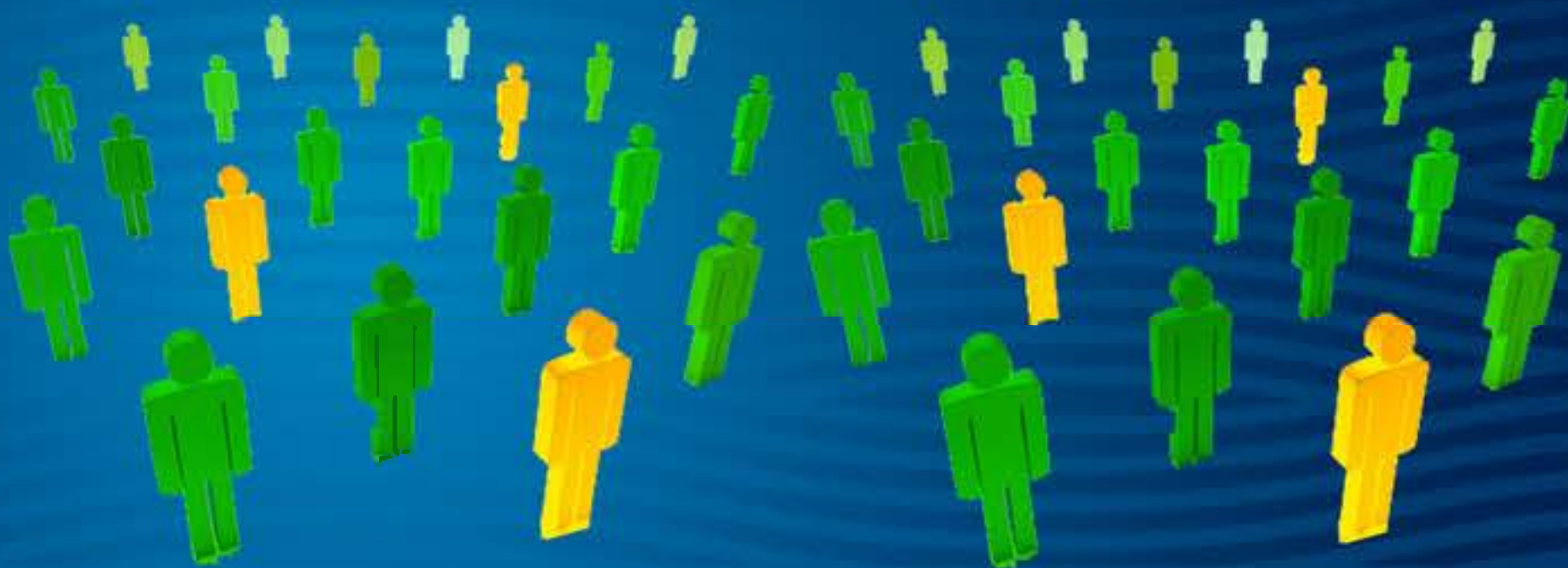




International Journal of Human Capital in Urban Management

Volume 5, Number 4, Autumn 2020





Publisher

Municipality of Tehran
Tehran Urban Research & Planning Center

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Printed at

Nashreshahr Institute
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(QUARTERLY PUBLICATION)



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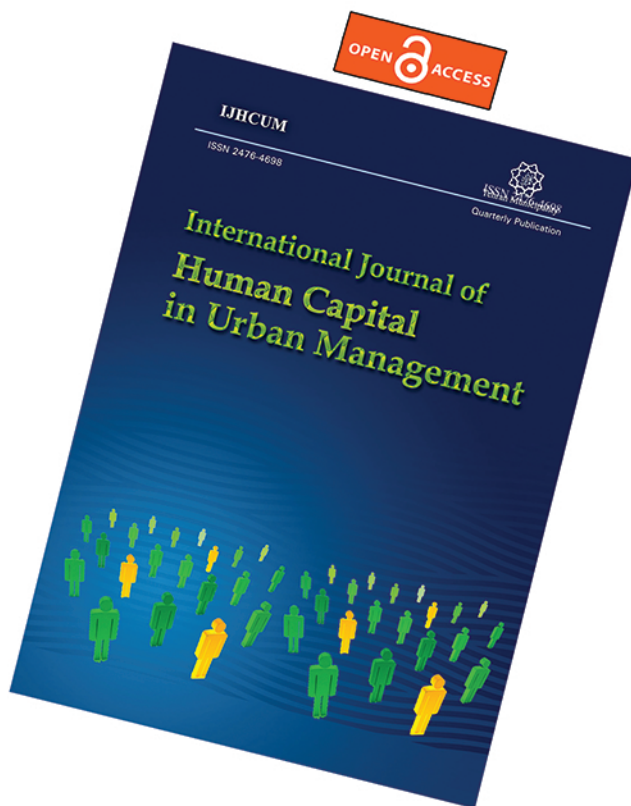
Editor-in-Chief
E. Sheikh, Ph.D.

pISSN 2476-4698

eISSN 2476-4701

QUARTERLY FULL OPEN ACCESS PEER REVIEWED PUBLICATION

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ORIGINAL RESEARCH PAPER

Improvements to increase the efficiency of solar dryers for different waste sludge management

Z. Amin*, N.K. Salihoglu

Department of Environmental Engineering, Faculty of Engineering, Uludag University, 16059, Bursa, Turkey

ARTICLE INFO

Article History:

Received 27 May 2020

Revised 30 July 2020

Accepted 16 August 2020

Keywords:

Absorber tubes

Cumulative solar radiation

Reflector

Renewable Solar Energy

Scanning Electron Microscopy

ABSTRACT

BACKGROUND AND OBJECTIVES: In this study, an integrated phase change material drying system was designed to evaluate the efficiency of the system with the use of renewable solar energy for different types of sludge with different moisture content.

METHODS: This study was performed on the wastewater treatment plant sludge, paint, and marble sludge. By distributing the screws on the sludge tray, covering the system floor with a black trash bag, and mounting the reflector around the absorber tubes has increased the efficiency of the system.

FINDINGS: All the types of equipment used in the construction of the system are used as heat storage material and increase the internal air temperature, and the sludge temperature of the system. Temperature is transferred sequentially through air and objects. This research was conducted in winter by 1156 Wh/m² mean internal cumulative solar radiation. Due to the reduction of solar radiation, as the system was upgraded, more water was released from the sludge surfaces. By Scanning Electron Microscopy imaging, the porous surface was observed after sludge drying.

CONCLUSION: In this study, the waste sludge moisture decreased from 80% to 52.2% during three improvement stages. The paint sludge moisture content reduced from 56% to 25%, and marble sludge moisture in the final stage reached from 26% to 5.2%. The proposed solar dryer system is an economical way to reduce the sludge volume in the transportation process.

DOI: [10.22034/IJHCUM.2020.04.01](https://doi.org/10.22034/IJHCUM.2020.04.01)

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NUMBER OF REFERENCES

39



NUMBER OF FIGURES

7



NUMBER OF TABLES

3

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

Renewable energy is one of the essential resources in energy supply and human development. Subsequently, the waste disposal process, especially sludge, has also become problematic. Solar radiation is a free energy source for various applications such as drying (Ali *et al.*, 2016). Traditional solar dryers, usually operated in the open air, which have been widely used in developing countries because of their simplicity and economic (Bolaji and Olalusi, 2008). Drying processes have previously required high energy costs (Di Fraia *et al.*, 2016), but recently it is known as an economical, convenient and slow process (Di Fraia *et al.*, 2018). Waste sludge, which is produced as a by-product of high-volume treatment plants. Liquid sludge from some industries is used as fertilizer on agricultural lands, but some types of sludge, such as pharmaceutical sludge, due to the specific content cannot be used as fertilizer, so it is dehydrated first. In some cases, it is possible to reuse the evaporated water (Mehrdadi *et al.*, 2007). Transporting sludge residues can cause problems due to high humidity and it has been suggested that solar dryers are an effective method to solve this problem (Świerczek *et al.*, 2018; Ying *et al.*, 2012). Solar dryers are used for a variety of purposes including drying food and heating location (Bano *et al.*, 2015). The water in the sludge is classified as the type of free surface water and inner bound water (Wang *et al.*, 2012). A large amount of sludge is produced daily by wastewater treatment plants (WWTPs.), which must be removed in a short time (Kacprzak *et al.*, 2017), and if not disposed, it will cause environmental pollution (Wang *et al.*, 2019; Wang *et al.*, 2019; Wang *et al.*, 2019; Archer *et al.*, 2017; Manara and Zabaniotou, 2012; Guo *et al.*, 2009). Solar dryers are investigated in both direct, indirect, and mixed-mode according to their performance and design (Simate, 2001). Integrated solar dryers are a good solution for continuous solar drying systems (Lakshmi *et al.*, 2018). Centrifuge, belt press, and drying bed are common techniques for sludge dewatering (Spinosa *et al.*, 2011). The efficiency of solar dryers depends on the type of absorber, area, wind speed, etc. The air is heated by absorbing solar radiation, and the drying chamber containing the sludge is exposed to hot air and direct radiation (Vlachos *et al.*, 2002). The efficiency of these systems can also be increased by extending

the surface area of the absorber or by installing the fins (El-khawajah *et al.*, 2011). The solar collectors are beneficial for solar power source storage (Kamble *et al.*, 2013), and can be a useful tool to save energy (Lakshmi *et al.*, 2018), and minimize drying area. A systematic method for classifying solar dryers has also been developed, in two, general groups of active and passive solar dryers for two stages (constant phase) and (fall phase) (Udomkun *et al.*, 2020). As the drying process progresses, the sludge becomes sticky and eventually turns into granules (Bennamoun *et al.*, 2013). The drying rate depends on the mass and heat transfer from the interior sludge surface (Darvishi *et al.*, 2018). The reflector is sometimes used to improve the drying process and has been recognized as a suitable material, especially in the construction of a large-scale solar dryer (Kalbande *et al.*, 2017). Heat transfer in solar dryers occurs through natural convection and conduction methods. The conventional drying process consumed more time and is in comparison with this designed solar drying system. Thermal energy is considered as latent heat (phase change), sensible heat, thermochemical, or combined heat (Khouya and Draoui, 2019). Phase change materials (PCM) such as paraffin results in the storage of reasonable heat to keep the temperature of the heated air at night or in hours when solar energy is not available (Bhardwaj *et al.*, 2017; Al-Abidi *et al.*, 2012). In this system, the paraffin-wax phase change material was used to store solar energy, also the absorption of solar radiation increased through steps such as conduction method by spreading the screws on the tray and coating the system floor by the black bag and supplying the reflector. The solar dryer is set up in the city of Bursa on the campus of the Uludag University, and the study was performed in winter season. Every year, millions of tons of sludge waste are produced by various processes from different industries, and depending on its content, most of them are not allowed to be buried. A large amount of sludge water is evaporated by a solar dryer and its volume is significantly reduced. In this system, the drying efficiency of three sludge samples was investigated under different conditions and time intervals. This system facilitates the sludge transportation process, which is considered as an economical method. This study have been carried out in Bursa, Turkey in 2019.

MATERIALS AND METHODS

Sludge samples

The first sludge sample was from the Bursa wastewater treatment plant after mechanical treatment with 80% moisture. The second sample was paint sludge, which was from the painting section of the automobile factory and is dangerous according to EU (European Union) standards 080113 code, also is not permitted to be buried. The moisture content in the paint sludge was 56%. The third sample was marble sludge, which results from the cutting, and polishing of marble slabs. Marble sludge is not considered hazardous waste. The bulk of marble sludge is calcium and magnesium oxide and contains 26% moisture content. The specifications of all three types of sludge are shown in Table 1.

Experimental study

The dryer setup in this study was made of a triangular aluminum frame. The surface and sides of the system are covered with poly carbonate coating. System absorber was dark glass heat pipes evacuated

tubes in which the copper pipes are embedded. Approximately 650 g of the copper pipes were filled with paraffin- wax phase change material that can absorb solar heat and stored during the night and in the absence of the sun. It prevents sudden temperature changes and causes more heat to enter the system. The generated heat by the paraffin-wax was transferred to the indoor air and the aluminum tray containing the sludge through convection, and finally to the sludge by the conductive method. Paraffin phase change material ensures that the dryers have enough heat to continue the drying process. Various sensors were used to different sections of the system to measure the temperature. Used sensors were (S3120, Comet, Czech Republic), a solar data logger (DT 185, CEM, India), (RX2100, HOBO onset data logger, USA), Thermal Camera (E5, FLIR, USA). A fan (120, Mutlusan, Turkey) and a pump (Vaillant VCK, UK) for regular air circulation were used. The installation of the fan resulted in a homogeneous distribution of air within the system, which accelerated the drying process. The sludge with 0.5 cm is loaded into the aluminum tray with

Table 1: Characteristics of three types of sludge

Sludge characteristics	Wastewater Treatment Plant Sludge	paint sludge	Marble Sludge
Total Solids (TS), %	20%	44%	74%
Magnesium oxide (MgO)			4,47%
pH	8.3		
Conductivity (µs/Cm)	267.83(µs/Cm)		
Lead (Pb)	31.77(mg/kg)	<0.05(mg/L)	
Calcium oxide (CaO)			49,07%
Zinc (Zn)	1212.04(mg/kg)	<0.1(mg/L)	
Aluminium (Al)	9005.25(mg/kg)		
Silicon dioxide(SiO ₂)			1,69%
Arsenic (As)	11.47(mg/kg)	<0.05(mg/L)	
Mercury (Hg)	587.4(mg/kg)	<0.001(mg/L)	
Iron(III) oxide(Fe ₂ O ₃)			0.21-1.3%
Chromium (Cr)	184.92(mg/kg)		
Selenium (SA) (mg/kg DS.)	2.34(mg/kg DS.)	<0.01(mg/L)	
Aluminum oxide(Al ₂ O ₃)			1.04-1.3%
Iron (Fe)	8857(mg/kg)		
Nickel(Ni)	84.84632(mg/kg)	<0.05(mg/L)	
Sulphate (SO ₄)	15209(mg/kg)	2.52±0.38 (mg/L)	
Carbon dioxide(CO ₂)			38.60%
Dissolved organic		1430±28 (mg/L)	

Efficiency of solar dryers in waste sludge management

a total area of 0.24 m². Fig. 1 shows the schematic diagram of the system.

Among the different methods, solar drying has more advantages than other methods, and in this study, during different stages, by improving the system, the priority of selecting this method is emphasized and with the development of science, the possibility of advancing this technique will continue. Drying technics are mentioned in Table 2.

Another important advantage of solar dryers is the inactivation of bacteria under solar radiation. In

research conducted in previous months in the same system Wastewater treatment plant sludge under 2312 Wh/m² cumulative solar radiation, the amount of E-coli Microorganism is reduced from 5 logs CFU/gr to 3 logs CFU/gr.

RESULTS AND DISCUSSION

Solar dryers should work in both cloudy and sunny weather. Increasing the collector surface reduces drying time. The produced hot air provides conditions for moisture evaporation from the sludge



Fig. 1: Schematic diagram of solar drying system.

Table 2: Drying Techniques (Zhang *et al.*, 2014)

Drying techniques	Advantages	Disadvantages
Vacuum Drying	Method is suitable for sensitive material Low risk and maintenance cost Free energy	Costly
Solar Drying	High possibility of progress and development Simple installation Bacteria reduction	Long process It needs a wide space
Freeze Drying	Reduce surrounding pressure Operate under vacuum	Costly
Osmotic Dehydration	Energy consumption 'Short dying time	Not remove enough moisture
Oven Drying	Short dying time	Needs more energy
Drum Drying	Rapid and efficient	Costly
Spray Drying	Rapid and efficient	Costly

(Simate, 2001). The drying rate is achieved by removing moisture from the surface and inner part of the sludge (Can, 2000). Many strategies have been proposed in this study to improve and increase the efficiency of the dryer. By placing one kg of sludge into the dryer, the performance of the system was evaluated from 10 a.m. to 16 p.m. for 6 h. During three stages, the system was repeatedly modified to improve dryer performance. For all three sludge samples, one kg of sludge was spread on an aluminum tray and the internal temperature of the system was increased during direct sunlight and through heat stored in paraffin-wax. In the first stage, sludge drying efficiency increases by adding steel screws that were dispersed and standing on the sludge surfaces. The steel screws transfer heat directly to the sludge by a conductive method due to the heat received from the solar radiation, in addition, with increasing cracking on the sludge surfaces, the drying rate was increased. In the next stage, coating the dryer floor with a black trash bag actually enhanced the absorption of solar radiation directly into the system. In the third step, the use of aluminum foil as a reflector around the glass tubes causes solar radiation to hit the reflector and return to the collector and increase the absorption of solar radiation. The aluminum foil as a reflective material was used for increasing the absorption of sunlight (Wagner et al., 1984), also can be used as cheaper material easily around the glass tubes. Due to the concave shape of aluminum foil, the solar radiation was easily reflected in the black glass tubes for further absorption. These reflectors were connected to the dryer itself and reflect solar

radiation to paraffin tubes, thereby the temperature of the paraffin increased. Drying speed was improved by system modification and sludge drying time was reduced. Fig. 2 shows the cracks created around the screws in three sludge samples.

In this study, the moisture content of all three sludge types at each stage in Eq. 1 is calculated.

$$\text{Moisture Content \%} = \frac{(M) - (D)}{(D)} \times 100 \quad (1)$$

M = Wet sludge weight(g)

D = Dry sludge weight (g)

Increasing the drying performance in WWTPs. by applying Screws, black trash bag, and Reflector

In Fig. 3(a). is shown the weight of WWTPs. sample has reached from 1000 g to 800 g within 6 h by 1120 Wh/m² internal cumulative solar radiation. The mean temperature and humidity inside the system were 16.8°C and 45.8%. In Fig. 3(b). by placing the steel screws on the surface of the waste sludge, the weight of the sludge has reached from 1000 g to 782 g, with 1120 Wh/m² internal cumulative solar radiation. In Fig. 3(c). in addition to the screws spreading, also the system floor was covered with black trash bag, and the sludge weight was reduced from 1000 g to 754 g by receiving 1064 Wh/m² internal cumulative solar radiation. The average internal temperature and humidity of the system were 18.6°C and 41.1%. In Fig. 3(d), the aluminum foil was used as a reflector along with the screws and black trash bag. At this stage, the weight of the sludge was changed from 1000 g to 722 g with 1046 Wh/m² internal cumulative solar



Fig. 2: Sludge morphology after solar drying by applying screws.

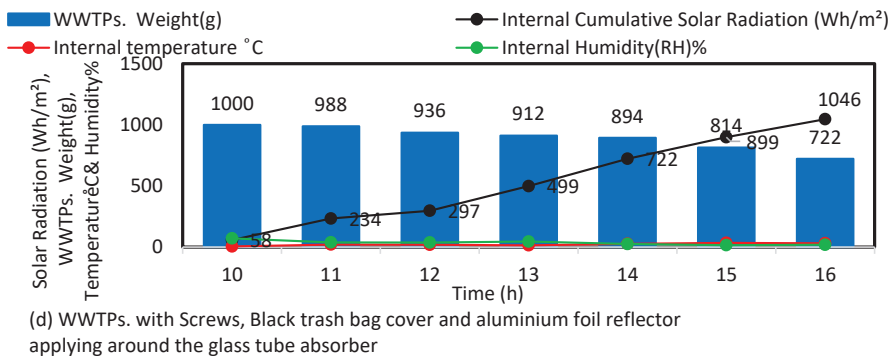
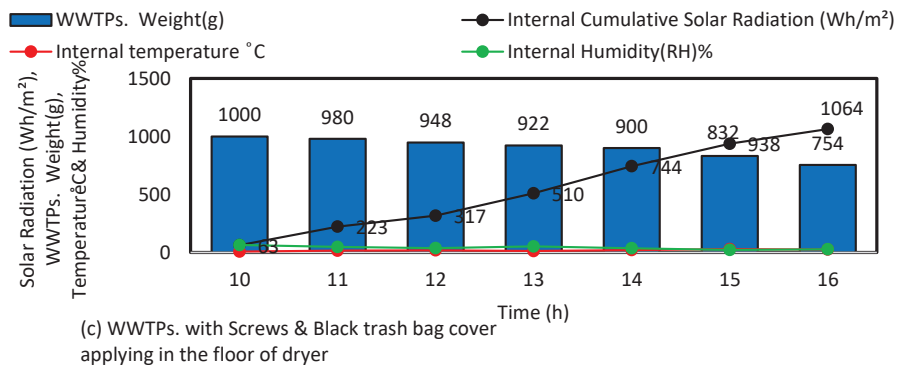
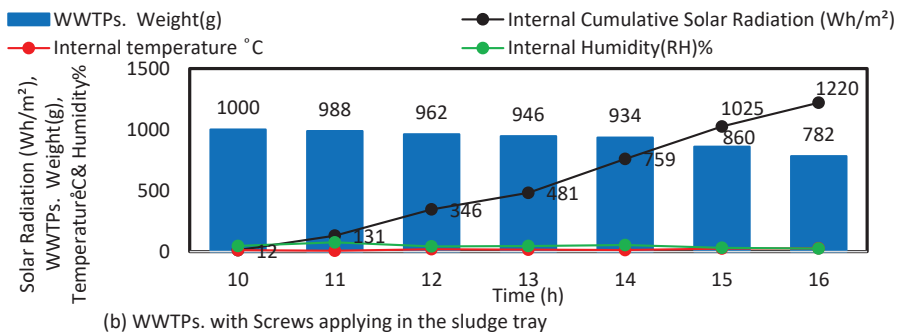
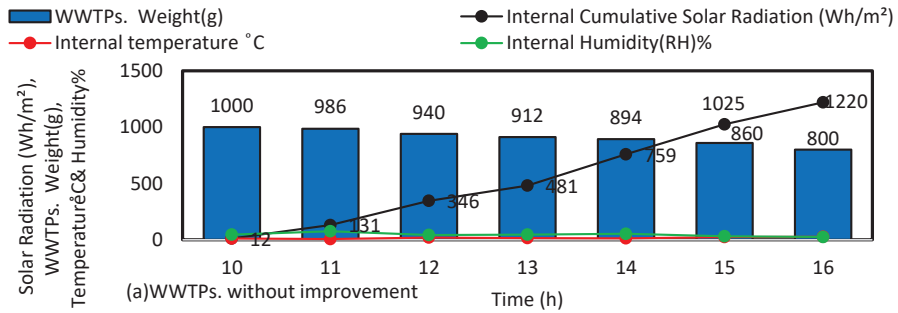


Fig. 3: WWTPs. drying performance by solar dryer; (a) WWTPs. without improvement; (b) WWTPs. with Screws applying in the sludge tray; (c) WWTPs. with Screws and Black trash bag cover applying in the floor of dryer; (d) WWTPs. with Screws, Black trash bag cover and aluminum foil reflector applying around the glass tube absorber.

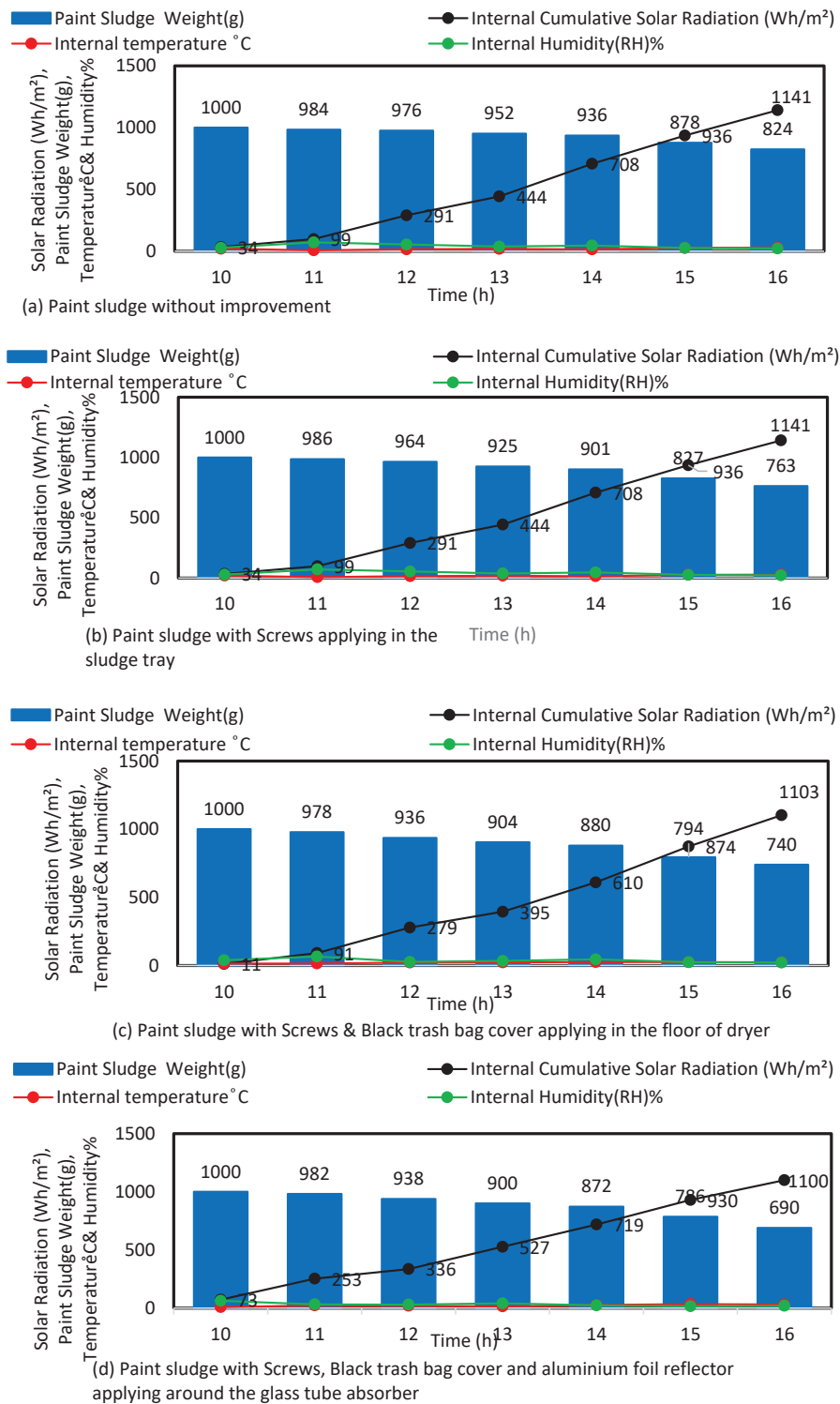


Fig. 4: Paint sludge drying performance by solar dryer; (a) Paint sludge without improvement; (b) Paint sludge with Screws applying in the sludge tray; (c) Paint sludge with Screws and Black trash bag cover applying in the floor of dryer; (d) Paint sludge with Screws, Black trash bag cover and aluminum foil reflector applying around the glass tube absorber.

