzzy-ANP comprehensive evaluation method. *J Food Qual* 2017;2017.
48. Lam JSL, Lai K. Developing environmental sustainability by ANP-QFD approach: the case of shipping operations. *J Clean Prod* 2015;105:275–84.
49. Hung S-J. Activity-based divergent supply chain planning for competitive advantage in the risky global environment: a DEMATEL-ANP fuzzy goal programming approach. *Expert Syst Appl* 2011;38(8):9053–62.
50. Saaty RW. *Decision making in complex environments, the Analytic Network Process (ANP) for dependence and feedback*, 2016, pp. 199.
51. Chen S-H, Lee H-T, Wu Y-F. Applying ANP approach to partner selection for strategic alliance. *Manag Decis* 2008;46(3):449–65.
52. Saaty TL. Time dependent decision-making; dynamic priorities in the AHP/ANP: Generalizing from points to functions and from real to complex variables. *Math Comp Model Dyn* 2007;46(7–8):860–91.
53. Shahabi RS, Basiri MH, Kahag MR, Zonouzi SA. An ANP–SWOT approach for interdependency analysis and prioritizing the Iran′ s steel scrap industry strategies. *Resour Policy* 2014;42:18–26.
54. Dedasht G, Mohamad Zin R, Ferwati MS, Mohammed Abdullahi M, Keyvanfar A, McCaffer R. DEMATEL-ANP risk assessment in oil and gas construction projects. *Sustainability* 2017;9(8):1420.
55. Ghassemi A, Darvishpour A. A novel approach for risk evaluation and risk response planning in a geothermal drilling project using DEMATEL and fuzzy ANP. *Decis Sci Lett* 2018;7(3):225–42.
56. Boran S, Goztepe K. Development of a fuzzy decision support system for commodity acquisition using fuzzy analytic network process. *Expert Syst Appl* 2010;37(3):1939–45.
57. Saaty TL, Takizawa M. Dependence and independence: from linear hierarchies to nonlinear networks. *Eur J Oper Res* 1986;26(2):229–37.
58. Shahroudi K, Rouydel H. Using a multi-criteria decision making approach (ANP-TOPSIS) to evaluate suppliers in Iran’s auto industry. *Int J Appl Oper Res* 2012;2(2):0.
59. Saaty TL, Vargas LG. *Decision making with the analytic network process economic, political, social and technological applications with benefits, opportunities, costs and risks.* Springer, Boston, MA; 2013.
60. Al-Jabri IM, Mustafa I, Sohail MS. A group decision-making method for selecting cloud computing service model. *Int J Adv Comput Sci Appl* 2018;9(1):449–56.