Efficiency of solar dryers in waste sludge management

radiation. Also, the average internal temperature and humidity of the dryer were 21.6°C and 35.9%. In the Fig. 3, the sludge drying efficiency increases from 20% in Fig. 3(a) to 28% in the Fig. 3(d). At each stage, the sludge moisture reaches from 80% to 60%, 58.2%, 55.4% and 52.2%, respectively.

Increasing the drying performance in Paint Sludge by applying Screws, black trash bag, and Reflector

In Fig. 4(a), is shown the weight of the paint sludge sample has reached from 1000 to 824 g by providing 1141 Wh/m² internal cumulative solar radiation. The average temperature and humidity inside the system were 19°C and 41%. In Fig. 4(b), by placing the steel screws, the weight of the sludge has reached from 1000 to 763 g with 1141 Wh/m² internal cumulative solar radiation. In Fig. 4(c), after covering the system floor with black trash bag, the sludge weight was reduced by receiving 1103 Wh/m² internal cumulative solar radiation from 1000 to 740 g. The average

temperature and humidity of the internal system were 21°C and 37%. In Fig. 4(d), by using the reflector, the weight of the sludge was changed from 1000 to 690 g with 1100 Wh/m² internal cumulative solar radiation. Also, the average internal temperature and humidity of the system were 23°C and 32%. In the Fig. 4(a), the sludge drying efficiency increases from 18% to 31% in the Fig. 4(d). At each stage, the paint sludge moisture reduces from 56% to 38.4%, 32.3%, 30% and 25%, respectively.

Increasing the drying performance in Marble Sludge by applying Screws, black trash bag cover, and Reflector

In Fig. 5(a), the marble sludge weight sample has reduced from 1000 to 854 g with 1367 Wh/m² internal cumulative solar radiation. The average internal temperature and internal humidity were 25°C and 45%. In Fig. 5(b), the sludge weight has reached by screws applying in the tray from 1000

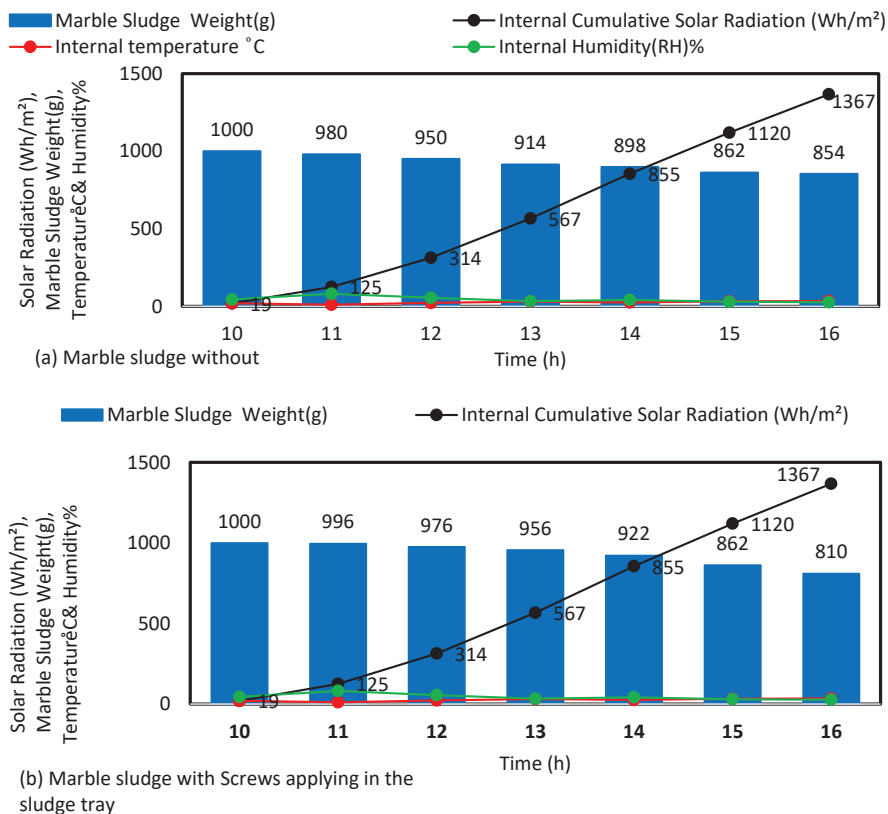
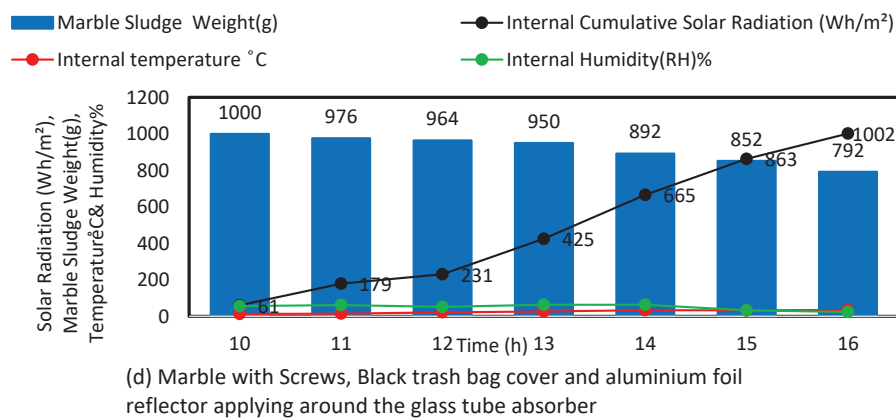
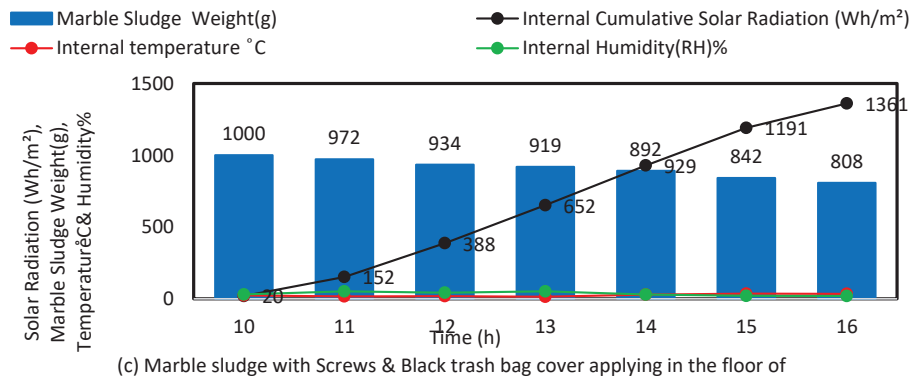


Fig. 5: The Marble sludge drying performance by solar dryer; (a) Marble sludge without improvement; (b) Marble sludge with Screws applying in the sludge tray



Continued Fig. 5: The Marble sludge drying performance by solar dryer; (c) Marble sludge with Screws & Black trash bag cover applying in the floor of dryer; (d) Marble with Screws, Black trash bag cover and aluminium foil reflector applying around the glass tube absorber.

to 810 g with 1367 Wh/m² internal cumulative solar radiation. In Fig. 5(c), the system modified by black trash bag and the sludge weight was reduced from 1000 to 808 g by receiving 1361 Wh/m² internal cumulative solar radiation. The internal average temperature and humidity of the system were 25°C and 35%. In Fig. 5(d). The sludge weight was changed from 1000 to 792 g with 1002 Wh/m² internal cumulative solar radiation. The average internal temperature and humidity were 26°C and 50%. In Fig. 5(a), the sludge drying efficiency increases from 15% to 21% in Fig. 5(d). At each stage, the marble sludge moisture changes from 26% to 11.4%, 7%, 6.8%, and 5.2%, respectively.

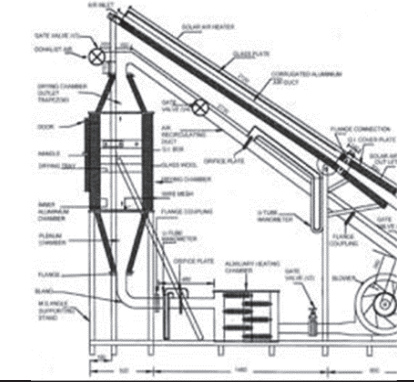
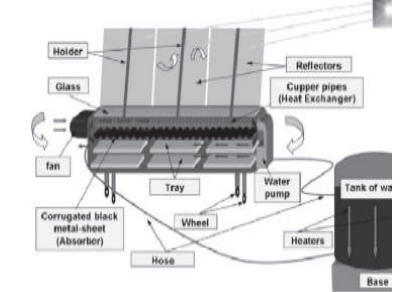
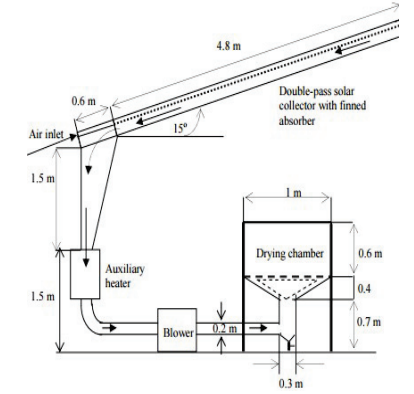
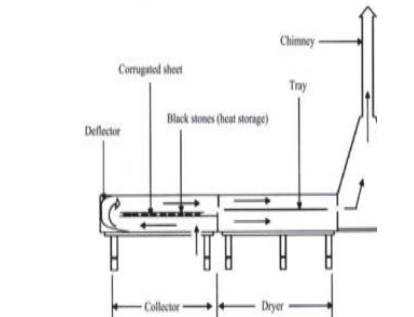
The solar radiation intensity decreases during each step, but due to system upgrading, sludge drying efficiency increases. This study was conducted in winter, with 1156 Wh/m² mean solar radiation, which improved the sludge drying process from the

first stage to third stage. Dryer efficiency increases with time and system quality increasing. This study was performed in a very short time when the solar radiation is very low. And the goal is just how to change the system improvement at each stage. In the drying systems that have been done in various studies in the previous articles, the improvement process has not been studied in steps and has been done for a longer period of time. Also, this study was performed only for one kilogram of sludge, which certainly has high efficiency in a larger volume of sludge will be more evident. Comparison of different solar dryer is shown in Table 3.



Heat transfer to sludge

Each material used in the system caused the system's internal temperature and sludge temperature to increase as a heat storage source, also Fig. 6 shows how the temperature rises sequentially. As the solar

Table 3: Comparison of different solar dryer

References	Moisture changes	Figure
(Sarsavadia, 2007) Onion slices	Moisture content reduces from 86% to 7% (wet basis).	
(Amer <i>et al.</i> , 2010) Banana slices	30 kg of banana slices in sunny day from moisture content of 82% to 18% (wb).	
(Fudholi <i>et al.</i> , 2011) Marine products	Moisture reduced from 90% to 10 % in 15 h.	
(Berinyuy <i>et al.</i> , 2012) Sliced cabbage	Moisture content reduced from 95% to 9% in five days.	

Continued Table 3: Comparison of different solar dryer

References	Moisture changes	Figure
(Eke, 2014) Tomato, okra and carrot	For tomato, okra and carrot dryers achieved 54.55, 52.88 and 50.98 percent gain in drying time and 21.80%, 21.18% and 24.95% system drying efficiencies respectively.	
(Garanto, 2016) Sludge	Sludge is dried from 18 % DS to > 95% DS;	

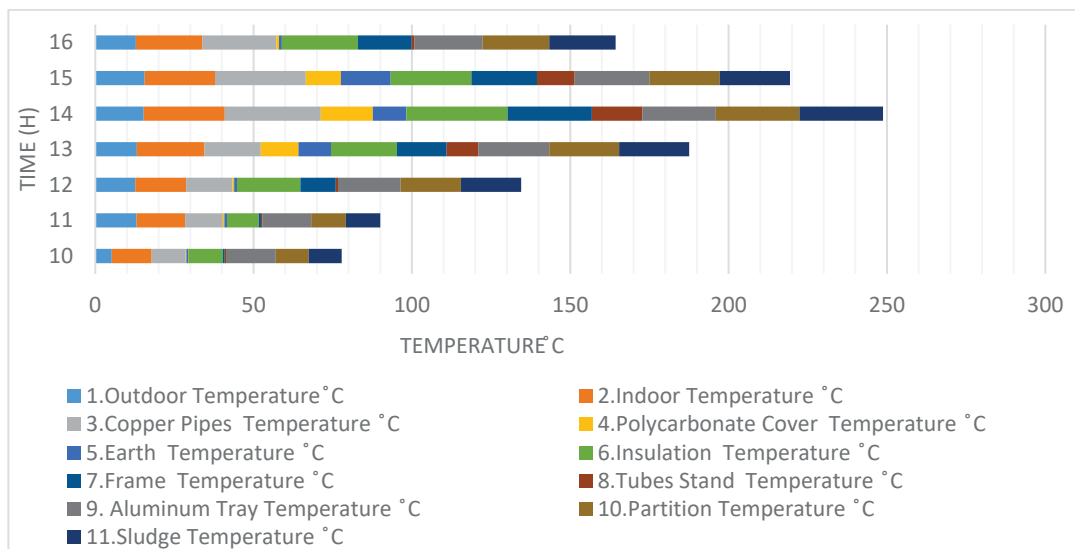


Fig. 6: Heat transfer in solar dryer system

radiation intensifies, all the components temperature inside and outside the system be increased, so the selection of equipment and the type of components

are important. In Fig. 6, the temperature changes are shown from 10:00 a.m. to 16:00 p.m. and the highest change was at 14:00 p.m.

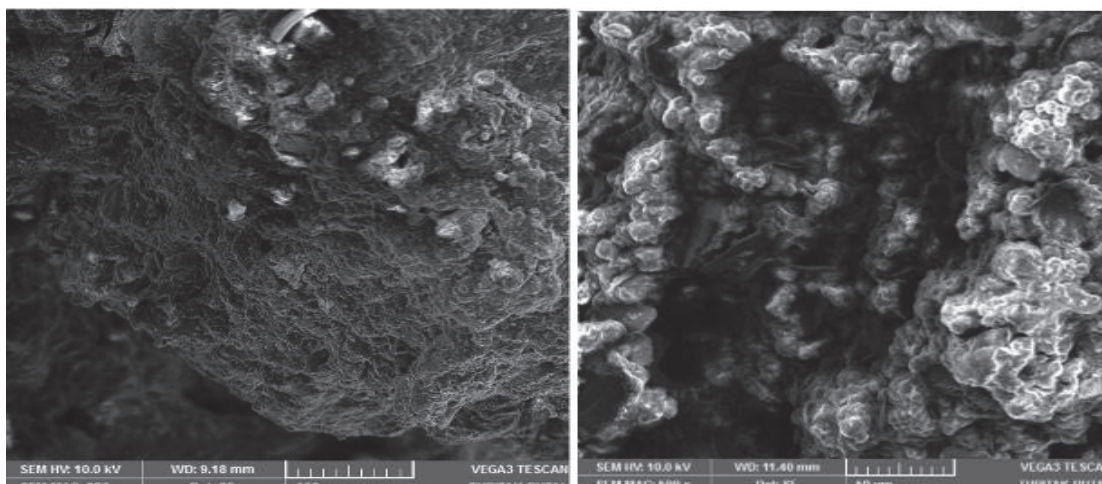


Fig. 7: SEM pictures from dried sludges: Left picture is WWTPs. with 11% Moisture and right picture is Paint sludge with 7% Moisture

SEM analysis

In this study, scanning electron microscopy (SEM) was imaged with a TESCAN VEGA3 SEM for WWTPs. with 11%, and paint sludge with 7% moisture content. As shown in Fig. 7, by increasing the temperature, the water particles rapidly detach from the sludge, resulting in pores and pipes of various dimensions on the sludge surface, which are more visible in the paint sludge. With this method, imaging the sludge morphology changes after drying were clearly visible. Wastewater sludge and paint sludge were imaged at 332 and 599 magnifications. The holes in the marble sludge does not form after drying and becomes a flat surface that is not visible by imaging.

CONCLUSION

In this study, the efficiency of a solar dryer designed for three different sludge types was investigated. During the drying process the system drying efficiency was improved from first step of spreading the screws in the tray to the third step of using the reflector in three sludge sample, with 1156 Wh/m² mean internal cumulative solar radiation in winter, which was more noticeable in the paint sludge due to the high amount of free water. The moisture content of WWTPs. reduced from 80% to 52.2% and paint sludge reduced from 56% to 25% and marble sludge moisture changed from 26% to 5.2%. At each stage, although the cumulative solar radiation be reduced, but due to system renewal, the sludge drying process

was improved, which was more effective in the paint sludge and was clearly visible in SEM imaging. The equipment used in the construction of the dryer must have a high heat storage capacity as a heat source and have a positive effect on the drying process. In the first stage, the sludge absorbs heat through tray and screws by conductive method and increases the drying rate. In the second stage, the black coating of the dryer floor leads to absorb the solar radiation completely, and in the third stage, by installing the reflector, the sun lights returns to the glass tubes and the paraffin temperature increases. The heat of the paraffin transfers to copper pipes and it cause to increase the internal air temperature. In addition, four factors such as cumulative solar radiation, indoor temperature, indoor humidity and time play important role in the drying process. The importance of using this system is to reduce the volume of sludge that leads to a reduction in transporting costs, also it improves waste management and can be used in various industries. Investigating the progress of solar dryer technology is appropriate for future development. As a result of the research, the necessary conditions for drying three types of sludge in the winter season in the Bursa region were determined.

AUTHOR CONTRIBUTIONS

Z. Amin is the corresponding author and has performed all the experiments and literature review.

Professor N. Salihoğlu is the supervisor and has installed the system.

ACKNOWLEDGMENTS

Thanks to Dr. M. Akif ÇİMENOĞLU in “TÜBİTAK BUTAL” for helping in SEM analysis and Ms. MELSA KORKMAZ Environmental Engineer for providing sludge samples.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS

<i>a.m.</i>	Ante meridiem
Eq.	Equation
°C	Degree Celsius
<i>cm</i>	Centimeter
%	Percentage
<i>EU</i>	European Union
<i>g</i>	Gram
<i>h</i>	Hour
<i>kg</i>	Kilograms
<i>m²</i>	Square meter
<i>PCM</i>	Phase Change Material
<i>p.m.</i>	Post meridiem
<i>RH</i>	Relative humidity
<i>SEM</i>	Scanning Electron Microscopy
<i>USA</i>	United States of America
<i>UK</i>	United Kingdom
<i>Wh/m²</i>	Watt-hour per square metre
<i>WWTPs.</i>	Wastewater Treatment Plant Sludge

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HOW TO CITE THIS ARTICLE

Amin, Z.; Salihoglu, N.K., (2020). Improvements to increase the efficiency of solar dryers for different waste sludge management. *Int. J. Hum. Capital Urban Manage.*, 5(4): 277-290.

DOI: 10.22034/IJHCUM.2020.04.01

url: http://www.ijhcum.net/article_44348.html



ORIGINAL RESEARCH PAPER

Analysis of factors affecting entrepreneurship, market, knowledge management in clean production and sustainable competitive advantage

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ARTICLE INFO

Article History:

Received 30 February 2020

Revised 1 May 2020

Accepted 11 June 2020

Keywords:

Cleaner production

Entrepreneurial orientation

Knowledge management

Market orientation

Sustainable competitive advantage

ABSTRACT

BACKGROUND AND OBJECTIVES: An emerging type of innovation that leads to dramatic improvement in management processes and methods, and at the same time promotes innovation, is entrepreneurship for preserving cleaner production. However, few studies have been conducted to examine the impact of entrepreneurial orientation, knowledge management, and market orientation on sustainable competitive advantage and cleaner production that indicates the necessity and importance of conducting such research. Therefore, the present study aimed to determine the impact of entrepreneurship, market, and knowledge management on sustainable competitive advantage and cleaner production.

METHODS: The study is a descriptive research based on the method and an applied one in terms of the purpose. The statistical sample includes 289 senior executives of small and medium enterprises which are selected by random stratified method. The Structural Equation Model was used for inferential analysis and Analytic Network Process was used for prioritization.

FINDINGS: According to the obtained results, entrepreneurial orientation, market orientation, and knowledge management affect cleaner production with the 0.75, 0.85, and 0.51 scores, respectively, and also, cleaner production leads to improvement of competitive advantage. As a result, companies operate more successfully when using a set of strategic guidelines for cleaner production and achieve the significant development, which produce a sustainable competitive advantage over competitors. The Analytic Network Process output also indicates that the knowledge orientation got first rank with the weight of 0.307, followed by entrepreneurial orientation and market orientation with the weight of 0.229 in the second rank, and cleaner production (0.141) and sustainable competitive advantage (0.095) ranked third and fourth, respectively.

CONCLUSION: It seems that the existing knowledge of manufacturing operations is insufficient at this level to cover the rapid growth of this field, and many small and medium enterprises are still lagging behind in taking advantage of these new opportunities.

DOI: [10.22034/IJHCUM.2020.04.02](https://doi.org/10.22034/IJHCUM.2020.04.02)

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NUMBER OF REFERENCES

45



NUMBER OF FIGURES

1



NUMBER OF TABLES

11

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

Concerns related to problems facing environment encourage citizens and companies to reduce waste, and recycle, reuse, or rebuild commodities. To this end, the environmental sustainability approach is utilized through environmental practices in organizations (Li *et al.*, 2017). Cleaner production (CP) is one of the environmental practices with the aim of rational use of natural resources, innovative organizational processes, and minimizing waste generation by companies for a Sustainable Competitive Advantage (SCA) in an advanced society. On the other hand, due to lack of natural resources, developing countries are under pressure to grow entrepreneurial activities to achieve rapid growth while reducing its negative effects on natural resources (Silajdzic *et al.*, 2015). The Green Revolution in 2010 has led to entrepreneurship through competitive, proactive, and sustainable innovations in a world moving towards globalization (Tan *et al.*, 2015). Initiatives are essential to promote and direct creativity. According to Hart (1995), and Saha and Darnton (2005), Green producers are committed to broad and long-term evaluation of the effect of their activities and thus they can affect the quality and well-being, protection, and security of society as well as the economic growth, and social and economic justice. As several studies show including Brandt (2007), Corbett and Klassen (2006), Dills and Stone (2007), the importance of green production is growing rapidly. Huge challenges facing the planet's ecosystem and resources due to population growth and emerging economic development (Kleindorfer *et al.*, 2005, Esty and Winston, 2009; Hart, 1995; Industry Today, 2010). Satisfying growing demand for goods by manufacturing systems is associated with devastating environmental impacts (Frosch and Gallopoulos, 1989). Entrepreneurship for sustained cleaner production, is a kind of innovation that leads to dramatic improvement in management techniques and processes and promotes innovation. In order to minimize the effects of economic activity, by reducing residuals, reducing natural resource consumption, or using alternative energy sources, many companies encourage sustainability by providing some public policy motivations (De Oliveira *et al.*, 2016). Determining the variables driving the entrepreneurial activities is difficult due to the existence of related factors, such as socio-cultural, economic, and environmental factors (Castano *et al.*, 2015). On the

one hand, unique collaborate is difficult in using specific resources that creates sustainable innovations. In this regard, Cleaner production (CP), aimed at increasing the firm's sustainable competitive advantage, as well as superior performance than competitors, can be developed by strategic approaches such as Marketing Orientation (MO), Entrepreneurial Orientation (EO), and Knowledge Management (KM). When social and businesses networks are developed, EO and MO will lead to improved business performance and its resulted advantages is better reflected (Boso *et al.*, 2013). Supply chain structures in integration with environmental initiative for cleaner production will benefit companies in emerging markets in this way (Hoof and Thiell, 2015). However, few studies have been conducted on interrelationships between entrepreneurship, marketing approach, knowledge management approach, and cleaner production, which will be addressed in the present study (Kim *et al.*, 2012). However, little is known about the relationships among EO, MO, KM, CP and SCA, for they are the same actions to guarantee a high business performance. Consequently, in this study based on the literature that there is a casual effect between the constructs (EO, MO, KM) which come before Cleaner Production and Sustainable Competitive Advantage.

Theoretical framework

Entrepreneurship

As a relatively new concept in economics, entrepreneurship plays an important role in the countries' economic growth and development in the competitive and market-based economy of the new age. Entrepreneurship makes it possible to adapt to the new conditions of a dynamic economy in which ideas, products, and services are rapidly changing. Accordingly, in general, all economic participants including consumers, producers, and investors, must be entrepreneurs and, in turn, participate in entrepreneurial activities (Birkinshaw, 2000).

Competitive Advantage definition and concept

"Competitive advantage is defined as the superiority in market competitive position due to the better performance compared to competitors (Porter, 1985)." The competitive advantage causes distinction in the features or dimensions of company that enables it to provide better services (better value) to its customers compared to its competitors. The above

mentioned and other definitions of competitive advantage indicate a direct relationship between the customer's desired values, the company's proposed values and the values proposed by competitors of the company with the requirements and dimensions of competitive advantage. In case that comparing the values of the company with the values proposed by competitors is more consistent and closer to the customer's values and expectations, it can be said that the company has competitive advantage over its competitors in one or more indicators so that outperforms competitors and thus, captures the customers' hearts (Guimaraes *et al.*, 2016).

Knowledge Management

Based on the literature review in this area, knowledge management is of fundamental importance in the global economy and plays an important role in the competitiveness improvement in large companies, as well as SMEs. Based on recent evidence, the knowledge management approach has been adopted by companies to promote innovation in business, social justice and the environment (Centobelli *et al.*, 2017). The purpose of knowledge management is to identify, collect, categorize and organize, store and share, disseminate and make available knowledge at the organization level (Yaghoubi *et al.*, 2011). Research and development in organizations, due to its valuable and effective nature, has led many researchers to consider knowledge management as a key factor for nurturing and the emergence of creativity in organizations and, consequently, the prosperity and viability of the organization. Myrthle Beach (2003) suggests that knowledge management is the extension of knowledge, insight, understanding, know-how and usage, technology and traditions with a combination of modern science. Finding, selecting, organizing, and disseminating important information is possible through the knowledge management process. For more complex activities such as problem solving, dynamic learning, planning, decision making and strategy, professional knowledge management is required (Spector, 2004). The American Productivity and Quality Center define knowledge as the extensive process of deploying, organizing, transferring and using information in the organization (Qasri, 2013). According to Tsekhouy *et al.*, (2019), knowledge digitalization technology, which encourages the creation of domestic robots,

helps CEOs in the field of machine intelligence improve R&D activities.

Cleaner production

The macro-environmental forces caused by the natural environment create environmental issues that have increasingly been addressed over the past two decades. The 1990s was called the Earth Decade and experts suggest that the natural environment has become a main issue for global companies and people. By increasing the pollution of water and air to a dangerous level, the Ozone layer is pierced and the earth becomes warmer. Many fear the land buried under the rubbish. Concerns about the environment have led to a movement called the Green Movement, and the far-sighted companies have gone beyond state regulation and adopted strategies to create a sustainable environment and tried to create an economic system that governs the world to ensure the survival and durability of the planet (Salehi Amiri, 2008). There are very complex relations between humans and nature. Traditionally, nature was considered a stronger force than human; however, today there are machines that can move mountains and available technology has the potential to penetrate in nature and destroy the environment. Examining consumers' willingness to use green products indicated that more than 92% of European multinational companies have turned to environmentally friendly products, and 85% have changed their product line. Also, green products grew more than doubled to 11.4 percent of all home products in the United States from the 1980's to 90's., although this growth rate remained constant in the 1990s. Nature or environment is a capital with many non-renewable components, and recycling the renewable ones is so long that can actually be considered non-renewable. On the other hand, any natural phenomenon is so interconnected with other components that any change in each of the components cause change even to the farthest points of the world (Nakhai, 2011). Cleaner production is an environmental initiative, focused on systematically reducing production costs by restoring consumer resources, and minimizing the production of industrial waste (Severo *et al.*, 2015; Neto *et al.*, 2015) as well as the reuse of materials and recycling them to minimize environmental damage (Guimaraes *et al.*, 2017). The present study aimed to investigate the

impact of entrepreneurship, market, and knowledge management on cleaner production and sustainable competitive advantage that each of these issues has been explained below:

Entrepreneurial Orientation (EO)

Entrepreneurial orientation, according to researchers, relies on the encouragement of change and innovation, risk-taking, and competitive aggressiveness in the organization (Wiklund and Shepherd, 2005; George and Marino, 2011). However, entrepreneurial orientation can also be defined as the company's ability to engage in activities related to innovation, risk-taking, and leadership in innovative activities (Engelen *et al.*, 2015). Entrepreneurial orientation is a decision-making process that influences a company's willingness to innovate, overcome competitors through reactivity and aggressiveness, and take risks (Miller and Friesen, 1983). Overall, the entrepreneurial orientation includes exploring, evaluating, and exploiting opportunities to provide the market with new products and services (Ribeiro-Soriano and Huarng, 2013). Entrepreneurial orientation is also a set of corporate features that lead companies to innovate in business, products and services based on management decisions (Birkinshaw, 2000). EO includes identifying behavior and creating market opportunities, emerging and developing organizations, creativity in forming teams, creating healthy disruptive innovation, and organizational transformation that can take place in individual, team, organizational, industries, and the community levels (Shane and Venkataraman, 2000).

Market Orientation

Market orientation in terms of Dobni and Luffman (2003) is a behavioral culture to determine the direction of employees' thoughts and actions. The market orientation approach highlights the customers by understanding their requirements, proposing value to them, and creating a high level of customer satisfaction. Also, great attention is paid to responding to competitive threats and continuous discussion about the strengths and weaknesses of competitors and coordination between their performances through the integration of all members of the company in meeting customer's requirements. In this regard, maximizing long-term profit (Narver and

Slater, 1990) and sustainable competitive advantage (Kumar *et al.*, 1998) is possible through providing superior value to customers. Market orientation is a continuous searching for customer data to identify market demands and quickly and satisfactorily provide solutions to customers by creating and commencing value of services and products to ultimately lead to improved organizational performance (Baker and Sinkula, 2005; Hult *et al.*, 2003).

Knowledge Management Orientation

Knowledge Management Orientation refers to having infrastructures and information technologies to save and supply the produced knowledge in addition to structural and cultural facilitators (Kim and Lee, 2001). Since it is created by individuals based on collective work during the daily activities, knowledge is the result of constant interaction between people inside and outside the organization (Prieto *et al.*, 2009).

Sustainable Competitive Advantage (SCA)

As one of the operational results and management decisions, SCA leads to organization superior performance compared to the competitors (Guimaraes *et al.*, 2016), and Tan *et al.*, (2015) mentioned quality improvement, innovation, costs reduction strategies, and social and environmental regulations as some factors influencing the organizational performance improvement.

Literature review

Hemmat and Qorbani (2017) conducted a research entitled "examining the relationship between strategic entrepreneurship and the competitive advantage of knowledge-based service companies: companies founded in Isfahan Scientific and Research Town". The research was conducted by structural equation method using SmartPLS software on a statistical sample including 134 companies from Isfahan research and development town. According to the obtained results, the five dimensions of strategic entrepreneurship derived from the Ireland model including entrepreneurial mentality, entrepreneurial culture, entrepreneurial leadership, strategic resource management and the use of creativity and the innovation development, have a positive impact on competitive advantage and thus, can improve competitive advantage. Supporting

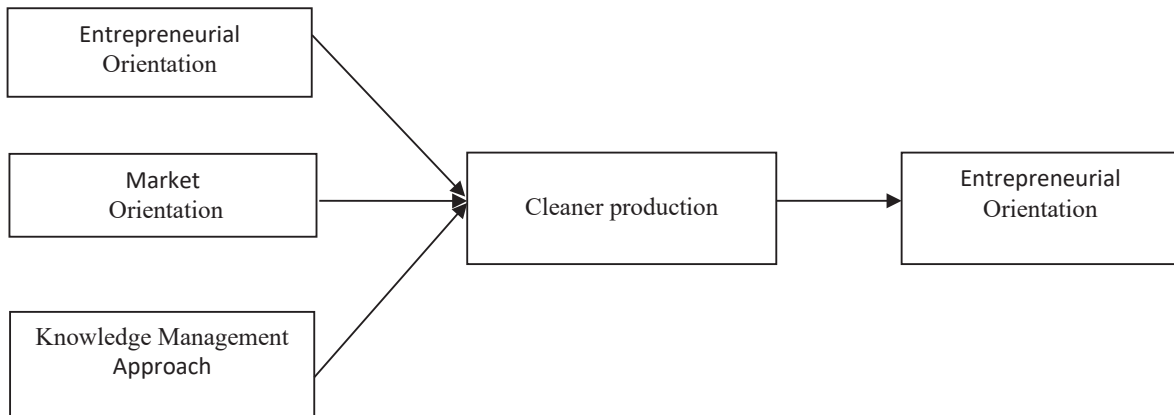


Fig. 1: Research Conceptual Model (Guimaraes et al., 2018)

ideas from employee and accepting potential risks, applying training programs to strengthen entrepreneurial culture, creating and developing networking with other companies, attracting investors, reducing external controls, and using self-assessment and participatory systems and focusing on customer-oriented culture in an organization also contributes improving the effectiveness of strategic entrepreneurship and competitive advantage. In their study entitled “green marketing as a competitive advantage against non-responsible companies”, FakhraAbadi and Baqai (2017) found that new concepts like clean technology, green consumer, competitive advantage, and sustainability are emerging in the environmental green marketing era. For instance, clean technology includes the innovative design of new products and the production system, so that waste and contamination are eliminated during the design phase. Today, green consumers do not use consume goods that could endanger the consumers’ or the others’ health or cause damage to the environment during production, cause unnecessary waste through packaging, harm animals or have a negative impact on other countries. Issues such as sustainable development in economy have had an important impact on marketing science and have proceeded the third century to sustainable green marketing. Looking ahead, equity and fairness, and emphasis on needs can be mentioned as the apparent challenges of this era. In such conditions, if there were a lot of consumers worried about the

environment, companies are distinguished from the others by adapting their products to the environment. This is a win-win relationship that causes both welfare and needs fulfillment for the consumer, as well as reducing costs through the proper activities and waste reduction for the company. In the research conducted by Guimaraes et al., (2018), the effect of entrepreneurship, market, and knowledge management were investigated on cleaner production and sustainable competitive advantage. Their study, conducted in a sample of 1,774 SMEs operating in the transformation industries, trade and services sectors in South of Brazil and using structural equation modeling, has been analyzed as a descriptive quantitative research. According to their results, strategic drivers have an intensive impact on cleaner production, which indicates the strong correlation between the three previous ones and also, research companies that use strategic orientation tend to have a greater impact on cleaner production. The current study have been carried out in the applications of small and medium enterprises In Iran during during the years 2015-2019.

Conceptual model

According to the theoretical framework and literature review, the research conceptual model, extracted from Guimares et al., (2018), is shown in Fig. 1.

Evidence and documents of conceptual model variables are given in Table 1.

Table 1. Evidence of Conceptual Model Variables

Variable	Researcher
Entrepreneurial orientation	Hernández-Perlines and Rung-Hoch (2017); Engelen <i>et al.</i> , (2015); George and Marino (2013)
Market orientation	Dobin and Luffman (2003); Narver and Slater (1990); Kumar <i>et al.</i> , (2002)
Knowledge Management Approach	Yaghoubi <i>et al.</i> , 2011; Centobelli <i>et al.</i> , (2017)
Cleaner production	Tsekhovoy <i>et al.</i> , (2019); Prieto <i>et al.</i> , (2009)
Sustainable competitive advantage	Guimaraes <i>et al.</i> , (2016)

MATERIALS AND METHODS

The present study is a correlative survey and an applied research. The statistical sample of this research includes the senior managers of small and medium enterprises that are 289 managers using the $5Q \leq n \leq 15Q$ rule. The Guimaraes *et al.*, (2018) standard questionnaire was used with 22 items for the purpose of this research. The Cronbach's alpha coefficient is also used to measure the reliability which is obtained higher than 0.7, that shows a high reliability. For the reliability analysis, 50 questionnaires were pretested in an initial sample. Then Cronbach's alpha technique was employed to calculate the reliability coefficient based on the data obtained from questionnaires. Cronbach's alpha was calculated at 0.90 for variables; confirming the questionnaire's reliability. The confirmatory factor analysis along with the structural equations has been used to analyze the information. The following assumptions hold respectively in this method:

- Expressing the model
- Estimating the model
- Testing hypotheses
- Interpreting the model

LISREL software has been used for this purpose. The ANP technique with the following assumptions is also used to rank the factors:

- Comparing the main criterion with the goal
- Paired comparison of the other criteria to each criterion separately
- Paired comparison of sub criteria of each criterion to that criterion
- Paired comparison of sub criteria to each sub criteria separately
- Paired comparison of alternatives based on sub criteria

Table 2 is a presentation of the most frequently mentioned sustainable competitive advantage in the reviewed literature and Delphi method.

Table 2 Study indicators and semantic code

Indicator	Semantic code
Cleaner production	(CP)
Sustainable Competitive Advantage	(SCA)
Entrepreneurial orientation	(EO)
Marketing Orientation	(MO)
Knowledge Management	(KM)
Cleaner production	(CP)
Priority based on Target (special vector)	(W21)

RESULTS AND DISCUSSIONS

Descriptive statistics indexes have been used to categorize data related to gender, educational level, and history in order to describe the demographic characteristics of the studied population.

A total of 289 respondents were selected among which, the most frequency is related to male with 224 people which constitutes of the sample 77.50%, followed by the number of 65 female which constitutes 22.49% of the sample size. Among the 289 respondents, 56 have the associate degree which constitutes 19.37% and the most frequency was related to bachelor degree with 154 (53.28%) followed by master degree with 79 people 79% of the sample. 33 out of 289 respondents or 11.44% of the sample size had the working experience from 1 to 5 years. 165 respondents or 57.09 % of sample had working experience of 6 to 10 years; also, 165 individuals or 57.09 % had 6 to 10 years of experience and 62 respondents or 21.45 percent in the range of 11-15 years. Finally, 29 people or 10.3 % of the sample had over 16 years of experience.

Explaining hypotheses was firstly performed by the confirmatory factor analysis and then, by the structural equation model.

Confirmatory Factor Analysis

The validity of the scale used should be confirmed at first in order to verify the research hypotheses based on this scale. Therefore, confirmatory factor

analysis has been used to measure the relationship between latent variables and their measurement items. Confirmatory factor analysis examines the relationship of the items (the same questionnaire questions) with the structures. In fact, the research hypotheses cannot be used based on questionnaire data until it is demonstrated that the latent variables are well measured by the questionnaire questions. Therefore, the accurate data measurement is proved utilizing the confirmatory factor analysis. The relationship power between the factor (latent variable) and the observed variable is determined by the factor loading. The factor loading is ranged from zero and one. According to Kline (2010), the relationship is a weak one and can be ignored if the factor loading is less than 0.3.

The confirmatory factor analysis results

The factor analysis results are presented in Table

3. The factor loading is greater than 0.3 in all cases, indicating the acceptable correlation between the latent variables and the observed variables.

The structural equations results

The power of relationship between the research variables is measured by the structural equation modeling. The research hypotheses analysis was also performed using structural equation model. The final model is presented to analyze the research hypotheses in Table 4. This model is drawn using the LISREL software output and its interpretations are as follows:

The Entrepreneurial Orientation has a positive relationship with cleaner production

According to Table 4, the power of the relationship between entrepreneurial orientation and cleaner production is calculated at 0.75, which indicates a

Table 3. Factor loading coefficients and T value

construct	Item	Factor loadings coefficient	t-statistic
Entrepreneurial Orientation (EO)	EO1	0.31	7.12
	EO2	0.51	5.22
	EO3	0.75	7.15
	EO4	0.61	2.26
Market Trending (MT)	MT1	0.45	3.14
	MT2	0.78	4.14
	MT3	0.31	5.11
	MT4	0.39	5.23
	MT5	0.52	6.23
Knowledge Management (KM)	KM1	0.68	3.14
	KM2	0.52	4.15
	KM3	0.81	9.15
	KM4	0.52	3.25
Cleaner production (CP)	CP1	0.63	2.14
	CP2	0.51	2.16
	CP3	0.87	3.15
	CP4	0.72	3.29
Sustainable Competitive Advantage (SCA)	SCA1	0.89	3.56
	SCA2	0.74	5.16
	SCA3	0.53	7.12
	SCA4	0.68	5.89
	SCA5	0.73	6.49

Table4; Hypotheses Testing Results

Hypothesis	Correlation value	t-statistic	Hypothesis results
Entrepreneurship orientation - Cleaner production	0.75	2.75	confirmed
Market orientation - cleaner production	0.51	3.62	confirmed
Knowledge Management Approach - Cleaner production	0.85	3.59	confirmed
Cleaner production - Sustainable competitive advantage	0.87	5.04	confirmed

desirable correlation. Therefore, the above hypothesis is confirmed and it can be said that entrepreneurial orientation affects the cleaner production in the manufacturing companies in Iran.

The Market Orientation has a positive relationship with cleaner production

According to Table 4, the relationship power for market orientation and lean production is 0.51, which indicates the desirable correlation. Therefore, the above hypothesis is confirmed and it can be said that the market orientation affects the cleaner production in the manufacturing companies in Iran.

Knowledge Management approach has a positive relationship with cleaner production

According to Table 4, the power of the relationship between the KM approach and the cleaner production is calculated at 0.85, which indicates the desirable correlation. Therefore, the above hypothesis is confirmed and it can be said that the knowledge management approach affects the cleaner production in the manufacturing companies located in Iran.

Cleaner production has a positive relationship with the sustainable competitive advantage

According to Table 4, the power of the relationship between cleaner production and sustainable competitive advantage has been calculated at 0.78, which indicates the desirable correlation. Therefore, the above hypothesis is confirmed, and it can be said that cleaner production has a positive effect on the competitive advantage of the manufacturing

companies located in Iran. Goodness of fit indicators has also been used to fit the structural model of the main research model. The regular χ^2 index is one of the main indicators to calculate the free parameters of fit indices, obtained by dividing the simple division of χ^2 to the model's degree of freedom (Eq. 1). If this value is between 1 and 5, it considered to be desirable (Kline, 2010).

$$\frac{\chi^2}{df} = \frac{201.56}{74} = 2.724 \tag{1}$$

The model also has good fit because the Root Mean Square Error of Approximation (RMSEA) score is 0.033. Based on the sample size, all the fit indices of the model show significant differences. Table 5 shows a summary of the model fit indices based on the p-value.

Priority based on Target (W21)

The main criteria are compared on a paired basis to perform the first analysis. For this purpose, a group of experts has been used and the Eigenvector has been calculated using the geometric mean and normalization techniques. The numbers obtained show the importance of each of the main criteria. The calculations performed in Table 6 are presented and the Eigenvector is displayed as W21.

According to the obtained Eigenvector:

- The “knowledge orientation” criterion is in the first rank with a normalized weight of 0.307.
- The “entrepreneurial orientation” and “market orientation” criteria with a normalized weight of 0.229 are in the second priority.

Table 5: Goodness of Fit Indicators for the structural model of the research main hypotheses

Fitness Index	RMSEA	GFI	AGFI	NFI	NNFI	IFI
Acceptable values	<0.1	>0.9	>0.9	>0.9	>0.9	1 – 0
Calculated values	0.033	0.95	0.97	0.93	0.92	0.98

Table 6: Ranking the main criteria

Norms	EO	MO	KM	CP	SCA	Geometric mean	Eigenvector
EO	1	1.259	1.259	1.729	1.569	1.240	0.229
MO	1.166	1	0.546	1.901	2.404	1.238	0.229
KM	0.794	1.832	1	2.972	2.931	1.662	0.307
CP	0.578	0.337	0.526	1	2.492	0.761	0.141
SCA	0.637	0.341	0.416	0.401	1	0.515	0.095

- The “cleaner production” criterion with a normalized weight of 0.141 is in the fourth priority.
- The “Sustainable Competitive Advantage” criterion is in the fifth priority with a normalized weight of 0.095.

The inconsistency rate of the performed comparisons is 0.044, which is less than 0.1, and therefore, the comparisons accuracy was confirmed.

Determining the priority of entrepreneurial orientation sub-criteria

The calculations performed to determine the priority of sub-criteria for entrepreneurial orientation are presented in Table 6. As this criterion is composed of 4 indicators, 7 paired comparisons have been made.

According to the obtained Eigenvector:

- The sub-criterion of “The Company develops market measures earlier than its competitors” is in the first rank with a weighted average of 0.440.
- The sub-criterion of “The Company encourages investment in high-risk, high-yield projects”, with a normalized weight of 0.323, is in the second priority.
- The sub-criterion of “The Company emphasizes the R & D activities, technological leadership and innovation in processes and products/services” is in the third priority with a normalized weight of 0.134.
- The sub-criterion of “Changes in the range of products or services has been very significant”,

with a normalized weight of 0.103, is in the last priority.

The inconsistency rate of the comparisons is 0.707, which is less than 0.1, and the comparisons accuracy was confirmed.

Determining the priority of Market Orientation (OM) sub-criteria

The calculations performed to determine the priority of Market Orientation sub-criteria are presented in Table 8. Since this criterion is composed of 5 indicators, 10 paired comparisons have been made.

According to the obtained Eigenvector:

- The sub-criterion of “This Company prioritizes projects and response measures in relation to market orientation.” is in the first rank with a weighted average of 0.263.
- The sub-criterion of “The Company considers response measures to be one of the most important market demand information.” is in the second priority with a normalized weight of 0.260.
- The sub-criterion of “There is a cultural unit in the company that continuously provides customers with higher values”, with a normalized weight of 0.230 is in the third priority.
- The sub-criterion of “The company has special departments or staff to collect and manage market data to transform them into the market information”, with a normalized weight of 0.154 is in the fourth priority.

Table 7: Determining the priority of entrepreneurial orientation sub- criteria

	EO1	EO2	EO3	EO4	Geometric mean	Eigenvector
EO1	1	0.538	3.356	3.090	1.537	0.323
EO2	1.858	1	5.866	1.750	2.090	0.440
EO3	0.298	0.170	1	1.127	0.489	0.103
EO4	0.324	0.571	0.887	1	0.636	0.134

Table 8: Determining the priority of Market Orientation sub-criteria

	MO1	MO2	MO3	MO4	MO5	Geometric mean	Eigenvector
MO1	1	0.646	0.587	2.443	3.084	1.234	0.230
MO2	1.547	1	0.627	1.712	3.169	1.394	0.260
MO3	1.702	1.594	1	1.104	1.876	1.412	0.263
MO4	0.409	0.584	0.905	1	1.757	0.824	0.154
MO5	0.324	0.316	0.533	0.569	1	0.499	0.093

- The sub-criterion of “product/service innovations and process include market information”, with a normalized weight of 0.093 is in the fifth priority.

The inconsistency rate of the comparisons is 0.052, which is less than 0.1 and therefore, the comparisons accuracy was confirmed.

Determining the Priority of Knowledge Management (KM) sub-criteria

The calculations performed to determine the priority of knowledge management sub-criteria are presented in Table 9. Since this criterion is composed of 4 indicators, 6 paired comparisons have been made.

According to the obtained Eigenvector:

- The sub-criterion of “formal procedures and systems influencing the processes of new products/services development, encourage employees to seek new knowledge regardless of organizational structure.” is in the first priority with a normalized weight of 0.350.
- The sub-criterion of “Managers welcome new offers and creativity from employees of new

product and process teams”, with a normalized weight of 0.315 is in the second priority.

- The sub-criterion of “formal procedures and systems influencing the processes of new products/services development are considered to enhance team behavior rather than individual behavior”, with a normalized weight of 0.216 is in the third priority.
- The sub-criterion of “formal procedures and systems influencing the processes of new products/services development are designed to help exchange knowledge with administrative boundaries.” is in the fourth priority with a normalized weight of 0.119.

The inconsistency rate of the comparisons is 0.707, which is less than 0.1, and therefore the comparisons accuracy was confirmed.

Determining the priority of the Cleaner production (CP) sub-criteria

The calculations performed to determine the priority of cleaner production sub-criteria are presented in Table 10. Since this criterion is composed of 4 indicators, therefore, 6 paired comparisons have been made.

Table 9: Determining the priority of Knowledge Management sub-criteria

	KM1	KM2	KM3	KM4	Geometric mean	Eigenvector
KM1	1	0.671	2.488	2.094	1.367	0.315
KM2	1.491	1	3.975	0.899	1.515	0.350
KM3	0.402	0.252	1	0.695	0.515	0.119
KM4	0.478	1.125	1.439	1	0.938	0.216

Table 10: Determining the Priority of Cleaner production sub-criteria

	CP1	CP2	CP3	CP4	Geometric mean	Eigenvector
CP1	1	1.632	4.048	2.865	2.091	0.452
CP2	0.613	1	3.284	1.551	11.329	0.287
CP3	0.245	0.305	1	2.458	0.654	0.142
CP4	0.349	0.645	0.407	1	0.550	0.119

Table 11: Determining the priority of sustainable Competitive Advantage sub-criteria

	SCA1	SCA2	SCA3	SCA4	SCA5	Geometric mean	Eigenvector
SCA1	1	0.646	0.820	2.443	2.763	1.290	0.234
SCA2	1.547	1	1.025	2.285	3.169	1.629	0.296
SCA3	1.220	0.976	1	1.457	2.685	1.360	0.247
SCA4	0.409	0.438	0.686	1	2.514	0.719	0.143
SCA5	0.362	0.316	0.373	0.398	1	0.719	0.080

According to the obtained Eigenvector:

- The sub-criterion of “CP measures caused decrease the use of raw materials, water, or electricity in organizational processes.” is in the first priority with a normalized weight of 0.452.
- The sub-criterion of “CP operations improve the production/service provision process “, with a normalized weight of 0.287 is in the second priority.
- The sub-criterion of “The Company encourages its staff to propose new ways for CP and sustainable innovations.” is in the third priority with a normalized weight of 0.142.
- The sub-criterion of “Use of CP measures leads to products/services of higher quality than competitors”, with a normalized weight of 0.119 is in the last priority.

The inconsistency rate of the comparisons is 0.707, which is less than 0.1, and therefore the comparisons accuracy was confirmed.

Determining the priority of Sustainable Competitive Advantage (SCA) sub-criteria

The calculations performed to determine the priority of the sustained competitive advantage sub-criteria are presented in [Table 11](#). Because this criterion is composed of 5 indicators, 10 paired comparisons have been made.

According to the obtained Eigenvector:

- The sub-criterion of “our operating procurement costs is less than our competitors during production/service delivery”, with a normalized weight of 0.296 is in the first priority.
- The sub-criterion of “our profit from new products/services is much better compared to our competitors”, with a normalized weight of 0.247 is in the second priority.
- The sub-criterion of “Our income from new products/services is superior to our competitors”, is in the third priority with a normalized weight of 0.234.
- The sub-criterion of “Our new products/services include sustainable environmental knowledge and concepts”, is in the fourth priority with a normalized weight of 0.143.
- The sub-criterion of “Our new products/services are produced with respect for entrepreneurship

social responsibility guidelines”, with the normal weight of 0.080 is in the last priority.

The inconsistency rate of the comparisons is 0.052, which is less than 0.1 and therefore, the comparisons accuracy was confirmed.

CONCLUSION

Regardless of the economic sector in which they operate, companies have a key task of promoting sustainable development in their region. Since companies’ environmental actions determine the direct effects of environmental sustainability, hence, small and medium producers, like other companies, are responsible for reducing the natural resources use and nuclear materials, and also the systematic increase of emissions of pollutants and waste. Therefore, there is a need to use strategic guides before using cleaner production, which led companies to achieve a sustainable competitive edge ahead of their competitors. The results of the tests show that Knowledge Management (KM) has the greatest impact on the cleaner production (CP). Therefore, it is very important for companies to create formal promotion and management structures. In this regard, the knowledge created by the organization is a tool to wise use of resources and to develop competitive innovations in business as well as environmental, economic and social sustainability. Companies use cleaner production to benefit from a set of strategic guidelines, resulting in significant developmental improvements that produce a sustainable competitive advantage in comparison with competitors. New results from this research include: “What effect do regional economic factors have on the relationship between constructs? What are the company’s main measures? Using research to determine market demands and meet them by sustainable ways; what are CP measures that companies use to create sustainable competitive advantage?” Such questions can help understand the dynamics between them. These constructs have been investigated and so managers can emphasize the measures that maximize CP utilization and cause improved organizational performance. The results of this research are consistent with [Hemmat and Ghorbani \(2017\)](#). They also stated in their research that entrepreneurship has a positive impact on competitive advantage and can therefore improve

their competitive advantage. The results are also consistent with Fakhri Abadi and Baqai (2017) in emphasizing the emergence of new concepts including cleaner technology, sustainability, green consumerism, and competitive advantage in the green environmental marketing era. They also found that cleaner production lead to competitive advantage. Since the existing knowledge base is somewhat fragmented, it has been difficult to investigate this subject. As the term cleaner production is widely used in popular publications, SMEs can claim to use cleaner production in a variety of ways. Different values are also assigned to cleaner production in a competitive strategy. Therefore, it seems that the existing knowledge of manufacturing operations is insufficient at this level to cover the rapid growth of this field, and many SMEs are still lagging behind in taking advantage of these new opportunities.

Also according to the findings, small and medium manufacturing companies are recommended to apply the following items:

1. Identifying and implementing formal procedures and systems affecting the processes of new products/services development.
2. Managers are advised to welcome the suggestions and creativity of their employees.
3. Companies should focus on R&D activities, technology leadership and innovation in processes and products/services.
4. Creating a cultural unit within companies that consistently provides customers with higher values.

AUTHOR CONTRIBUTIONS

Y. Vakil Alroaia performed conceptualization, methodology, software, and literature review and manuscript preparation. R. Tayyebirad and Y. Vakil Alroaia performed data correction, writing original draft preparation, writing reviewing and editing references.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the SME's for their contribution to this study. Also, authors would like to thank the anonymous reviewers for their useful comments, which helped to improve the study significantly.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATION

CP	Cleaner production
SCA	Sustainable Competitive Advantage
EO	Entrepreneurial Orientation
MO	Marketing Orientation
KM	knowledge Management
CP	Cleaner production

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HOW TO CITE THIS ARTICLE

Tayyebirad, R.; Vakil Alroaia, Y., (2020). Analysis of factors affecting entrepreneurship, market, knowledge management in clean production and sustainable competitive advantage. *Int. J. Hum. Capital Urban Manage.*, 5(4): 291-304.

DOI: [10.22034/IJHCUM.2020.04.02](https://doi.org/10.22034/IJHCUM.2020.04.02)

url: http://www.ijhcum.net/article_43172.html



ORIGINAL RESEARCH PAPER

The impact of climate change on economic growth based on time series evidence, 1969-2016

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ARTICLE INFO

Article History:

Received 09 June 2020

Revised 10 August 2020

Accepted 14 August 2020

Keywords:

Climate Change

Stationarity

The Gambia

Vector Autocorrection

Vector Error Correction

ABSTRACT

BACKGROUND AND OBJECTIVES: Climate change is one of the existential threats of modern times, which deserves urgent attention by policymakers. The objective of this paper is to comprehend the impact of climate change on the Gambian economy both in the short and long-run.

METHODS: This paper analyses time series data from 1969 to 2016. The study incorporated rainfall and temperature as proxies of climate change into the Cobb-Douglas production function. The Augmented Dickey-Fuller and the Phillips-Perron stationarity test for unit root found that the growth rate of rainfall is not statistically significant with the Mackinnon approximate p-value for $z(t) = 0.2306$. The first lag is significant at 5% and 10% but has a negative coefficient in the first differential up to the fourth lag. In contrast, the growth rate of temperature is statistically significant with a p-value of 0.0196.

FINDINGS: The findings revealed that human capital growth is not significantly related to economic growth in The Gambia. In the long-run, the growth rates of climate change variables are all statistically significant and associated with a negative impact on economic growth. For the short-run, the lag difference of rainfall against its own lag is statistically significant and has a positive impact on economic growth. The lag difference in the growth rate of the Gross Domestic Product is not statistically significantly related to the growth rate of rainfall.

CONCLUSION: The Gambia is vulnerable to climate change shocks, consequently climate change will negatively impact economic growth resulting in high unemployment, low productivity, and high poverty rate.

DOI: 10.22034/IJHCUM.2020.04.03

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NUMBER OF REFERENCES

36



NUMBER OF FIGURES

3



NUMBER OF TABLES

11

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

Climate change is one of the greatest threats confronting humankind, which poses enormous challenges for human welfare and development. The scourge of climate change has resulted in the deterioration of economies, ecologies and standard of living globally. The Gambia, being one of the countries that is both economically and environmentally fragile, necessitated this study which assesses the impact of climate change on economic growth. Numerous factors trigger weather and climate variation as highlighted in the literature. Africa is becoming one of the fastest warming continents with several days being warmer. This phenomenon will result in the decline in crop yields; by 2020 to 2100 yield will reduce from 50% to 90% respectively, thus affecting Africa's food security by the end of the century (Wiebelt, 2011). Sub-Saharan Africa (SSA) has witnessed a rapid growth in average yearly temperature compared with the global average of 0.6°C-0.7°C over the period 1951 to 2010; out of the 30 countries sampled 20 countries in SSA have mean temperature above the global average. The Gambia's observed surface temperature change averages 1°C, thus a warmer atmosphere in SSA will affect the lives and livelihoods of the region's dwellers (Brahmbhatt et al., 2016). File and Derbile, (2020), buttress that the current generation in Ghana are more exposed to higher temperatures and stronger sunshine which have an impact on smallholder farmers thus affecting the livelihoods of inhabitants. This scenario is not farfetched since it reflects the Gambian situation. There is empirical evidence in Africa that shows an inverse relationship between temperature and economic growth, and hence a 1°C increase in temperature in Africa reduces Gross Domestic Product (GDP) in the continent by over 0.5%. Numerous studies project that Africa will be warmer over time and hence economies in Africa are expected to contract (Abidoye and Odusola, 2015). Abeygunawardena et al., (2016) forecast that climate change will negatively impact the entire economies of poor countries causing a decline in growth. This situation will be further exacerbated by inappropriate adaptation techniques, thus diverting funds needed for development to combating climate change. Alehile (2018) found that in Nigeria temperature has an indirect relationship with GDP both in the short-run and long-run, whereas precipitation in the short-run has direct relationship

GDP but in the long-run the relationship is inverse. Hence climate variables of temperature and rainfall may have differing relationships with economic performance in the short-run and long-run. In Ivory Coast N'Zué (2018) elucidates that climate change has no significant effect on economic performance, thus buttressing that precipitation effect on crop yields is both significant and positive; ultimately agriculture value-added contribution to GDP is also significant and positive. This means that Ivory Coast, from the aforementioned studies, has no significant economic vulnerability as a result of climate change. However, that is not the case for other countries in SSA. In a related study of 43 African countries shows that rainfall is closely correlated with GDP per capita; hence the study countries will economically benefit from an increase in rainfall (Olanrewaju, 2019). In Pakistan temperature has a significant effect on economic growth both in the short-run and long-run whereas rainfall has a positive but insignificant effect on growth in the short-run (Ali et al., 2019). In Malaysia there exists no short-run relation between climate variables and growth (Rahim and Puay, 2017), it could be observed there are variations on the impact of climate variables on GDP from various countries. There exist widely held belief that adaptation practices are the best mechanism of alleviating the negative effects of climate change on farmers, thus providing farmers with food and income security to ameliorate the costs (social and economic) of climate change (Marie et al., 2020). The adaptation cost of climate change in West Africa, given a conservative estimate of low-warming and high-warming scenarios, will be approximately 0.3% and 0.4% respectively of Gross Regional Product (GRP) (Baarch et al., 2017). (Qaisrani, 2015), human capital (education and health) is affected by climate change where climate change is considered among the factors responsible for the spread and aggravation of some diseases. It also triggers water-borne diseases (diarrhea), vector-borne diseases (malaria and dengue), heat stress and malnutrition. Education is seen as a catalyst that strengthens social networks which may be crucial in times of environmental risks. Education alleviates people from environmental danger since the educated earn higher incomes, have better access to information and enjoy an improved standard of living. Numerous other studies enumerated the negative impact of climate

change on Africa's agricultural production and food security; they include but not limited to the following studies (Ngaira, 2007; Ayanlade and Ojebisi, 2019; McCarl *et al.*, 2016; Masipa, 2017; Berhe and Kidanu, 2020). Awojobi and Jonathan (2017) expound that climate change in Africa is not fallacious; thus provide tangible evidence of the havoc that climate events are causing to the environment and the livelihood for the continent dwellers.

The study was conducted in The Gambia in 2019.

MATERIALS AND METHODS

Geographical background of The Gambia

The Gambia is the smallest country in mainland Africa, with a total landmass of 10,120km² and water area of 1,180 km². It is surrounded on the north, east and south by Senegal and on the west side by the Atlantic Ocean. The country is divided into north and south banks by the River Gambia (Forde *et al.*, 2019). The Gambia Bureau of Statistics (GBOS, 2013), population and housing census 2013 estimated the country's population at 1.8 million with an average growth rate of 3.3% per annum, thus making the country one of the most populous countries in SSA, given its meagre resources and high poverty rate. The topography of The Gambia is predominately characterized by dissected plateaus with sandy hills, sandstone plateaus and valleys. According to Jaiteh

and Sarr (2011), the natural flora of the plateau areas is altered and utilized for the cultivation of crops, dwellings and collection of firewood fuel. The paper stresses that the plateau terrain is the epicenter for groundnut (The Gambia's main cash crop) production and coarse-grain (sorghum and millet) cultivation. This topography is useful for both agriculture and human habitation purposes; however, it is still vulnerable to the effects of climate variability thus the need to conserve and preserve its vital function for human survival. The paper further explains that the valley areas are found alongside the River Gambia, and are prone to seasonal flooding, making the soil poorly drained with high salinity content where only mangroves can thrive. Finally, they paper note that the sandstone plateau is mostly unfit for cultivation. The limited arable land of sandstone plateau is used for the cultivation of groundnuts. The looming climate change challenge will pose further constraints on arable land availability for food production, human dwelling and animal grazing. The Food and Agriculture Organization (FAO, 2017) buttresses that the future temperature and precipitation for The Gambia will change by 2030. (Fig. 1) shows projected changes (increase) in annual average temperature across the length and breadth of The Gambia, with Banjul registering a +1.5°C increase and the Upper River Region registering +2°C during the period

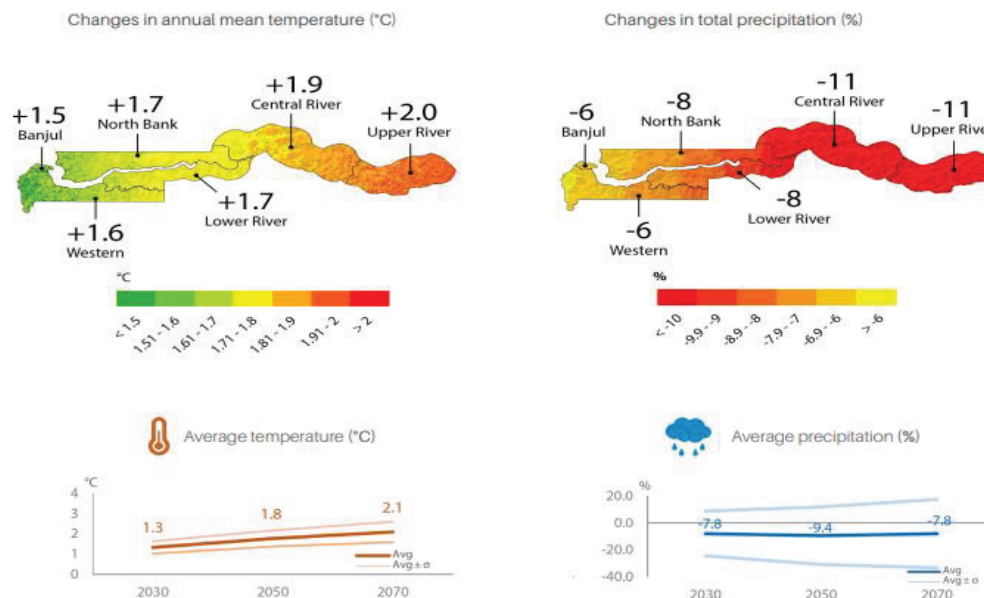


Fig. 1: Projected Changes in Temperature and Precipitation in The Gambia (FAO, 2017)

2030 to 2070. (Fig. 1) also shows projected changes (decrease) in total percentage precipitation across The Gambia with Banjul registering a -6% decrease and the Upper River Region registering -11% during the period 2030 to 2070. These projections are a real threat to agriculture and food security in the country in the future, thus illustrating the imminent dangers of climate change on human livelihoods.

The Gambian economy

The Gambian economy in 2018 showed signs of recovery following a sluggish performance in 2016 as a result of both internal (political impasse) and external (Ebola outbreak in some countries in West Africa) shocks. Real GDP estimates for 2018 were 5.4% up from 3.5% in 2017. This growth was mainly driven by the services sector – tourism, trade and financial services and insurance. The fiscal deficit was slightly under control in 2018 - about 3.9% of GDP from 7.9% of GDP. Inflation decreased to an estimated 6.2% in 2018 from 8% in 2017 (ADB, 2019). Despite these modest macroeconomic gains, poverty, economic inequality and deprivation continue to be a challenge for The Gambia. According to The World Bank (WB, 2018), the most recent poverty study conducted in 2015/16 shows that the population living in poverty, based on the national poverty line, remained almost constant at about 47% to 48% from 2010 to 2015. The study shows that poverty in The Gambia is more pronounced in the rural communities. For the period

reviewed rural poverty increased from 64.2% to 69.5% whilst urban poverty declined from 33.4% to 31.6%. From 2010 to 2015 extreme poverty increased by 17%. These facts are a manifestation of the severity of poverty in the country, which continues to be plagued with a high unemployment rate (50%) whilst youth unemployment is at a staggering 62%. 55% of the population in 2015 found it difficult or impossible to meet their daily required minimum calories of 2,400. These statistics could possibly aggravate the already dire situation if the country continues to experience erratic rainfall due to climate change. It is paramount that a small impoverished country like The Gambia understands the serious consequences of climate and weather variability on its future economic growth which is one of the motives for the study.

Other issues of climate change in The Gambia

Sea-level rise

(Serdeczny *et al.*, 2016), study three cities in West Africa (Abidjan, Lomé, Lagos) and one city in Southeast Africa (Maputo), predicted that those cities will experience sea-level rise between 0.4 meters and 1.15 meters in a 4°C temperature increase world, and with a median rise of 0.65 meters. In a 2°C temperature increase world, sea-level rise is expected to be consistently lower, with a range of 0.2 to 0.7 meters and a median rise of 0.4 metres. The study is relevant in predicting how changes in temperature will impact on sea-level rise; is apt because a good

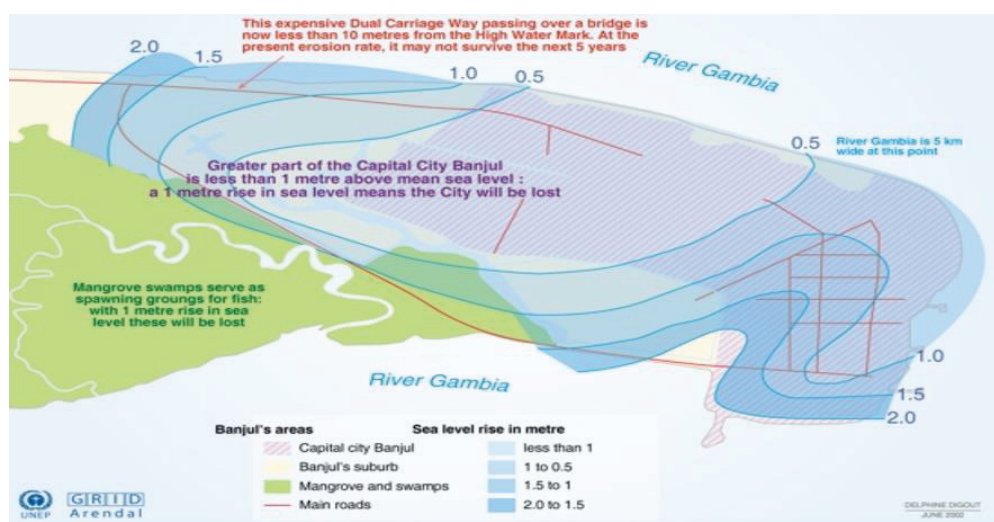


Fig. 2: Impact of Sea-level Rise in Banjul, The Gambia (UN Environment, 2019)

number of West African cities are located at the coastline of the Atlantic Ocean. A rise in sea-level without adaptation techniques will render some coastal cities and towns vulnerable, making them inhabitable in the long term. Banjul, the capital city of The Gambia, is not an exception. (Fig. 2) shows the expected sea-level rise in meters for various parts of the city of Banjul, and the impact of sea-level rise on the city, most parts of which are less than 1 metre above sea-level. Therefore, a meter sea-level rise will result in the loss of Banjul and its suburbs. The only highway that links Banjul to other important towns will also be destroyed. Nearby mangrove swamps, which serve as spawning grounds for fish and other aquatic animals, will also be seriously affected (UN Environment, 2019).

Carbon emission

Loum and Fogarassy (2015) stress that carbon-dioxide (CO₂) is an essential element for plant development and also has a direct effect on crop productivity. At the same time, it serves as the catalyst for all climate change-related activities. There is strong evidence that the agriculture sector in The Gambia as a whole is vulnerable to climate change challenges. The paper scrutinizes historical data from 1960 to 2013 on climate change and crop production (maize and millet) which provided ample evidence that the effect of climate change on crop production in The Gambia could affect the food chain system which will have a multiplier effect on socio-economic development. Given the foregoing, it is important that effective measures are instituted to mitigate and combat the negative impact of carbon emission into the country's natural environment which has far-reaching consequences despite The Gambia being a relatively low carbon emitter. (Camara, 2013) points out that over 80% of The Gambia's estimated domestic energy is from biomass (fuel wood), emitting CO₂ into the atmosphere during daily domestic food preparation. This report goes on to explain that the use of alternative energy like solar and wind could minimize CO₂ emission into the atmosphere. The blueprint notes that efforts have been made to encourage Gambians to use efficient cooking stoves in order to conserve energy. In recent times the report points out that the country introduced a new biogas technology to replace fuel wood in some rural settlements. Such technology introduction in

the rural and semi-urban settlements is vital to curb CO₂ emissions, given that an overwhelming number of inhabitants of The Gambia use fuel wood to prepare their daily meals.

Economic impact of climate change

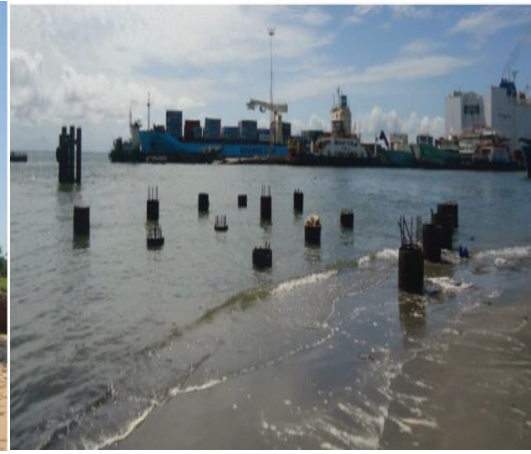
(Amuzu *et al.*, 2018), in a study on the socio-economic impact of climate change on the coastal zone of The Gambia point out that by the end of this century, given a scenario of a 1 metre sea-level rise, total land to be lost due to inundation will be 12.46 km² (1,246 ha) with an equivalent economic cost of US \$788 million (GMD 37 billion) along the coastal zone of the country. According to the study, the land loss along the coastline of The Gambia will be due to coastal erosion, forecast to be annually approximately 6 meters. Such a situation will result in a number of inhabitants (15,560 persons per km²) exposed to the risk of flooding and erosion. The study stresses that from Bald Cape to Solifor Point had the greatest area of land, 2.79 km² to be lost under scenario 1 metre sea-level rise, which is forecast to result in an economic loss of US \$176.4 million. (Fig. 3) is an illustration of some of the economic damage/losses due to erosion. It is evident from this study that a poor resource constraint and an underdeveloped country like The Gambia does not possess the wherewithal of combating climate change due to the fact that the economic impact of climate change is colossal. Funds that will be used to combat climate change and its impact could be used for much-needed social services and infrastructure development, hence the need for maximum precautionary measures to avert such expenditure.

Weak institutional and environmental regulatory framework

The Gambia's National Development Plan (NDP) 2018-2021 highlights the difficulties hindering sustainable environmental management, which is a consequence of poor institutional and regulatory frameworks coupled with the weak enforcement of current environmental legislation. The government blueprint buttresses the major factors affecting the environment: land degradation, coastal erosion, deforestation, biodiversity loss, ineffective waste and pesticide management. The development plan posits that deforestation through illegal logging and bushfires, sand mining, illegal settlements and other



(i) Old Wharf at the Banjul Port



(ii) Old Wharf at the Banjul Port



(iii) A Structure at Risk Due to Coastal Erosion



(iv) A Structure at Risk Due to Coastal Erosion



(v) Coastal Erosion along Kololi



(vi) Eroding Cliffs along the Coastline

Fig. 3: Some Images of Economic Damages/Loses Due to Erosion and Sea Level Rise (Amuzu et al., 2018)

uncontrolled activities are the contributing factors of environmental degradation in the circumstances already made precarious by climate change. Hence the blueprint reiterates that the government will assess the NEMA Act, 1994 and strengthen the institutional and regulatory frameworks (Republic of The Gambia, 2018). Finally, the Republic of The Gambia, (2018) notes that “the impact of climate change has emerged as one of the most significant external factors hindering the performance of the growth-driving sectors, especially agriculture, tourism and industry, which have the greatest impact on the economy”, hence the motivation for undertaking this study to analyse the impact of climate change on the economic growth of The Gambia in the short and long run. The finding will provide insightful information for policymakers and academics to understand The Gambian economy in light of the imminent threat of climate change.

Theoretical model

The paper adopts the theoretical concept of the production function by including climate variables into it as used by (Dell et al., 2008; Bond et al., 2010). Hence the growth accounting equation offers guidance for the decomposition of the impact of climate change on economic growth as derived below:

$$Y_{it} = e^{\alpha T_{it}} A_{it} L_{it} K_{it} \tag{1}$$

$$\frac{\Delta A_{it}}{A_{it}} = g_i + \beta T_{it} \tag{2}$$

Y is real GDP, L is labour force/population, A is technology and can also be referred to as labour productivity, K is human capital, T is the impact of climate, g is the growth rate of capital, t is time period and e is a constant. Eq. 1 captures the direct effects of climate on economic growth, e.g. the effects on

labour productivity and Eq. 2 captures the indirect (dynamic) effects of climate, e.g. the effects of climate on other variables that indirectly impact on the GDP. Introducing logarithm into Eq. 1 and differentiating with respect to time, as derived Eq. 3:

$$g_{it} = g_i + (\alpha + \beta)T_{it} - \alpha T_{it-1} \tag{3}$$

g_{it} is the growth rate of output, direct effects of climate change on economic growth are accounted for by α and indirect effects are accounted for by β and finally, g_i is the fixed effects.

Data and data source

The data generated for this study were from the (WB, 2019), World Development Indicator (WDI). The period covered 1969 to 2016. The variables of interest are GDP growth rate, human capital, population density, temperature and rainfall as indicated in Table 1.

Economic model

Economic theory explains the behavior of one or more variables, say $Y_1, Y_2, Y_3, \dots, Y_n$ as a function of some other variables, say $X_1, X_2, X_3, \dots, X_m$ which are determined outside the model or which are exogenous in nature. Thus considering the following model: GDP growth as a function of population growth, climate change variables and human capita $Y = F(POP, CLM, HC)$, in which POP is population density, CLM is climate change variables, i.e. rainfall and temperature and HC is human capital.

Econometric model

The econometric model can be expressed thus:

$$Y = f(X_1, X_2, X_3, \dots, X_k; \beta) + \varepsilon \tag{4}$$

β is a vector of unknown parameters and ε is the error term. The nature and the interpretation of

Table 1: Data and data sources

Name of Variable	Source	Comment
GDP Current(US\$)	WDI	Current GDP US \$
Human Capital	WDI	Secondary Enrolment
Rainfall	WB	Total Average Rainfall
Temperature	WB	Total Average Temperature
Population Density	WDI	Population Density

WDI= World Development Indicator

Eq. 4 depend on the assumption of the error term in the model. Therefore, (Eq. 5)

$$Y = \beta_0 + \beta_1 POP + \beta_2 HC + T\beta_3 + RF\beta_4 + \varepsilon \quad (5)$$

For this study of the impact of climate change on economic growth, secondary data was used. It is difficult to identify the economic linkages to climate change unless the use of sector performance variables like the agriculture, manufacturing and services sectors. Climate change variables like rainfall, temperature, marine resources, biodiversity, risk management, pollution, land degradation, deforestation, erosion, CO₂ emission affect the human ecosystem which in turn affects the economic growth of the country. In The Gambia, each of the aforesaid sectors is potentially affected by the interruption of climate change.

Time series analysis

Econometricians developed economic theory but no serious attempts are made to study the structure of the data. On the other hand, the time series analysis tried to allow the data to be modelled based on time intervals and to see whether the series is stationary at a certain point in time. According to Maddala (1992), the time series analysis is divided into two, i.e. frequency and time domain. This study uses time domain of time series analysis expressed as X_t .

Model specification

Research on the impact of climate change on economic growth is imperative, given the threat posed by climate change. However, limited research has focused on the subject matter in developing countries in recent times (Mendelsohn and Dinar, 1999). No study on the subject matter was done in The Gambia incorporating various economic models on climate change variables, hence the rationale for this study. The paper adopted the Solow and Romer model of production so as to determine the effect of climate change on growth in Real GDP. The focus is on output, capital, labour and the available technology. These factors of production combined to produce an output. The time series modelling of the variables is by lagged structure, the relationship between the series past, present and future values of y_t . The method involve is to fit the model as the

Autocorrelation, Autoregressive Moving Average (ARMA), and Autoregressive Integrated Moving Average (ARIMA). Time series explains how current values depend on past values and their effect on future values of y_t . Hence, the data used was time series which applied unit roots and co-integration testing in order to estimate the long-run and short-run relationship. The unit root tests for the models used were the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test, and apply co-integration test like, the Error Correction Model (ECM), the Vector Error Correction Model (VECM) and the Vector Autoregressive Model (VAR).

Unit root test

Co-integration test between the variables is stated in Eq. 6:

$$\hat{y} = \hat{\alpha} + \hat{\tau} + \hat{\beta}x_t \quad (6)$$

The Dickey Fuller (DF) test for the residual $\hat{\varepsilon}_t$ is stated as:

$$\Delta Z_t = c + \beta Z_{t-1} + \sum_{i=1}^T \phi_i \Delta X_{t-1} + \varepsilon_t \quad (7)$$

Symbol Δ in Eq. 7 is the first difference, which is always stationary, T is the optimal lagged structure for the model, ϕ_i is time-dependent, β is the rate of change of Z_{t-1} , c is the constant-coefficient and ε_t is the residual for ADF test at time t. The hypothesis testing for the unit root is that $H_0 : \beta = 0$ vs. $H_1 : \beta \neq 0$. The condition for the stationarity process is that the coefficient β is statistically significant, the hypothesis that Z_t contains unit root is not rejected and the alternative is rejected. To conduct the co-integration test in multivariate analysis the study used Johansen co-integration with maximum lag length structure. By considering K lags, a general VAR (K) model is formulated as shown in Eq. 8:

$$Y_t = c + A_t \sum_{i=1}^K Y_i + U + \phi D_t + \varepsilon_t \quad (8)$$

$Y_t = a_n$ n by 1 vector I (1) process

A_t , t=1... k is n by n vectors

U Is a constant term

D represents vector dummies

ε Is a vector of normally distributed, iid with mean zero and variance square i.e. (0.1).

Simulating using VECM and ECM to capture the

relationship between and among variables, the VECM is use as shown in Eq. 9:

$$\Delta Y_t = \omega Y_{t-1} + \theta_t \sum_{i=1}^K \Delta Y_t + U_t + \varphi D_t + \varepsilon_t \quad (9)$$

The long-run relationship is captured by the term ωY_{t-1} and θ_t is the short-run coefficient of shocks on ΔY_t . Which yields Eq. 10 below:

$$\omega = -(1 - \varepsilon A_i) \text{ and } \theta_t = -(1 - \varepsilon A_j) \quad (10)$$

RESULTS AND DISCUSSION

Descriptive statistics

Table 2 contains descriptive statistics results. The descriptive statistics indicated that there are period gaps in the human capital data, hence the limited observations for human capital compared with other variables. The study logarithmized the variables to interpret them as a rate of change. The descriptive statistics contains the means and the standard deviations of the variables used in the study. The growth rate of GDP has the highest mean (19.733) and the highest standard deviation (0.985). This is the result of the spread of the data on the GDP; hence it has the highest volatility. The growth rate of human capital has the lowest mean (2.843); this is due to its limited number of observations compared with the other variables. However, it possesses the second-highest standard deviation (0.489). The variables

with less volatility are the growth rate of temperature followed by the growth rate of rainfall as indicated by their standard deviation results of 0.017 and 0.161 respectively.

Correlation

The correlation results illustrate the nature of the relationship that exists between the variables under study as shown in Table 3. The growth rate of population in The Gambia has a negative correlation with the growth rate of the GDP (-0.0092). This result was surprising, given the expectation that population growth will lead to the growth of GDP due to innovation and the discovery of new technology by the population. However, population density growth causes the GDP to increase drastically by approximately 93%. The growth rate of human capital has a strong positive relationship (83%) with the growth rate of the GDP. In the case of a change in temperature, an increase in temperature causes the GDP to increase approximately by 72% whilst an increase in rainfall leads to an increase in the GDP by approximately 19%. Hence the growth rate of temperature has a stronger degree of influence on the growth of the GDP than changes in rainfall in The Gambia.

Time series test

The data used in the model is time-series data.

Table 2: Descriptive statistics

Variables	Observation	Mean	Standard Deviation
LnGdp	48	19.73355	0.9853304
LnH	29	2.843349	0.4892193
LnTM	48	3.320104	0.0176179
LnRF	48	4.365117	0.1619504
LnPden	48	4.592953	0.4803583

LnGdp =Growth rate of GDP; LnH= Growth rate of human capital;
 LnTM= Growth rate of temperature; LnRF = Growth rate of rainfall;
 LnPden=Growth rate of population density

Table 3: Correlation of Variables

Variables	LnGdp	LnH	LnTM	LnRF	LnPden
LnGdp	-	-	-	-	-
LnH	0.8332	0.7612	-	-	-
LnTM	0.7276	0.7143	-	-0.17	-
LnRF	0.1934	0.3013	-0.1718	-	-
LnPden	0.9332	0.9488	0.7565	0.2924	-
Population growth (Annual)	-0.0092	-0.0785	0.0318	0.0165	0.0529

Computation using Stata 13

Preliminary tests were conducted before proceeding to conduct further estimation techniques. The tests include unit root tests of ADF and PP test and cointegration testing. In order to test the long-run and short-run dynamics relationship between the variables, VECM (Vector Error Correction Modelling) and VAR (Vector Auto regression) modelling were applied.

ADF test for unit root

Table 4 indicates the ADF test results for unit root test showing both the trend and constant have a positive slope and both are stationary at 5%. The results show that the lag of GDP is negative, but the mean, variance and covariance are stationary; however, its coefficient is positive for the lag of the first differential of the GDP. The results for the first

differential are not statistically significant at 5% with stationarity at the lag length of four. For the growth rate of rainfall in Table 5 is not statistically significant for the Mackinnon approximate p-value for $z(t) = 0.2306$. The first lag is significant at 5% and 10% but has a negative coefficient in the first differential up to the fourth lag. In contrast, the growth rate of temperature in Table 6 is statistically significant at a p-value of 0.0196. Human capital growth is not statistically significant in The Gambia according to the time series analysis.

Phillips-Perron test for unit root

The Phillips-Perron test for unit root is to modify the ADF by correcting any serial correlation, heteroskedasticity in the error term and in order to make robust the serial correlation, heteroskedasticity

Table 4: The ADF stationary test for the natural logarithm of GDP with trend and constant in The Gambia

Variables	Coef.	t-statistics	ADF/P-value	Results	Lag Length
Lag1(LnGdp)	-0.2388017	-2.57	0.014**	Stationary	4
1 st Differential	0.0760815	0.50	0.623	Not Stationary	4
2 nd Differential	0.1643747	1.06	0.294	Not Stationary	4
3 rd Differential	0.187936	1.20	0.240	Not Stationary	4
4 th Differential	0.0571842	0.33	0.741	Not Stationary	4
Trend	0.0133028	2.12	0.041**	Stationary	4
Constant	4.435275	2.64	0.012**	Stationary	4

Computation using Stata 13; * p=0.10; ** p=0.05; *** p=0.01

Table 5: The ADF stationary test for natural logarithm of rainfall with trend and constant in The Gambia

Variables	Coef.	t-statistics	ADF/P-value	Results	Lag Length
Lag1(LnRF)	-1.041604	-2.71	0.010**	Stationary	4
1 st Differential	0.1147444	0.34	0.735	Not Stationary	4
2 nd Differential	-0.017909	-0.07	0.948	Not Stationary	4
3 rd Differential	-0.0690262	-0.3	0.754	Not Stationary	4
4 th Differential	-0.0673283	-0.44	0.663	Not Stationary	4
Trend	0.0038512	1.59	0.120	Not Stationary	4
Constant	4.449262	2.72	0.010**	Stationary	4

Computation from Stata 13; * p=0.10; ** p=0.05; *** p=0.01

Table 6: The ADF stationary test for natural logarithm of temperature with trend and constant in The Gambia

Variables	Coef.	t-statistics	ADF/P-value	Results	Lag Length
Lag1(LnTM)	-1.266052	-3.74	0.001***	Stationary	4
1 st Differences	0.2800077	0.92	0.362	Not Stationary	4
2 nd Differences	0.2823839	1.07	0.290	Not Stationary	4
3 rd Differences	0.2277942	1.18	0.246	Not Stationary	4
4 th Differences	0.1991193	1.46	0.153	Not Stationary	4
Trend	0.001397	3.59	0.001***	Stationary	4
Constant	4.167695	3.75	0.001***	Stationary	4

Computation from Stata 13; * p=0.10; ** p=0.05; *** p=0.01

and autocorrelation consistent with the covariance matrix estimator. The results generated for both growth rate in rainfall and temperature show that all the coefficients and the intercepts are positively sloped and a lag of the growth rate of rainfall is not significant and the trend is significant at 5%, whilst the intercept is highly significant at 1% as indicted in Table 7. The Phillips- Perron test of change in temperature pattern in The Gambia is highly significant at a p-value of 0.0000; likewise the intercept, as shown in Table 8, human capital growth is not significant in The Gambia. This means a small country like The Gambia should invest in human capital to ameliorate the phenomenon of climate change.

Cointegration test

Applying the Varsoc to select the optimal lag length for the model, a maximum lag of 8 was selected. The exogenous variable is constant and the endogenous variables are LnGDP, LnRF, LnTM, Lnh, Lnpopdn, and the population growth rate. The cointegration equations were tested using Johansen tests for cointegration as shown in Table 9. Various kinds of tests were conducted for the selection of the maximum lag length for the model; the test

included the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC) and the Hannan-Quinn Information Criterion (HQIC). Based on the aforesaid selection method, lag 4 was used. In addition, the optimal lag structure for the model was used in order to identify the Johansen cointegration equation and ranking for the model. The Johansen tests for cointegration indicated that the rank of the cointegrating model is 3, as seen in Table 9. For the Log-likelihood model, it is observed that population growth annually is highly significant and has a negative coefficient. The growth rates of climate change variables, i.e. temperature and rainfall growth, are also statistically significant and associated with a negative coefficient, as indicated in Table 10. Hence in the long run these variables will be statistically significant. The implication of the foregoing is that population growth, and changes (increase) in rainfall and temperature will have a negative impact on the growth rate of the GDP in The Gambia. In the short-run dynamic model in Table 11, the lag difference of rainfall against its own lag is statistically significant and has a positive relationship on economic growth. Lag difference in the growth rate of the GDP is not statistically significant against the growth rate of

Table 7: The Phillips-Perron test for stationary for rainfall with trend and constant in The Gambia

Variables	Coef.	t-statistics	ADF/P-value	Results	Lag Length
Lag1(LnRF)	0.0470148	0.33	0.741	Not Stationary	4
Trend	0.0036722	2.18	0.034**	Stationary	4
Constant	4.065723	6.67	0.000***	Stationary	4

Computation from Stata 13; * p=0.10; ** p=0.05; *** p=0.01

Table 8: The Phillips-Perron test for stationary for temperature with trend and constant in The Gambia

Variables	Coef.	t-statistics	ADF/P-value	Results	Lag Length
Lag1(LnTM)	0.1043908	0.76	0.449	Not Stationary	4
Trend	0.0009184	5.29	0.000***	Stationary	4
Constant	2.951304	6.55	0.000***	Stationary	4

Computation from Stata 13; * p=0.10; ** p=0.05; *** p=0.01.

Table 9: Johansen tests for cointegration

Max Rank	Log-likelihood	Eigen value	Trace Statistic	5% Critical Value
0	401.06254	-	87.6582	47.21
1	419.91639	0.55945	49.9505	29.68
2	433.1465	0.43742	23.4903	15.41
3	444.23093	0.38241	1.3215*	3.76
4	444.89166	0.02832	-	-

Computation from Stata 13; *Indicates that this estimator has a triple rank (r=3) cointegration equation

Table 10: Johansen normalization (Long-run model)

Variables	Coefficient	Standard Error	T-Statistic	P-Value
LnGDP	1			
Ln _h				
LnTM	-41.62783	5.852506	-7.11	0.000***
LnRF	-6.39962	0.713533	-8.97	0.000***
Population growth (Annual)	-1.210737	0.1665041	-7.27	0.000***

Computation from Stata 13 * p=0.10; ** p=0.05; *** p=0.01

Table 11: Short-run Dynamic Model Results

Lag Dependent LD-LnGDP is the dependent variable				
Variables	Coefficient	Standard Error	T-Statistic	P-Value
Constant	-0.1105073	0.2244751	-0.49	0.623
LD.LnTM	1.004803	2.281878	0.44	0.660
LD.LnRF	0.0555166	0.1404195	0.40	0.693
LD.Ln _{pdn}	7.089166	5.030694	1.41	0.159

Computation from Stata 13 * p=0.10; ** p=0.05; *** p=0.01; LD=lager difference;
Ln*=Natural logarithm

rainfall. The lag differences of population density against lag differences in the growth rate of GDP are not statistically significant in The Gambia in the short run.

CONCLUSION

The study used time series analysis in order to determine the short-run and long-run dynamic relationship between economic growth and other variables of interest such as growth rate in rainfall, temperature and population growth in The Gambia. Economic growth is significantly decreased or increased by rainfall and temperature patterns in the country. From the result, population growth annually is highly significant and has a negative impact on economic growth. The growth rate of climate change variables, i.e. temperature and rainfall growth, are all statistically significant and associated with a negative coefficient; thus they both also have a negative impact on economic growth in The Gambia. In the long-run, these variables will all be statistically significant, but surprisingly they have negative impact on the growth rate of the GDP in The Gambia. In the short-run dynamic model, the lag difference of rainfall against its own lag is statistically significant and has a positive impact on economic growth. The consequences of climate change in The Gambia will negatively impact on economic growth resulting in high unemployment, low productivity, a decrease

in the standard of living, an increase in government spending, borrowing and deficit culminating in the high poverty rate in The Gambia. The novelty of this study, unlike other Gambia climate change papers, is the utilization of numerous empirical models to account for nuance not captured in the previous studies. We strongly recommend that: 1. Given the long-run negative relationship between economic growth and climate change variables, i.e. rainfall and temperature changes, policymakers should formulate efficient environmental policies that will mitigate the impact of climate change in The Gambia, thereby accelerating economic growth. 2. Owing to the long-run indirect relationship between population growth and GDP in The Gambia, the government should institute policies that will promote family planning to reduce population growth; consequently, this will reduce poverty, given the meagre resources of the country. 3. The Gambia, being prone to environmental and climate shocks, e.g. sea-level rise, erosion, and drought has to create public awareness on climate and environmental education in order to promote reforestation, biodiversity, conservation etc. to sustain economic growth.

AUTHOR CONTRIBUTIONS

C. Belford commenced the process by conceptualizing and formulating the research idea, followed by data collection and cleaning. He was

also extensively involved in reviewing the literature and preparing the manuscript. H. Delin reviewed and edited the final manuscript. E. Ceesay performed the data analysis, results interpretation and discussion. Y. Nasr Ahmed reviewed the analysed data and helped in the data interpretation. L. Sanyang and R. Happy Jonga did the proofreading and literature review.

ACKNOWLEDGMENTS

The authors of this paper wish to express their utmost appreciation to the Institute of Agricultural Economics and Development (IAED) at The Chinese Academy of Agricultural Sciences (CAAS), Beijing, China, for providing all the necessary materials and a conducive academic environment to undertake this research on the economic impact of climate change in The Gambia. The authors wish to also acknowledge the support and forbearance of their respective families.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

ABBREVIATIONS

<i>DF</i>	Dickey-Fuller
<i>ADF</i>	Augmented Dickey-Fuller
<i>AIC</i>	Akaike Information Criterion
<i>ARIMA</i>	Autoregressive Integrated Moving Average
<i>ARMA</i>	Autoregressive Moving Average
<i>BIC</i>	Bayesian Information Criterion
$^{\circ}\text{C}$	Degree Celsius
<i>CLM</i>	Climate Change Variables
<i>CO₂</i>	Carbon dioxide
<i>ECM</i>	Error Correction Model
<i>FAO</i>	Food and Agriculture Organization
<i>GBoS</i>	Gambia Bureau of Statistics
<i>GDP</i>	Gross Domestic Product
<i>GMD</i>	Gambian Dalasis

<i>GRP</i>	Gross Revenue Product
<i>HC</i>	Human Capital
<i>HQIC</i>	Hannan-Quinn Information Criterion
<i>NDP</i>	National Development Plan
<i>POP</i>	Population
<i>SSA</i>	Sub-Saharan Africa
<i>VAM</i>	Vector Autoregressive Model
<i>VECM</i>	Vector Error Correction Model
<i>WB</i>	World Bank
<i>WDI</i>	World Development Indicator

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HOW TO CITE THIS ARTICLE

Belford, C.; Delin, H.; Ceesay, E.; Ahmed, Y.N.; Sanyang, L.; Jonga, R.H.,(2020). *The impact of climate change on economic growth based on time series evidence, 1969-2016.*, *Int. J. Hum. Capital Urban Manage.*, 5(4): 305-318.

DOI: 10.22034/IJHCUM.2020.04.03

url: http://www.ijhcum.net/article_44279.html



ORIGINAL RESEARCH PAPER

Proposing a performance measurement framework for the Municipalities

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ARTICLE INFO

Article History:

Received 24 May 2020

Revised 25 July 2020

Accepted 14 August 2020

Keywords:

Balanced Scorecard (BSC)

Municipal Performance

Measurement

Public services

Process Improvement Plan

ABSTRACT

BACKGROUND AND OBJECTIVES: The main objective of this paper is to propose a performance measurement framework for Iranian municipalities as a public institution.

METHODS: By selecting Karaj Municipality and referring to Balanced Score-Card Methodology (BSC), an attempt has been made to provide a framework that can be used in public institutions as an efficient tool for measuring performance. The research used analytical methods and stand-alone questionnaire survey techniques, a case study approach by cross-sectional method. The research environment was the central municipality of Karaj and the relevant deputies. Content validity was used to determine the validity of the questionnaire. The reliability of the questionnaire was determined based on Cronbach's alpha. Also, the Balanced Score-Card framework is integrated with an Analytic Hierarchy Process (AHP).

FINDINGS: The results show that through the citizenship viewpoint, the satisfaction level of personal investors and makers is almost 7 times more important than citizens' satisfaction. The Municipality of Karaj pays more attention to the interests of the private sector than the public interests which comes from the municipality money making target. The improved implemented projects index was, through the internal processes of business, about 3 times more important than the number of new projects index. It seems more logical to focus on the process improvement plan and project management improvement. Completion of the current projects can increase the added value to Karaj municipality. Also proper performance of Information Technology (IT) unit shows the growing importance of e-government to improve the performance of municipalities and process improvement plan.

CONCLUSION: Finally, it seems a continuous process of such framework has the ability to bring together all key internal and external shareholders and rulemakings can be shaped during time and this process can be accepted by Iran's municipal management with methodologies that compare relative importance in performance criteria.

DOI: [10.22034/IJHCUM.2020.04.04](https://doi.org/10.22034/IJHCUM.2020.04.04)

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NUMBER OF REFERENCES

42



NUMBER OF FIGURES

2



NUMBER OF TABLES

9

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

The performance measurement system goals can be described under the performance management strategy. It will cause the development simplification, responding acceleration, and learning and innovation simplification, giving the initial alerts, generating a performance culture and making great decisions (Van Dooren et al., 2015). The reinventing government book by Osborne (1993), can be considered as one of the key stimulators in this domain. These systems have the ability to regulate the aims, assess them in organization management and responsibility, strategic planning, economic development evaluation, customer satisfactory and the municipal competitiveness (Van and et al., 2015). It can also be a great management tool for planning, monitoring and reviewing the performance criteria and assessment requirements of municipal services effects (Ammons and Rivenbark, 2008; Padovani et al., 2010). In the last 30 years, managerialization movements have regularly stressed the indispensability of the use of performance measures in the public sector, while underlining certain limits and peculiarities (Giacomini, 2020). McGill (1993, 1995) believes that a big difference could be found among the performance of profit organizations and non-profit organizations, during the performance assessment. The difference has been reported in Table 1.

According to Table 1, third part, the executive performance, is common for both profit and non-profit sectors, while the performance criterion, at first and second level, separates the public and private sectors (Van Dooren et al., 2015). At these two levels, public sectors must work to succeed in the particular projects and citizens' satisfaction and also overall performance of programs in relation to general social conditions; while in contrast to a financial organization, it has automatic special sales and profits feedbacks. Therefore, there are two different challenges in the measurement. First, as Self (1983) stated, it is easy to

state the executive paths and goals and then complete them without attention to the external environment. An external look raises the question of the consequences of this project and its distributional effects, usefulness and popularity in society. The second challenge is to go beyond financial and profit criteria (Julnes and Holzer, 2001; Rainey et al., 1976). As an example, the aforementioned challenges were happened in Malawi (McGill, 1995). The project of the development of the local government of the World Bank has considered the task of urban management as one of its components, which a part of that, was the Malawian City councils' improvement. The framework was developed in three parts. In order to evaluate the urban management performance, first step was performance development which related to organization and urban structure. What development should be initially planned and then be implemented? Executive operations that is a bridge between development by itself and the organizational ability to operate effectively and economically in the city, was the second step. And third step was impact performance that its objective was assessing the impact of work done on overall social indicators. This step suggests that the impact of performance is related to the cumulative outcomes of the development as well as the executive levels of organizational activity. Ideally, in this situation the impact of urban management processes on some social indicators should be evaluated (McGill, 1995). Kaplan and Norton (1995) developed a conceptual framework and performance measurement based on balanced scorecard (BSC) which included different dimensions of performance. They tried to propose a more complete methodological framework in organization performance assessment, considering the organization complexity, environment dynamics and market competitiveness (Kaplan and Norton, 1996b; Olson and Slater, 2002). Welcoming the adoption of performance management methods and control systems such as the BSC that has the capability to be used by both public

Table 1. Relation between performances of the profit and non-profit organizations

Executive Performance	Organization Performance	Review Level
Program Performance in Context of Social Conditions	Total Profit and Capital Growth	Level 1 3-5 years
Success in Major Projects and Citizenship Satisfaction	Success in Market and It's Profit	Level 2 1-3 years
Executive Efficiency, Budget Control, Staff Sprit and Project Management	Executive Efficiency, Budget Control and Production Management	Level 3 1-1.4 years

(McGill, 1993)

and private sectors, has been emphasized by many researchers (Sharma and Gadenne, 2011; Watson and Fisher, 2008). Although there is an abundance of literature on the BSC framework, there is a scarcity of literature on how this framework should be properly implemented in municipalities and community-based organizations. The Balanced Scorecard (BSC) is an important multi-attribute evaluation framework that has been accepted by many companies. The BSC advocates the incorporation of nonfinancial attributes into the company reward system, and highlights the contribution of nonfinancial attributes to the wealth creation process (Guimares et al., 2010; Lawson et al., 2006). The conceptual framework of the Balanced Scorecard has been implemented and utilized effectively for years in a large number of for-profit organizations. More recently, the model has been effectively utilized in not-for-profit organizations as well (Martello et al., 2016). Therefore, there is a lack of literature that addresses the actual implementation of the scorecard in local governments and Community-Based Organizations (CBO). However, the multiple dimensions of a balanced scorecard may provide better multiplier nature of performance evaluation, there are some problems with prioritization of decisions. Also, it is believed that the AHP is a versatile multi-attribute decision methodology that can be adapted to a wide range of BSC decision environments like Local Government. Many governments including local governments are reviewing the way they plan, prepare budgets, implement and manage programs and deliver services to meet the government's and citizens' demands for improved performance and accountability (Umashev and Willett, 2008). In order to enhance the efficiency and effectiveness of plans and projects, new accounting systems and participation of key internal and external stakeholders, Iran's Municipal Management requires this new public management system. The paper aims to examine whether the implementation of the Balanced Scorecard (BSC) has been of value to a municipality in Iran. As Salamzadeh (2020) mentioned, a theoretical contribution of the article is related to examine a previously tested theory in a new context. However, there is fairly broad consensus that there are significant challenges in transposing the BSC principles to public sector organizations, and that particular circumstances unique to the public sector give rise to the need for adjustments in both BSC design and implementation (Sharma and Gadenne,

2011). Accordingly, the performance assessment framework has been done in Karaj municipality as a public institution in Iran. The framework used in this article is based on the work of Sharma (2011) and Martello et al., (2016). Also, for this purpose, an Analytic Hierarchy Process (AHP) is used to facilitate the implementation of the BSC. Also some of complex problems of a balanced performance assessment, such as the use of subjective versus objective measures can be determined using Analytic Hierarchy Process (AHP) method (Bentes et al., 2012; Chan, 2006). Accordingly, the article is comprised of the following parts: first, we try to establish the context of the work being done. This is accomplished by discussing the relevant literature review and summarizing our current understanding of the problem we are investigating and finally, briefly explain our rationale and approach. Second, we describe both specific techniques and the overall experimental strategy. And we try to describe the research design. Third, it includes our results and the data collected during the research. There are analyzed the raw data in tables and figures to draw our own conclusions. Finally, in discussion section, it will be explained interpretations of the data and described what the work suggests and how it relates to other studies.

Literature Review

Some of researchers like Venkatraman and Ramanujam (1986) stated that the traditional financial measurement is not enough for the accurate assessment of organizational performance (Venkatraman and Ramanujam, 2002). Financial measurements typically show the returns or margins of past results and do not speak about expectations of future performance. Some financial measurements, such as NPV (net present value) and Tobin's q or share value show the expectation of long-term future performance (Wang and Chen, 2010). Ambler (2000), Performance is a function of external criteria (such as financial metrics and adjustment interest with changes in value) and internal criteria (such as innovation and employee commitment) (Clark and Ambler, 2001). A four-level hierarchy is enough for the structural performance, based on Diamantopoulos and Kakkos (2007), including: 1. Overall Objective (e.g. export performance), 2. Different objectives (or outputs) (e.g. sales versus profits compared to new product introductions) 3. Reference framework (e.g. a competition or customer plan) 4. Time frame

(e.g. short and long term). In the case of a structure linkage with two or some sides (e.g. assessment of performance), researchers should determine the side which is the best reflect (Bollen and Lennox, 1991).

Therefore, a change in the performance index will cause a change in the hybrid standard (Bentes *et al.*, 2012). One of the most popular performance assessment models is the Balanced Scorecard, developed by Kaplan and Norton (1995). This model suggests that some balance indices should be utilized for each organization performance assessment. Different sides make it possible to answer four principle questions (Kaplan and Norton, 1996a) as below:

1. How is the look on shareholders? (financial side)
2. In which domains, governments should work properly? (internal side of business)
3. How the customers are thinking about us? (customer side)
4. How can we continue to generate value? (Innovation and learning side)

Balanced Scorecard contains that kind of financial criteria which depict the previous activities in addition to non-financial criteria considering which are the prerequisites and stimuli for the future financial performance. Kaplan and Norton (1995) believe that knowing the financial processes, customer, internal business and training and innovation sides will eliminate the increasing of information problem. Managers also have to concentrate on some limited numbers of criteria. Applying these kinds of different performance sides, on the other hand, prevent the partial optimization while makes a balance between the short-term and long-term targets, financial and non-financial criteria and the external and internal viewpoints. As the public sector comes under greater pressure from both internal and external sources to demonstrate improvements in its performance, various local/municipal governments are taking an interest in performance measurement and reporting with an emphasis on improving performance and increasing accountability (Bouckaert *et al.*, 2016; Sharma and Gadenne, 2011). Other challenges include a culture of not trusting business solutions, a lack of staff skills in developing innovative measures, and failure to link the scorecard to compensation. Wisniewski and Stewart (2004) emphasize the importance of public sector firms recognizing that the performance management system is required to serve multiple purposes to meet the needs of a somewhat diverse array of stakeholders. For instance, in the municipality of Tehran, As Mirpour

and Mirafshar (2018) mentioned, in order to bridge the gap between the current and the desired situation, it is necessary to implement a new comprehensive plan that addresses the integrated Human Resources management systems. The main contribution of the Balanced Scorecard is the acceptance of multifaceted performance relative to a difficult economic position, although it creates complexity in performance appraisal. This complexity is observable via the extra information, judging prerequisites and combined judgment making (Huang, 2009; Wu *et al.*, 2009). The most important weakness of this approach is that it has been designed to show the overall performance to high level managers of the organization. The multi-criteria decision-making framework is suitable for the performance assessment and the AHP is a beneficial tool for the Balanced Scorecard analysis. But an important point is that managers give the same importance to all related measures while they are different in real world. However, in the last decade, the balanced scorecard's multi-dimensional focus has also been viewed as a way of addressing the need for a strategic performance measurement (Umashev and Willett, 2008). Some studies in public sectors were done like Sharma and Gadenne (2011) who investigate if the implementation of a BSC has been of value to a large Local Government Authority (LGA) within Australia. This study has shown that the LGA experienced problems in relation to each of the seven major themes encompassing the planning phase; deployment, assessment and review; leadership and motivation; communication mechanisms; measurement techniques; reward and incentive schemes; and transferability to other internal public sector divisions. This is not surprising when it is realized that the LGA has many divisions and programs, and designing a BSC for such a complex organization would involve challenges of the highest order. However, there is also evidence that the LGA has learned from its experience with BSC implementation. Verzola *et al.*, (2009) studied a multidimensional evaluation of performance in Ferrara university hospital. They concluded that the fast releases of BSC in public institutions are testament to its great potential. Such projects could be seen as a preparatory phase in the strategical analysis of a subsequent business plan.

In addition, prioritization of indicators from scorecards helps focus and weight more on the most important ones. Thus, AHP is considered as the second phase of the study. After selecting the most relevant indicators and weighting them, it will be feasible to

rank our alternative organizations (municipal districts) based on them (Gholipour *et al.*, 2018). The analytical hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. The ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value. The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. This capability distinguishes the AHP from other decision-making techniques. In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action (Leung *et al.*, 2006; Bentes *et al.*, 2012). The Municipality of Karaj has been selected as sample study and the balance Scorecard has been selected as the best method for explaining the four aspects and finally AHP method has been used for quantifying the weights of the four indices. Considering the AHP tree, at first the relative degree of importance of balanced Scorecard is assessed, containing the innovative and learning, financial, customer and internal business process sides. Then the relative degree of importance of each side performance criteria is evaluated. The learning and innovative side consist of employees' skill enhancement and the improvement of education and skill. The internal process of business includes the new project operations and the improvement of the annual performed projects. The customer side consists of the citizens, investors and makers' satisfaction, while the financial side includes the value modification, decreasing the operational costs and the costs of the performed projects. Finally, the best municipality unit is determined via the Balanced Scorecard indices. This study has been implemented in the Municipality of Karaj during the 2019 by using of AHP method.

MATERIALS AND METHODS

Since the aim of the present study is finding a framework for the municipality performance assessment in Karaj, Iran, it is an applicable study. The research used analytical methods and stand-alone questionnaire survey techniques, a case study approach. Content validity method was used to determine the validity of the questionnaire. For this purpose, to evaluate the validity of the content of the questionnaire items, the items were studied by

experts and their opinions were obtained. Then, by applying the opinions of experts, the content validity of the questionnaires was confirmed. Internal reliability (Cronbach's alpha index) was used to measure the reliability of the questionnaire. For this purpose, 10 balanced scorecard questionnaires were distributed. The reliability of the questionnaire based on the internal reliability coefficient was 0.92, which indicates the reliability of the questionnaire.

Then, three units of Municipality of Karaj which were chosen includes the Inspection and Oversight unit (IO), Information Technology unit (IT) and Income Guarantee unit (IG). The statistical society of the study consists of active municipality employees, related to aforementioned units. A non-random purposeful judgment sampling method has been used. In order to select the performance indicators and conduct the comparative judgments, the researchers invited nineteen personnel to participate in the research, include: three municipality master managers (one for each section, all with long experience in the municipality); three supervisors (one for each section); Twelve master experts (four for each part); and the chief financial officer. For constructing the comparison matrices, the research used the agreement building approach, which resembles a focus group design. An agreement-building approach whereby evaluating judges reach some (pseudo-)consensus about the value of priorities and of performance levels. The criteria used in this study, were selected based on the theoretical fundamentals of the Kaplan and Norton (1996) study and contain the financial, customer satisfaction, internal process of business and the learning and innovation sides. The performance criteria were selected for each side and then experts in Municipality of Karaj by asking from the municipal management. It can be seen in AHP model (Table 2).

Accordingly, researchers collected two types of data: (i) the values for the nine performance indicators selected for the study; (ii) the relative importance of each indicator versus the others, and of each BSC perspective versus the others. Balanced Scorecard is an example of a closed-loop controller or cybernetic control applied to the management of the implementation of a strategy. Closed-loop or cybernetic control is where actual performance is measured (Sharma and Gadenne, 2011). The measured value is compared to a reference value and based on the difference between the two corrective interventions are made as required. Balanced Scorecard was initially proposed as a general purpose

performance management system. Subsequently, it was promoted specifically as an approach to strategic performance management. Balanced Scorecard has more recently become a key component of structured approaches corporate strategic management. Two of the ideas that underpin modern balanced scorecard designs concern making it easier to select which data to observe, and ensuring that the choice of data is consistent with the ability of the observer to intervene. In another aspect, balanced Scorecard is a type of card that the strategy for them is related to a set of financial and non-financial indices. It has 4 sides, including financial, customer, internal process of business and the learning and Innovation (McLean, 2006). These sides are changeable; in other words, they can be changed, considering the kind of assessed organization (Northcott and Ma’amora Taulapapa, 2012). For example, the organization may be a local one which doesn’t follow the financial aims, therefore the financial side can be removed for this organization, or a new side can be defined.

Financial Side

Financial measurements are from the balanced assessment system important parts. Especially in profit organizations, this factor expresses that the successful performance of the other three sides finally make what kind of results. In Non-profit organizations maybe, valuism (improving the value) is the most important performance of financial side which emphasizes the integration of various ways to improve value with organizational activities. Removing additional functions and creating and improving useful functions, will decrease the operational cost.

Citizenship Side

Selecting the aims and measurements related to citizenship aspect, the organizations should answer

two questions. First, who the target citizens are? And second, what is the suggested values for them? In this domain, people who are using the municipality services are divided into two groups including citizens and the investors and personal makers.

The side of business internal processes

In internal processes side, the organization should define those kind of processes, which can continue the process of making value for the citizens. The target of each defined targets in citizenship side, needs to do some operational performances applicable and effective. These processes should be determined in internal processes side and suitable measurements should be expanded to develop their controlling. Increasing the citizen’s satisfaction may be done by some new processes such as the improvement and rehabilitation of finished projects and performing the new projects. In other words, the internal processes that are set of activities which are done for the citizen satisfaction increasing their living place, is paid to environmental quality improvement of objective standards and welfare of citizens.

The Innovation and Learning Side

How can we achieve, the determined targets in internal process, citizenship and local investors sides? The answer to this question relates to learning and innovative side. In other word, this side is a fundamental empowering to make it easy to reach the other sides’ goals. The gap between the employees’ skills and the current situation, has been recognized after setting of citizenship and internal processes sides. Upon to that, the learning and innovative side consists of employees’ skill improvement beside the learning and skill development. The main duty of BSC is to translate the organization strategies into a set of performance criteria. But the main question is that, how BSC can do

Table 2. Criterion and the Municipality Units in AHP and BSC Framework.

Identify the best part of the administrative								
Perspective of learning and innovation		Perspective of internal process		Citizenship perspective		Financial perspective		
Development of training and skills	Employee Skills Development	Improved implemented projects	Number of new projects	Investors and personal developers	Citizens	Decrease in operating costs	Cost of implemented projects	Improve the value
	IO		IO		IO		IO	
	IT		IT		IT		IT	
	IG		IG		IG		IG	

Balanced Scorecard (BSC)

it? The answer is that BSC considers some cause and effect relationships among the different levels. Strategy is made of a set of cause and effect hypotheses. Fig. 1 shows the cause and effect relationship in 4 balanced assessment sides in a local organization.

Achieving the citizenship value making and the citizens' satisfaction could not be done unless the costs be decreased and incomes be more stable. It can make a work space suitable for the creativity, novelty, experiences exchange and learning (learning and innovative side). Fig. 1 shows the steps, we took to conduct the research. Accordingly, the mission and strategy of the organization in BSC is translated into aims and 4 side's operation indices. The BSC, indeed, is a content for the interpretation of organization strategy aims to a set of operational indicators in 4 financial, citizenship, business internal processes and the learning and innovative sides. Therefore, the BSC using will improve the current operation of an organization in addition to attempts for the development of correction processes, employees' educating and the information systems' increase. The data for implementing BSC and AHP have been extracted by a standard questionnaire.

RESULTS AND DISCUSSIONS

The obtained results have been shown via the internal dependence Matrix, Non-weighted Super Matrix, Weighted Super Matrix, Limited Matrix, the final and relative priorities of criteria and selection. Table 3 shows the final matrix of performance criteria and related normal weight.

In 3*3 Matrix through the financial viewpoint, the CR/L ratio is below 10, which is acceptable. Three remained matrices are 2*2 and their compatibility ratio is zero. The C1 index is almost 3.5 times more important than the C2 index and is almost 9 times more important than the C3 index. Through the citizenship viewpoint, the C4 index (the satisfaction level of personal investors and makers) is almost 7 times more important than the C5 index (citizens' satisfaction). In other words, the Municipality of Karaj pays more attention to the interests of the private sector than the public interests which comes from the municipality money making target. The C6 index was, through the internal processes of business, about 3 times more important than the C7 index. Focusing on the projects' modification and upgrading is more sensible, considering the municipality current

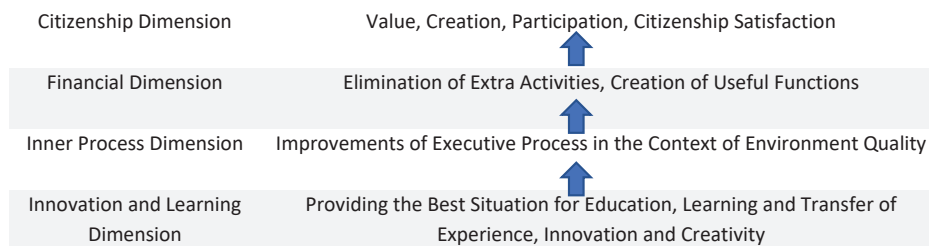


Fig. 1. Cause and Effect Relationship in 4 Balanced Assessment Sides in Municipality

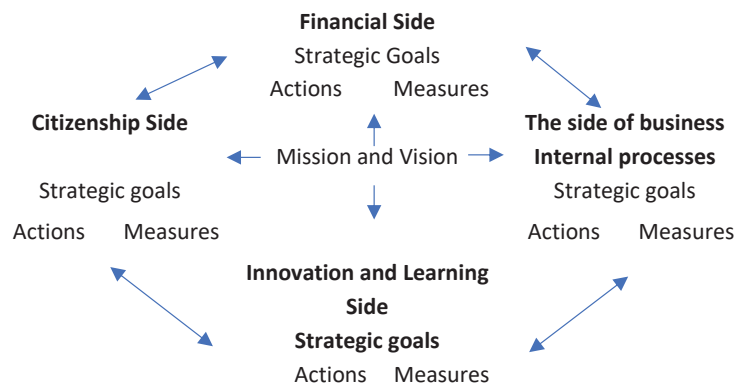


Fig. 2. Balanced Scorecard Diagram

situation; while the progression and completion of existing projects can increase the added value of the municipality. Finally, for the Innovation and learning viewpoint, the C8 index was about 5 times more important than the C9 index. Then the managers defined the relative weight of each BSC viewpoint, using the 9th scale. Researchers afterward calculated the normal weight of each viewpoint in a similar style to the previous step. The compatibility rate of every comparative matrix revealed that the managers should participate whether in a collaborative process for the no compatibility rate or not. Table 4 shows the raw and normal weights in addition to 4*4 compatibility matrix. It should be considered that the managers assessed the financial viewpoint as the most important viewpoint. The financial side was about 3, 5 and 7 times more important than the citizenship, internal business processes and innovative and learning sides, respectively.

In the next step, the total weight of each performance criterion was estimated, which is the result of performance criterion local weight and BSC side local weight equality (Table 5).

Then a pairwise comparison of the performance of each functional area was performed according to each performance criterion. Table 6 shows a relative assessment of each function unit (Normal and raw weights) in each 9th performance criterion with 3*3 compatibility rate matrix.

The Information Technology (IT) unit is much

more successful than the two other units, considering the financial viewpoint based on C1 and C3 indices. The Inspection and oversight unit, on the other side, is more successful in C2 index and has the minimum success in C1 and C3 indices. Considering the citizenship side, the Information Technology (IT) unit operates much better than the two other units in both C4 and C5 indices. The income unit has the worst operation in both indices. Considering the internal business process, has better rank in C6 and C7 indices. The inspection and oversight unit have the worst performance. In innovative and learning viewpoint, the Information Technology (IT) unit has the higher rank again than the other two units in C8 and C9 indices. The inspection and oversight unit has the lower rank than the income unit. Only consideration to units' performance based on specific criteria is a difficult issue in finding the best unit. Due to that, the results should be conjugated to find a good criterion for the units ranking. The AHP, deterministically, provides the best solution. The best performance at the moment is that the researcher considers universal relative importance of all indices. The final step eventually was the finding that how much that each unit helped the Balanced Scorecard (Table7). In next step, the best performance unit is obtained in each side via the comparison of the business unit local weights and the universal weight of criteria. Table 7 shows each unit share in every viewpoint weight. For example, the inspection and oversight,

Table 3. The relative importance, normal amounts and the stability ratio in performance criteria

Financial	C ₁	C ₂	C ₃	W	Internal	C ₆	C ₇	w
C ₁	1	4	7	0.69	C ₆	1	3	0.75
C ₂	0.25	1	3	0.20	C ₇	0.33	1	0.26
C ₃	0.14	0.33	1	0.79	CR	0		
CR	0.03							
Citizenship	C ₄	C ₅	W	Innovation	C ₈	C ₉	W	
C ₄	1	7	0.10	C ₈	1	5	0.85	
C ₅	0.14	1		C ₉	0.2	1	0.19	
CR	0			CR	0			

*C indicates Criteria in each dimensions

Table 4. The ratio of viewpoints stability and the BSC amounts

Perspective	Financial	Citizens	Internal	Innovation	w
Financial	1	5	4	5	0.58
Citizens	0.2	1	3	3	0.2
Internal	0.25	0.33	1	2	0.13
Innovation	0.2	0.33	0.5	1	0.09
CR	0.09				

Table 5. The relative succession grades in performance indices by each function unit

C ₁	IO	IT	IG	W
IO	1	0.14	3	0.1
IT	7	1	0.33	0.63
IG	2	0.2	1	0.27
CR	0.01			
C ₂	IO	IT	IG	W
IO	1	4	0.5	0.61
IT	0.25	1	5	0.18
IG	0.33	3	1	0.19
CR	0.06			
C ₃	IO	IT	IG	W
IO	1	0.25	0.5	0.15
IT	4	1	4	0.5
IG	2	0.25	1	0.35
CR	0.05			
C ₄	IO	IT	IG	W
IO	1	0.5	3	0.2
IT	5	1	7	0.71
IG	0.33	0.14	1	0.09
CR	0.06			
C ₅	IO	IT	IG	W
IO	1	0.25	2	0.2
IT	4	1	3	0.65
IG	0.5	0.33	1	0.15
CR	0.09			
C ₆	IO	IT	IG	W
IO	1	0.5	0.2	0.18
IT	2	1	0.25	0.24
IG	5	4	1	0.58
CR	0.02			
C ₇	IO	IT	IG	W
IO	1	0.5	0.16	0.15
IT	2	1	0.33	0.22
IG	6	3	1	0.63
CR	0			
C ₈	IO	IT	IG	W
IO	1	0.2	0.33	0.11
IT	5	1	3	0.59
IG	3	0.33	1	0.3
CR	0.03			
C ₉	IO	IT	IG	W
IO	1	0.25	1	0.2
IT	4	1	2	0.59
IG	1	0.5	1	0.21
CR	0.05			

Table 6. Local to Universal amount of each index

Perspective	Indicator	W		Perspective	indicator	W	
		local	global			Internal	local
Financial	C ₁	0.67	0.4	weight	C ₆	0.78	0.10
	C ₂	0.23	0.1		C ₇	0.22	0.05
	C ₃	0.10	0.08				
Citizens	indicator	W		Innovative	indicator	W	
		local	global			local	global
		C ₄	0.10			0.05	C ₈
Weight	C ₅	0.90	0.16	0.08	C ₉	0.20	0.03

Table 7. Regional share of each operational unit in general performance goals

Financial	C ₁	C ₂	C ₃	Indicator	outcome	Financial	C ₁	C ₂	C ₃	Indicator	outcome
IO	0.10	0.61	0.15	C ₁ 0.4	0.12	IO	0.10	0.61	0.15	C ₁ 0.4	0.12
IT	0.63	0.18	0.50	C ₂ 0.1	0.31	IT	0.63	0.18	0.50	C ₂ 0.1	0.31
IG	0.27	0.19	0.35	C ₃ 0.08	W0.58	IG	0.27	0.19	0.35	C ₃ 0.08	W0.58

Internal process	C ₆	C ₇	Indicator	Outcome	Internal process	C ₆	C ₇	Indicator	Outcome
IO	0.18	0.15	C ₆ 0.10	0.02	IO	0.18	0.15	C ₆ 0.10	0.02
IT	0.24	0.22	C ₇ 0.05	0.03	IT	0.24	0.22	C ₇ 0.05	0.03
IG	0.58	0.63		0.08	IG	0.58	0.63		0.08
				W0.13					W0.13

Table 8. The final results for the best operation zone assessment

Aspects of BSC	Financial	Citizens	Internal	Innovative	Total
IO	0.12	0.04	0.02	0.01	0.19
IT	0.31	0.14	0.03	0.05	0.53
IG	0.15	0.02	0.08	0.03	0.28
Total	0.58	0.20	0.13	0.09	1.00

the Information Technology (IT) and financial units show the importance of financial viewpoint in overall analysis, with 12, 31 and 15 percent, respectively.

Each unit's share, as the same way, will be found in final analysis. Table 8 shows the obtained results in each viewpoint. Results revealed that the IT unit has had the best performance in financial, customer and the innovative and learning fields. The income unit has the better performance than the internal business processes. Its quota is equal to 0.28 in final decision making. Decision-makers in municipality, consider the information technology quota equal to 0.53. Therefore, the AHP method lets the managers recognize the IT unit as the best unit in relative situations.

CONCLUSIONS

For years, the Balanced ScoreCard conceptual framework has been effectively implemented and operated in private sectors. The BSC implementation in the public sectors obviously have their own unique challenges which is rooted in the nature of its accountability to citizens within communities rather than to stockholders. The aim of this study was to investigate if this framework can be used in public organizations as an efficient tool for performance assessment. Accordingly, we chose Karaj's municipality

as a public organization sample in Iran. In this case integrated AHP and balanced value card used as the methods. The logic behind such a combination was while the balanced value card gathers multiple viewpoints beside the financial lookout. AHP helps the managers to have a more proper insight into the performance criteria from the balanced value card. Three departments of Municipality of Karaj were assessed. There was an equal emphasis on citizenship (consumer) approach and financial outlook in implementing a balanced scorecard approach. This equal emphasis, has been based on the necessity that municipalities carry out its primary mission for its citizens as well as the necessity to maintain financial stability within the municipality. The emphasis on both of these has become a necessity for the municipality to increase efficiently and effectively. The summary results in Municipality of Karaj show that it is more reasonable to focus on process improvement project. In terms of process improvement projects, they can be defined as those temporary or short-term endeavors designed to improve a process and resulting in improved performance in a key performance indicator and improving results are considered important. Accordingly, A Process Improvement Project is an effort to incrementally reduce cost, cycle time, variation or

defects within a process and optimize performance. Completion of the current projects can increase the added value to Municipality of Karaj. Also, proper performance of Information Technology (IT) section shows the importance of e-government to improve the performance of municipalities and process improvements' plan. Finally, while acknowledging that the such performance processes need a continuous development process, managers have emphasized that there are now regular and coordinated efforts to provide better results through surveys and discussions with key internal and external shareholders and rulemakings can be shaped during time. The current research tried to investigate if the implementation of a BSC has been of value to a public institution like municipalities in Iran. Although there are some challenges, it seems, based on some evidence, that this performance measurement framework has the potential and capabilities that Iranian municipalities can learn from their experience with BSC implementation. It seems that while using BSC in the long-term planning process for Iran's municipalities is relatively new, this process can be accepted by Iran's municipal management. Although, there is an understanding that over time the implementation of a BSC based on a "one size fits all" approach is not appropriate for many sections and programs within public administrations and such a process would be improved by methodology that compare relative importance in performance criteria e.g. AHP, ANP or FUZZY.

AUTHOR CONTRIBUTIONS

M. Valibeigi performed the literature review, experimental design, analyzed and interpreted the data, prepared the manuscript text, and manuscript edition. M. Feshari performed data analysis and interpretations, compiled the data and manuscript preparation. M. Valibeigi performed various administrative tasks and was an assistant in data gathering process and data analysis. E. Sarhanghi helped in literatura review and manuscript preparation.

ACKNOWLEDGEMENT

The authors wish to thank the managers, employees of Karaj Central Municipality for their cooperation and Mr. A. Azimi, Municipality of District 4 at Karaj Municipality, for his dedication and support. The authors received no financial support for the research, authorship, and/or publication of this article.

CONFLICT OF INTREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

AHP	The analytic hierarchy process
BSC	The Balanced ScoreCard
C	Criteria
CBO	Community-Based Organizations
IG	Income Guarantee unit
IO	the Inspection and Oversight unit
IT	Information Technology unit
LGA	large Local Government Authority
OU	operating units

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HOW TO CITE THIS ARTICLE

Valibeigi, M.; Feshari, M.; Valibeigi, M.; Sarhanghi, E., (2020). Proposing a performance measurement framework for the Municipalities. *Int. J. Hum. Capital Urban Manage.*, 5(4): 319-330.

DOI: 10.22034/IJHCUM.2020.04.04

url: http://www.ijhcum.net/article_44278.html



ORIGINAL RESEARCH PAPER

The effect of coronavirus restrictions on air quality and exiting daily traffic

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ARTICLE INFO

Article History:

Received 27 July 2020

Revised 24 August 2020

Accepted 01 September 2020

Keywords:

Air Pollution

Coronavirus

Quarantine

Traffic volume

Transportation

ABSTRACT

BACKGROUND AND OBJECTIVES: This research attempted to analyze the negative and positive aspects of Coronavirus: its effect on air quality and traffic volume. The sample city of this research was Tehran and transportation behavior toward the Coronavirus and minor quarantines in specific.

METHODS: Six indices were considered for Tehran city in two consecutive years (in quarantine period): carbon mono-oxide, nitrogen dioxide, sulfur dioxide, particulate matters, air quality index, and daily traffic volume, which depart from Tehran city to other destinations. Daily traffic volume changes were examined for four roads separately, and total departed trips were also investigated. This comparison was made graphically and statistically by using the regression model and one-way t-test.

FINDINGS: Results showed that from 20th February to 19th March, the average of produced CO, NO₂, and PM₁₀ decreased in 2020 compared to 2019, but other indices related to air pollution were increased in 2020. The average daily traffic in existing roads of Tehran City was declined significantly in 2020. Regression models and a one-way t-test showed that the growth rate of emission production was higher in 2019 compared to 2020. Also, this rate for daily traffic volume was higher from March 20 to April 19 of 2020 compared to 2020.

CONCLUSION: The regression model on indices showed valuable results. For instance, the O₃ emission slope in the second month reduced from 0.6 to 0.5; however, the exiting traffic of Tehran city reduced by 47 percent that indicates the higher resident population of Tehran city compare to the last year.

DOI: [10.22034/IJHCUM.2020.04.05](https://doi.org/10.22034/IJHCUM.2020.04.05)

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NUMBER OF REFERENCES

38



NUMBER OF FIGURES

3



NUMBER OF TABLES

2

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

Coronavirus is a big family encompassing usual cold to intense and dangerous diseases like MERS Coronavirus and SARS Coronavirus. SARS- Cov 2 was initially observed in Wuhan city in China on 31st December 2019, and it was called "Covid-19" (Haas et al., 2020; Lee and Ong, 2020; Li et al., 2020a). In the following, this virus was reported in some other countries. In Iran, after several negative tests given on suspicious people, two positive results were reported regarding two patients in Qom province on 19th February 2020. Then, positive results of Covid-19 tests were reported first from the nearby provinces to Qom, and subsequently, from all provinces of the country. The government attempted to prevent Coronavirus from spreading by closing academic places, reducing present employee numbers, closing some guilds, and prohibition of inter-province transportation (Abdi, 2020; Amlashi et al., 2020; Behzadifar et al., 2020; Tran et al., 2020). The statistics by the time of this article (July 2020) showed more than 12 million and 250 thousand patients and 550 thousand and 12 thousand death all over the world and in Iran, respectively (Worldometers, 2020). On the other hand, each year, many people all over the world die due to air pollution (Nunes and Hernandez, 2020; Rojas-Rueda et al., 2012; Wadud and Waitz, 2011). Tehran, as the capital city of Iran and a metropolis, is not an exception, and according to available data, air pollution is the main reason for 4000 deaths in Tehran city (Hadian et al., 2020; Tehran times, 2019). Some primary causes of air pollution in Tehran city include industrial, production and vehicle pollution production, and so on, from which vehicle is the primary source of air pollution in Tehran city (Heger and Sarraf, 2018; Hosseini and Shahbazi, 2016; Vafa-Arani et al., 2014). Due to the limitations of human-based activities actions resulting from Coronavirus and quarantine, the reports indicate the positive effect of Coronavirus on air pollution in some countries (Isaifan, 2020; Gupta et al., 2020). One of the main challenges of this research is the effect of this virus on the air quality of Tehran city, which will be analyzed in the next sections. Another view is about traffic volume. In Iran, during the New Year holidays, which begin in late March, there are many leisure trips from Tehran city to other cities, especially to northern Iran (Vahdati et al., 2014). However, travel restrictions because of the Coronavirus epidemic in the current

year affect traffic volume and air pollution, which is examined in this study.

Quarantine, Air Pollution, and transportation engineering

Many factors affect the air quality of a city. Coronavirus and quarantine effects on air quality are some of these factors analyzed recently. Many studies have considered air quality in various cities and countries, which will be described later. Most of these studies have considered quarantine effect only on pollution and compared the air quality of the quarantine period to the same period last year. Bao and Zhang (2020) used a baseline regression model on 44 northern cities of China to predict the air quality index. Their prediction was with the help of variables like air quality index in the past, lockdown, and human, and the results showed the vital role of human activities on air pollution. Another study by Dantas et al., (2020) is investigated the effect of partial quarantine on air pollution graphically by using the data of Rio de Janeiro in Brazil. Their results showed an improvement in air pollution indices. Gupta et al., (2020), the same as Dantas et al., (2020), made a graphical comparison on China and the USA. The results were similar to Dantas et al (2020) and some other cases (Kerimary et al., 2020; Li et al., 2020b; Mahato et al., 2020; Masum and Pal., 2020; Otmani et al., 2020; Quere et al., 2020; Sharma et al., 2020; Sicard et al., 2020). Some studies analyzed the effect of Coronavirus and quarantine on the economy as well as the environment. The results of environment indices were promising; however, the effect of Coronavirus on the economy showed significant differences in retail, grocery, pharmacy, and industry (Caraka et al., 2020). Also, the article of Haghani et al., (2020) is useful for accessing more comprehensive information regarding published articles about Coronavirus, particularly in safety sciences like medicine safety, food safety, blood safety, and patient transport. Also, in quarantine time, urban and suburban transportation is affected by the Coronavirus epidemic. Roads and cities experience low traffic volume and high traffic speed. Some studies around the world investigated on pandemic and transportation engineering. For example, in the United States in stay-at-home areas, average daily travel distance declined from 8.0 to 1.6 km in late March 2020 (Glanz et al., 2020). Traffic jams

have disappeared in San Francisco and Los Angeles. Also, traffic speed on D.C.-area roads on quarantine Tuesdays moved an average 38 percent faster than on a typical Tuesday. By Wednesday morning, Chicago's traffic speeds were 77 percent higher than usual, and this percentage for Los Angeles equals to 53 percent. On Wednesday, Metro ridership had declined by 84 percent and by 63 percent on buses (Shaver, 2020).

Contribution

Based on the presented literature review, many studies have been published in different countries during Coronavirus spreading, from which Iran is not an exception. Studies performed about Iran dealt with Coronavirus's effect on people's lives, most of which have considered it based on medical aspects (Ahmadi *et al.*, 2020; Behzadifar *et al.*, 2020). However, the shortage of transportation studies and in specific, studies regarding the coronavirus effect on air pollution and traffic volume is actually realized. Based on these points, this research attempts to consider corona spreading effect on air pollution and traffic volume in Tehran city according to six indices. These six indexes are collected from February 20 to April 19 in 2019 and 2020, and their values are compared for these years. The current study has been carried out in Tehran city in 2020.

MATERIALS AND METHODS

Study area

Tehran city, as the capital city of Iran, is located in the northern part of this country- with almost 8.5 million populations (Edrisi and Askari, 2020; Maghmoumi *et al.*, 2020). This population reaches 12.5 million in daylight, due to daily transportation for work and business goals. Seventeen million vehicle trips are reported each day, and due to air pollution made by these trips, people breathe polluted air in most days of the year (Nourzadeh *et al.*, 2019). On the other hand, due to its geographical position -located between the Alborz Mountains, it seems impractical to remove the polluted air (Heger and Sarraf, 2018). The location of Tehran is presented in Fig. 1.

Data selection and methodology

The present research data include Carbon Monoxide, Sulfur Dioxide, Nitrogen Dioxide, Particulate Matters, Air Quality Index, and the Daily vehicle traffic of Tehran province. These data are

provided through the website of the Air Pollution Control System, and the toll stations loop detectors (AQMS, 2020; RMTO, 2020). However, the primary purpose is to compare the trend and measure of these data in the quarantine period, February 20 to April 19 in 2019 and 2020 to the same period of the previous year. The research stages include 1- data collection 2- preparation and drawing charts 3- optical analysis of results and charts 4- statistical comparison of indices. Carbon mono-oxide (CO) is a very harmful gas for the human, produced by vehicles, light, and heat equipment. Nitrogen dioxide (NO₂) is produced by the combustion of fossil fuels, while vehicle traffic is the primary source producing NO₂. Each year 4.6 million people die due to nitrogen dioxide emissions. The primary source of sulfur dioxide (SO₂) involves industrial, mineral, and powerhouse actions, causing acid rains. Particulate matters (PM) are pollutants made of solid and liquid matters, having natural and human made sources. Air quality index (AQI) is a computable measure whose main merit includes air quality awareness of vulnerable groups, and the method of protection against it (Gupta *et al.*, 2020). Air pollution-related data are provided using the website of the Air Pollution Control System of Iran. Loop detectors collect daily traffic volumes. These loop detectors are installed on exit roads of Tehran city, in toll stations. Data includes 60 days, from February 20 to April 19 in 2019 and 2020. The reason for selecting this period is the approved first positive Coronavirus test at this period. In this period, closed academic places such as schools and universities, remote working of several employees and clerks, and closing the guilds because of epidemic coincide with the Persian new-year holidays. Paying insufficient attention to these matters will misguide researchers and bring the wrong results.

RESULTS AND DISCUSSION

Graphical comparison

In this study, the effect of Coronavirus and quarantine on air pollution and daily traffic volume analyzed, by comparing corresponding values for February 20 to April 19 of 2019 and 2020. Table 1 shows the average of produced emission and the average daily traffic volume for these periods of 2019 and 2020.

Table 1 indicates that only the average of produced CO, NO₂, and PM₁₀ decrease in 2020, which

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Table 1: The average of produced emission and the average daily traffic volume

Indices	Type of indices	Units	Average in 2019	Average in 2020
CO	Produced emission	ppm	29.3	29.1
O ₃	Produced emission	ppm	22.7	35.8
NO ₂	Produced emission	ppm	57.2	49.3
SO ₂	Produced emission	ppm	22.6	24.9
PM ₁₀	Produced emission	µg/m ³	40.2	39.0
PM _{2.5}	Produced emission	µg/m ³	57.9	66.2
Index	Air quality index	-	57.9	66.7
Saveh	Daily traffic volume	veh/hr	67359	36921
Pardis	Daily traffic volume	veh/hr	17923	21357
Qom	Daily traffic volume	veh/hr	62819	13322
Karaj	Daily traffic volume	veh/hr	93673	55310
Total	Daily traffic volume	veh/hr	228000	121414

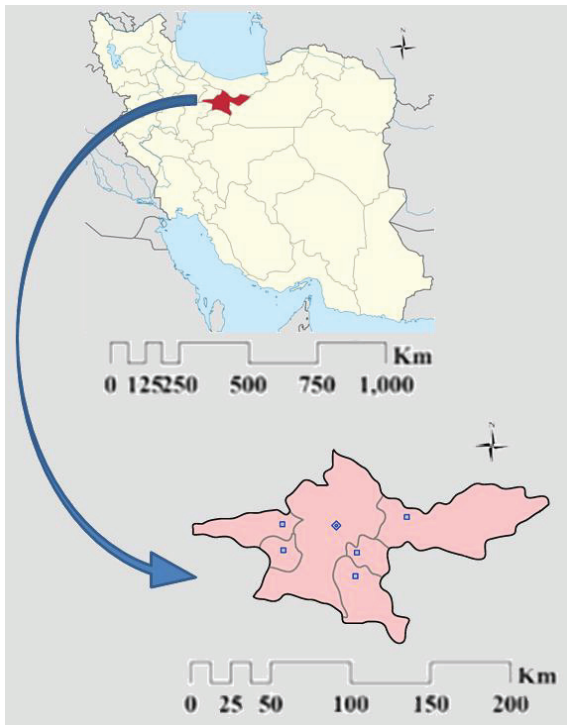


Fig. 1: Geographical location of the study area in Tehran, Iran

this increase seems to be insignificant. On the other hand, the average daily traffic except for those to Saveh is declined drastically in 2020. Figs. 2 and 3 show the trend of air pollution production and daily

traffic volume. Based on these graphs, there is no apparent difference between air pollution production in 2019 and 2020. However, daily traffic volume is affected by the Coronavirus epidemic significantly.

Statistical comparison

Another critical point to be considered is to find the general trend of changes and employing another method for comparing indices for different years statistically. For this purpose, the linear regression analysis is used as Eq. 1:

$$y_t = \beta_0 + \beta_1 * y_{t-1} + \varepsilon \quad (1)$$

This regression investigates the relationship between the amount of each parameter in day t and previous day t-1. If the coefficient of y_{t-1} (β_1) has a positive sign the trend of indices is growing in that period. β_0 is the intercept, and ε is the error term of the regression model. Regression models are calibrated for each parameter for the year 2019 and 2020 separately. Higher β_1 means a higher growth rate. To compare β_1 s statistically, the one-way t-test is employed (Eq. 2).

$$t = \frac{\beta_{1,2019} - \beta_{1,2020}}{\sqrt{\frac{(se_{1,2019})^2 + (se_{1,2020})^2}{n}}} \quad (2)$$

Where $\beta_{1,2019}$ and $\beta_{1,2020}$ are regression

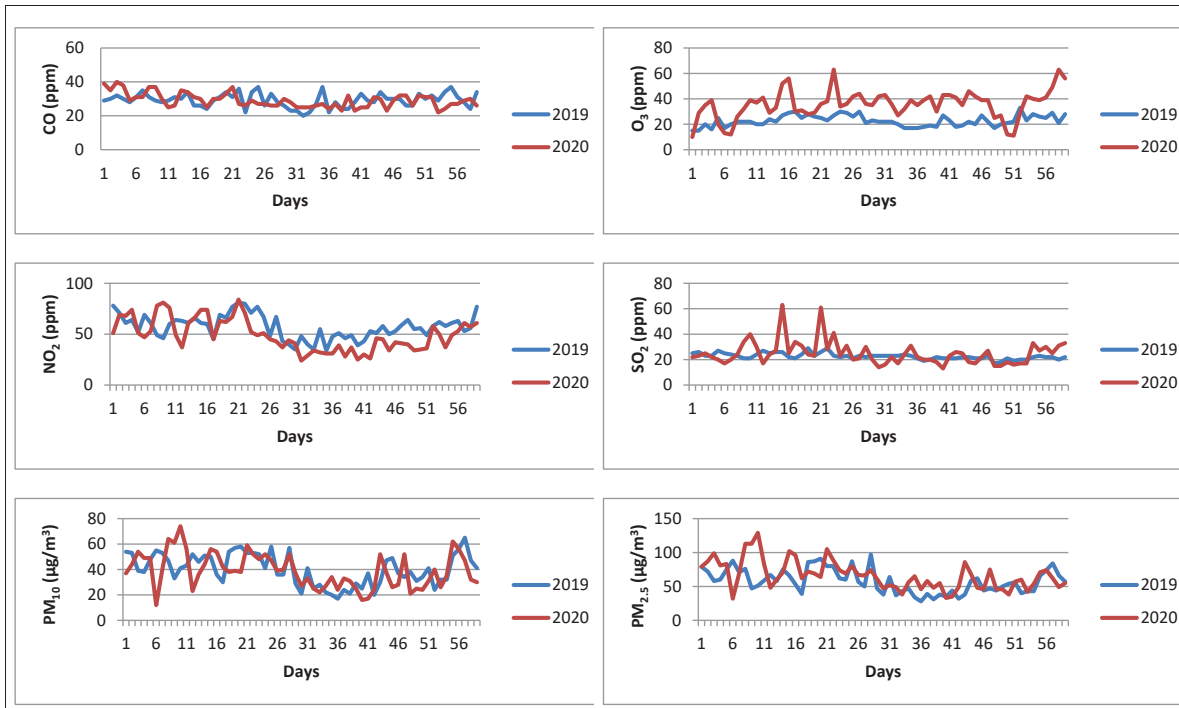


Fig. 2: Trend of air pollution production and daily traffic volume (A)

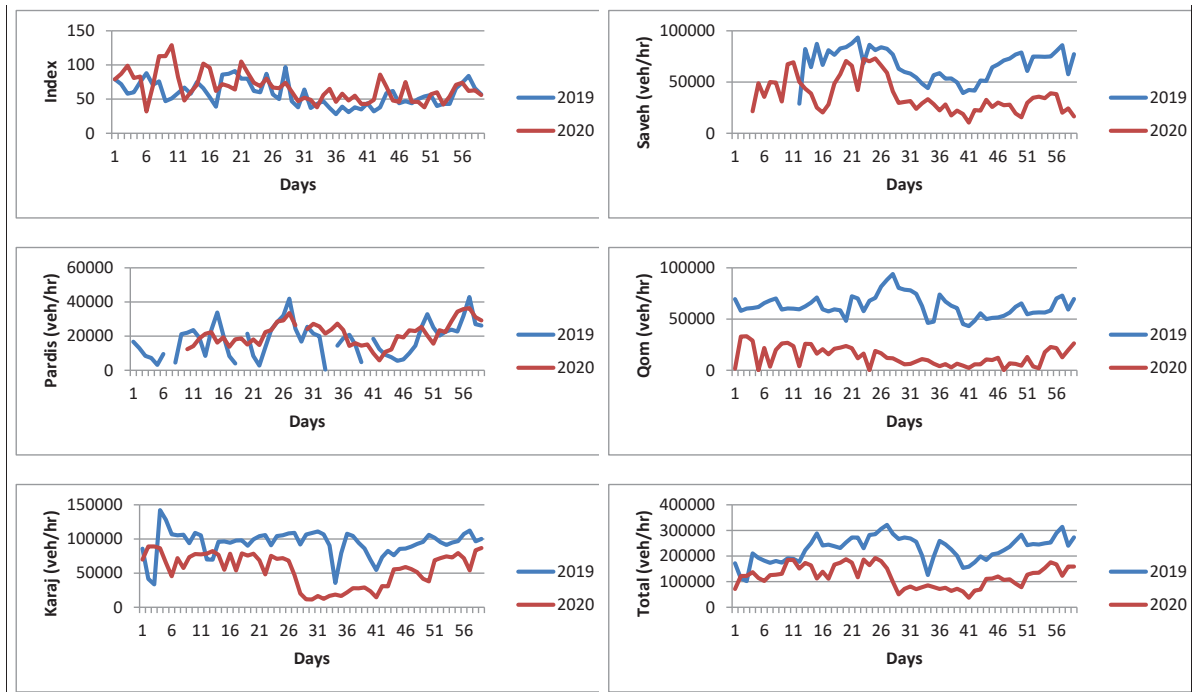


Fig. 3: Trend of air pollution production and daily traffic volume (B)

Table 2: Statistical comparison by using the regression model and one-way t-test

Indices	Period	First-year β_0	First-year β_1 (t)	Second-year β_0	Second-year β_1 (t)	One way t-state	P-value
CO	First month	34 (5.8)	0 (0.7)	15.7 (2.8)	0.5 (2.8)	-12.5	8.327325e-13
CO	Second month	19.6 (3.8)	0.3 (1.7)	25.5 (5)	0.1 (0.4)	5.3	1.616313e-05
O ₃	First month	14.6 (3.6)	0.3 (1.9)	11 (2)	0.7 (5)	-9	5.646415e-10
O ₃	Second month	9.7 (2.6)	0.6 (3.7)	18 (3.1)	0.5 (2.9)	2.4	0.02573682
NO ₂	First month	39.3 (3.1)	0.4 (1.9)	30.5 (2.7)	0.5 (2.7)	-2.2	0.04028434
NO ₂	Second month	23.3 (2.5)	0.6 (3.1)	14 (2.2)	0.7 (4.2)	-2.3	0.03091777
SO ₂	First month	18.4 (3.9)	0.2 (1.2)	28 (4.7)	0 (0.1)	4.2	0.0003853051
SO ₂	Second month	11.6 (3.3)	0.5 (2.8)	12.2 (3.2)	0.4 (2.5)	0.4	0.3604773
PM ₁₀	First month	38.9 (4.1)	0.2 (0.9)	34.5 (3.8)	0.3 (1.4)	-1.5	0.3604773
PM ₁₀	Second month	16.1 (3)	0.5 (3.5)	20.4 (3.6)	0.4 (2.2)	4	0.0005751396
PM _{2.5}	First month	57.4 (4)	0.2 (0.8)	51.7 (3.4)	0.4 (1.9)	-3.4	0.002427118
PM _{2.5}	Second month	28.2 (4)	0.4 (2.9)	43.2 (4.4)	0.2 (1.1)	5.1	2.247563e-05
Index	First month	57.4 (4)	0.2 (0.8)	51.7 (3.4)	0.4 (1.9)	-3.4	0.002427118
Index	Second month	28.5 (4)	0.4 (2.9)	45.4 (4.6)	0.2 (1)	5.6	5.831283e-06
Saveh	First month	90173.9 (8.4)	0 (0.9)	26121.3 (2.9)	0.5 (2.9)	-15	9.580514e-15
Saveh	Second month	16509.7 (2.1)	0.7 (5.8)	13931.4 (3.1)	0.5 (2.9)	7.5	3.26434e-08
Pardis	First month	6758.5 (1.9)	0.6 (3.4)	6585.5 (1.9)	0.7 (4.2)	-2.4	0.02767826
Pardis	Second month	3741.2 (1)	0.8 (4.5)	3301.7 (1.4)	0.9 (8.2)	-2.6	0.01612949
Qom	First month	15474.1 (1.3)	0.8 (4.2)	17395 (4.5)	0 (0.2)	14.9	1.292032e-14
Qom	Second month	22730.5 (3.2)	0.6 (5.3)	3272.9 (1.9)	0.7 (4)	-1.7	0.0951005
Karaj	First month	66410.7 (3.6)	0.3 (1.7)	48954 (3.4)	0.3 (1.4)	0.4	0.3672489
Karaj	Second month	43057.9 (2.9)	0.5 (3.4)	4524.9 (1.1)	0.9 (11.2)	-12.8	1.206325e-13
SUM	First month	41648.2 (1.6)	0.8 (7.3)	75566.7 (3.6)	0.5 (3.5)	10	1.547252e-10
SUM	Second month	72898.8 (0.7)	0.7 (5.2)	15314.6 (1.3)	0.9 (7.9)	-5.8	3.15942e-06

coefficients of y_{t-1} for 2019 and 2020, respectively. se is the standard errors, and n is the number of observations.

Table 2 shows the results.

To interpret the results of Table 1, for example, regression models for O₃ in the second month show that the slope of growing O₃ production in 2019 is 0.6 and in 2020 is 0.5. P-value indicates that by 97.5% level of confidence, the slope of increasing O₃ production in 2019 is higher than in 2020. Based on table 1, the slope of the Co-first month, O₃-first month, NO₂-first month, NO₂-second month, PM₁₀-first month, PM_{2.5}-First month, Index-first month, Saveh-first month, Pardis-first month, Pardis-second month, Qom-second month, Karaj-second month and sum-second month are higher in 2020 compared to 2019. The results showed that the emission production rate is higher in the first month of 2020 compared to the same period in 2019. Also, the results showed that the daily traffic volume growth rate is higher in the second month of 2020 compared to the same time period in 2019. Estimated P-value for SO₂-second month, PM₁₀-first month, and Karaj-first month are higher than 0.36, which means the

difference between the slope of growth of these indices in 2020 and 2019 is insignificant and similar pattern have been observed.

CONCLUSION

Coronavirus is probably the most dangerous virus in the 21st century, affecting all countries around the world. This virus has brought economic damages to the governments and companies and made millions of people unemployed, besides endangering millions of lives around the globe. Up to now, no cure has been reported for this virus, and quarantine is the only available solution. Quarantine application in various countries- by restricting human actions- has improved the biological condition of the earth. This research has considered quarantine effects on the Tehran city air pollution level and daily traffic volume. This research has compared behavioral differences in air pollution and daily traffic volume in this year and the same period of last year. By using the mentioned points in this research, we can compare these parameters for attractive destinations of Tehran city residents in the Persian new-year holidays, for the same periods in this year and the previous year.

Results show that there is no difference between air pollution production in 2019 and 2020, but the Coronavirus epidemic affects daily traffic. The growing rate of emission production is higher in 2019 compared to 2020 for the second month. Also, the growing rate of daily traffic volume is higher in the first month of 2020 compared to 2020.

AUTHOR CONTRIBUTIONS

Moghadami, M. performed the literature review and analyzed and interpreted the results with the help of Rasaizadi, A. Rasaizadi, A. analyzed and interpreted the data and prepared the manuscript with the help of Askari, M. and Askari, M. designed and led the research and prepared the manuscript text and manuscript edition.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to various people for their contribution to this study. Also, there is no funding information available in the performance of the study.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

AQI	Air Quality Index
CO	Carbon mono-oxide
COVID-19	COrona Virus Disease 2019
MERS	Middle East respiratory syndrome
NO ₂	Nitrogen dioxide
O ₃	Ozone
PM	Particulate matters
PM _{2.5}	Particulate matter less than 2.5 microns in diameter
PM ₁₀	Particulate matter less than 10 microns in diameter
PPM	Parts per million

SARS	Severe Acute Respiratory Syndrome
SO ₂	Sulfur dioxide
veh/hr	Vehicle per hour
µg/m ³	Micrograms per cubic meter

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HOW TO CITE THIS ARTICLE

Moghadami, M.; Rasaizadi, A.; Askari, M., (2020). The effect of coronavirus restrictions on air quality and exiting daily traffic. *Int. J. Hum. Capital Urban Manage.*, 5(4): 331-338.

DOI: 10.22034/IJHCUM.2020.04.05

url: http://www.ijhcum.net/article_44694.html



ORIGINAL RESEARCH PAPER

Sequential extraction and bioavailability of some heavy metals on dumpsite soils in a semi-urban community

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ARTICLE INFO

Article History:

Received 01 June 2020

Revised 10 August 2020

Accepted 22 August 2020

Keywords:

Anthropogenic

Flame atomic absorption spectroscopy

Geogenic

Solid waste

Tessier's extraction

ABSTRACT

BACKGROUND AND OBJECTIVES: Solid wastes are composed of organic and inorganic pollutants (heavy metals) that can contaminate soil, underground and surface water; resulting in serious health challenges to humans. The bioavailability of cadmium, chromium, copper, lead and nickel on dumpsite soils, were investigated during the wet and dry seasons of 2018 by a sequential extraction method (Tessier).

METHODS: The soils were sampled from eight points within each of two dumpsites in Ilisan-Remo, Ogun State. Top soil of 0–15 cm depth was sampled, air-dried and sieved. The extracted soil samples were analysed for heavy metal concentrations using flame atomic absorption spectrometer.

FINDINGS: In the dumpsite soils examined, cadmium, chromium, copper and lead were majorly bound to the residual fractions at the first and second dumpsites, respectively for both seasons with mean concentrations (mg/kg) of: Cd – 0.65 ± 0.12 and 1.20 ± 0.07 , Cr – 36.83 ± 5.70 and 26.83 ± 3.57 , Cu – 28.37 ± 3.69 and 8.04 ± 0.32 , Pb – 12.40 ± 2.34 and 14.11 ± 2.44 , but Ni was found mainly in the Fe-Mn oxide fraction during the wet season, with mean concentrations (mg/kg) of 6.22 ± 1.33 and 8.24 ± 0.78 , for dumpsites A and B, respectively. The values obtained for these metals were higher during the dry season than a wet season and there were no metals in the mobile fractions for wet season. However, cadmium and lead were found in the carbonate fraction during the dry season, resulting in their bioavailability in the soils.

CONCLUSION: The speciation results revealed that heavy metals were more bioavailable in the residual fractions. The absence of mobile fractions in the soils indicated that metals are not bioavailable for plants uptake at present condition; hence, the metals obtained are of geogenic rather than anthropogenic origin.

DOI: [10.22034/IJHCUM.2020.04.06](https://doi.org/10.22034/IJHCUM.2020.04.06)

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NUMBER OF REFERENCES

63



NUMBER OF FIGURES

6



NUMBER OF TABLES

5

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

One of the biggest challenges faced by cities (both small and large) in developing countries is managing solid wastes (Guerrero *et al.*, 2013). Unfortunately, increase in population, urbanization, flourishing economy, and higher standard of living make the amount of solid wastes being generated to skyrocket in these countries (Minghua *et al.*, 2009). Solid wastes are substances which are non-fluid, and are apparently useless with no instant economic use; whether as a raw material, end product, expired products, or remnants, and certainly must be discarded (Eni *et al.*, 2011; Longe and Balogun, 2010). Anthropogenic activities like agricultural, domestic, industrial, and hospital activities, generate solid wastes. Following Udiba *et al.*, (2015) definition, wastes are grouped based on their origin (industrial, construction, and domestic, commercial or institutional), their contents (metal, plastic, organic substances, glass and paper etc.) or their plausible hazards (flammable, radioactive, toxic, non-toxic and infectious). Solid wastes management occurs through several methods. In major cities of Nigeria, solid wastes disposal takes place on landfills and open dumpsites. Wastes dumped at these dumpsites usually biodegrade and generate some leachates with time, which become the source of water and soil pollutions (Agbor *et al.*, 2013). Municipal wastes compose of a heterogeneous mixture of materials like metals, plastic, textiles, and so on. Meanwhile, a serious problem posed by these municipal wastes (due to their contamination on soil and water), is that it consequently put human health and their environments at greater risk of toxicity (Drechesel and Kunze, 2001). Solid wastes comprise organic and inorganic pollutants, which contaminate soil and water (underground and surface), leading to various health challenges (Srivastava, 2014). Metal toxicity depends on its mobility, transformation, potential bioavailability as well as their specific forms or binding state. In sediment and soil, total metal concentration can be used to characterize pollution intensity. However, heavy metal speciation with selective agents for extraction provides information about the key reactions controlling the metal behaviour in different matrices, and this helps to check the environmental impact of polluted sediment and soil (Ogunfowokan *et al.*, 2013; Salomons *et al.*, 1995). More so, speciation gives vital

and accurate information on how metals are mobile and bioavailable for plant metabolism (Nagajyoti *et al.*, 2010; Shuman, 1991). Mobility is the capability of metals to flow within fluids after decomposition. Prediction about quantitative element mobility is quite difficult in the environment. Mobility is considered empirically by making comparison among elemental behaviors, within changing environmental conditions. Chemical fractionation is largely influenced by several factors like pH, redox state, and so on. Thus, sequential extraction of metals helps to differentiate the relationship of the individual metal with the soil matrix; to establish metal bioavailability and its potential threat to the environment. Bioavailability is the tendency of metals to be soluble, and it increases in the order: residual < organic < Fe-Mn oxide < carbonate < exchangeable < water soluble (Ma and Rao, 1997). The fraction of elements from an ingested material like food, soil or water, which are absorbed by organisms, is termed as bioavailable fraction (Ng *et al.*, 1998). Bioavailability and mobility of metals rely on the various forms in which the metals are linked with the soil (Jaradat and Momani, 1998). One approach in determining the bioavailability and the potential danger is through sequential extraction of metals into different fractions, in order to estimate the labile fractions in atmospheric particulate matter, soils and sediments (Filgueiras *et al.*, 2002; Gleyzes *et al.*, 2002; Ross, 1994; Smichowski *et al.*, 2005; Tack and Verloo, 1995). One of the most important aspects of health risk assessment programs is the bioavailability of metals from sites that have been contaminated (Ng *et al.*, 1998). Trace element species are well understood in terms of distribution of metals, their bioavailability in soil, accumulation of these metals by organisms, and their toxic effects to humans (Bernhard *et al.*, 1986). Consequently, identifying speciation of elements for proper understanding of environmental processes is quite imperative. Soils contain different components of solid and soluble substances, which are organic and inorganic in nature (Xian, 1989). Thus, in order to gain better understanding on the chemical behavior of potentially harmful heavy metals in the environment, it is imperative to assess their bioavailability and mobility (Ng *et al.*, 1998). Several research studies have reported the total metal concentration, toxicity, mobility, and bioavailability of heavy metals in dumpsite soils from

several cities in Nigeria (Ogunfowokan *et al.*, 2013; Osakwe *et al.*, 2012; Yusuf, 2007). However, there is little or no data about bioavailability of heavy metals, through speciation on dumpsites soils in small towns like Ilisan Remo in Ogun State. Therefore, the aim of this study is to extract species of heavy metals using Tessier's extraction method. It further focuses on how to identify the bioavailability of these metals in major dumpsite soils. We carried out the study during the wet and dry seasons of 2018, in Ilisan Remo, Ogun State, Nigeria.

MATERIALS AND METHODS

Study area

Ilisan Remo is a settlement situated in Ikenne Local Government Area of Ogun State, South-Western, Nigeria. It is located within Latitude 6° 54' 0" N to 6° 57' 0" N and Longitude 3° 42' 0" E to 3° 39' 0" E (Fig. 1), in the rain forest climatic region of the country. Two major dumpsites and one control site (which was about 1 km from the dumpsites, with very minimal anthropological activities) within the town were used for the study. The first dumpsite (tagged dumpsite A)

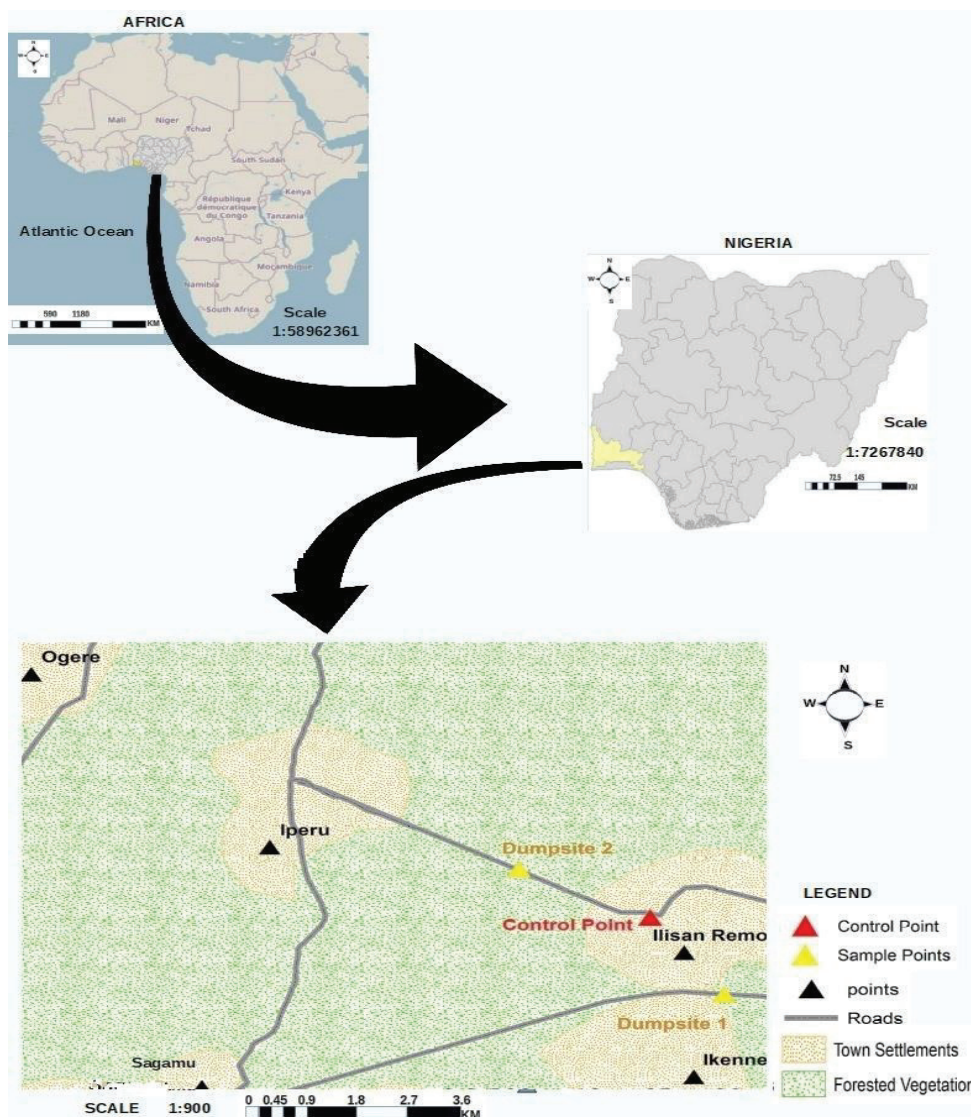


Fig. 1: Geographic location of the study area in Ogun State, South-Western, Nigeria

is located along old Ilisan-Ikenne road, whereas the second dumpsite (tagged dumpsite B) is located at Ilisan-Iperu road.

Sample Collection

Soils were sampled during the dry and wet seasons between August and December, 2018 from two major dumpsites and one control site. They were sampled from the top soil (0 – 15 cm depth) using a soil auger from eight points on each sampling site, with composite and representative samples obtained using the quartering method.

Determination of physicochemical properties of dumpsite soils

pH

Following Folsom method, the pH of soil was ascertained using water (Folsom, 1981). One gram representative soil sample was dissolved in 20 mL of distilled water. The mixture was stirred continuously for 30 minutes with a glass rod and the pH reading was taken. Calibration of pH meter was carried out with buffer 4, 7 and 9 solutions. The electrode was cleaned with distilled water and was used to take the pH reading, by immersing into the soil-water mixture. The pH was obtained as pH (H₂O).

Total organic carbon

The rapid wet oxidation procedure was used in determining the total organic carbon (Walkley and Black, 1934). Half gram of the soil was measured into a 250 mL beaker; 10 mL of 1 M K₂Cr₂O₇ solution was added and shaken carefully to properly moisten the sample. Twenty milliliters of concentrated H₂SO₄ was added and the whole mixture was left to cool for 30 minutes. One hundred milliliters of distilled water was thereafter added, then few drops of the Ferriin indicator and the mixture was titrated against 0.5 M FeSO₄ solution till a wine-red endpoint was obtained. A blank titration was carried out similarly. The percentage organic carbon was calculated using Eq. 1 and the percentage organic matter was further extrapolated with Eq. 2.

$$\% \text{ Organic carbon} = \frac{(B-T) \times 0.5 \times 0.003 \times 1.33 \times 100}{\text{Weight of sample}} \quad (1)$$

$$\% \text{ Organic matter} = \% \text{ Organic carbon} \times 1.729 \quad (2)$$

Where, B = titer value for blank, T = titer value for

sample, F = factor of correction = 1.33, and 0.5 M is of the ferrous sulphate.

Total nitrogen

The total nitrogen was measured using Macro-kjeldahl method (Black, 1965). Half gram soil sample weighed into a kjeldahl flask, 10 mL of concentrated H₂SO₄ and a selenium tablet were added and the mixture was heated for about 2 h until the solution became clear. The digest was distilled into a 2% boric acid solution containing a mixed indicator. Ammonia was trapped out of the whole digest by using 20 mL of 40% NaOH solution. The liberated ammonia was released into boric acid in receiver flask, which turns light green. Distillation continued until about 50 mL of distillate was collected into receiver flask. The solution obtained from the distillation was titrated against 0.1 M HCl until the initial color (pink) was detected at the end point.

Particle size determination

Particle size of the soil sample was estimated using the Hydrometer method and further classified using the Textural Triangular Diagram (Bouyoucos, 1962). Fifty grams of soil sample was weighed and transferred to a dispersing cup, then 100 mL of 5% dispersing solution was added and mixed for 60 s. The suspension was carefully transferred to a 1000 mL graduated cylinder, filled to mark with deionized water and the suspension was left to stand overnight to equilibrate. For 40 s reading, the hydrometer was inserted and the reading was taken after 40 s to measure the amount of silt (Eq. 3) plus clay suspended. After 6 h, the reading was taken again to know the amount of clay (Eq. 4) in the suspension. Finally the percentage of sand was determined using Eq. 5.

$$\% \text{ silt} = \frac{\text{corrected hydrometer reading at 40 s} \times 100}{\text{Weight of sample}} \quad (3)$$

$$\% \text{ clay} = \frac{\text{corrected hydrometer reading at 6 h} \times 100}{\text{Weight of sample}} \quad (4)$$

$$\% \text{ sand} = 100\% - (\% \text{ silt} + \% \text{ clay}) \quad (5)$$

Sequential extraction

Metal extractions were carried out using the method of Ma and Rao (1997), which is a modified

Tessier method (Tessier *et al.*, 1979) for speciation studies. For the sequential extraction processes, 1 g of the sieved soil samples was used. The top soils of the dumpsites for dry and wet seasons were investigated using a total of eight representative samples.

Water soluble fraction

Ten milliliters deionized water was poured in a test tube with 1 g of air-dried soil sample, and was mixed continuously for 1 h using a mechanical shaker. After an hour of shaking, it was taken through centrifugation, and the supernatant obtained was filtered (using Whatman filter paper No 42) into a 25 mL volumetric flask, and filled up to mark using distilled deionized water before heavy metal analysis.

Exchangeable fraction

Eight milliliters of 1 M MgCl₂ at pH 7 was used to leach the residue from soluble fraction (Fraction 1) at room temperature with continuous shaking for 1 h. The resulting solution was centrifuged at 4000 g for 10 mins and the supernatant (fraction 2) was carefully filtered (using Whatman filter paper No 42) into 25 mL volumetric flask, and made up to mark with distilled deionized water for metal analysis.

Carbonate fraction

The exchangeable fraction residue was further extracted to obtain carbonate fraction (fraction 3) using 8 mL of 1 M NaOAc solution of pH 5.0 with CH₃COOH at 96 °C and continuously agitated for 1 h, before centrifuging at 4000 g for 10 min. The supernatant was filtered (using Whatman filter paper No 42) and filled up to 25 mL mark with distilled deionized water before metal analysis.

Fe-Mn oxides (reducible) fraction

Fraction 3 residue was carefully extracted using 20 mL of 0.04 M NH₂OH.HCl in 25% (v/v) acetic acid at 96 °C with intermittent shaking for 5 h before being centrifuged at 4000 g for 10 min. The supernatant was filtered (using Whatman filter paper No 42) and made up to 25 mL mark using distilled deionized water, before being analysed for metal concentrations.

Organic matter (oxidisable) fraction

To the residues from Reducible fractions, 3 mL of 0.02 M HNO₃ and 5.0 mL of 30% H₂O₂ (adjusted to pH 2 with HNO₃) were added before heating

at 85 °C for 2 h, with intermittent shaking. Then, another 3 mL portion of 30% H₂O₂ was added to the resulting mixture, and maintained at 85 °C for 3 h with occasional shaking. On cooling, 5 mL of 3.2 M NH₄OAc was added to the sample, diluted with distilled deionized water to 20 mL and shaken ceaselessly for half an hour. Ammonium acetate was added to prevent the metals extracted from adhering into the oxidized sediment. The supernatant was filtered (using Whatman filter paper No 42) into 25 mL standard flask and filled up to mark with distilled deionized water, before metal analysis.

Residual fraction

Forty milliliters of aqua regia was used in digesting the residues from oxidisable fraction. The digested residue was allowed to cool, filtered (using Whatman filter paper No 42) into a 25 mL measuring flask, and filled to mark with distilled deionized water.

Besides, blanks were also prepared for the different fractions and were taken through similar protocol as carried out on the soil samples.

Analysis of heavy metals

Pure analytical grade reagents were used in this study and were checked for possible trace metal contamination. All glassware for metal analysis had been previously soaked in 10% HNO₃ (v/v) for 24 h to remove all embedded metals, and then rinsed with distilled deionized water before use.

The sequentially extracted soil samples were analysed for heavy metal concentrations with the use of air/acetylene flame atomic absorption spectrophotometer (210 VGP model, East Norwalk, Connecticut, USA) at the Department of Agronomy, University of Ibadan, Nigeria.

Quality control was done by running the analyses in triplicate, with blanks also processed for each of the sequential steps, analysed for heavy metals and used for calculation of metal contents. The percentage recoveries of the metals in the sequential extraction methods were between 90 and 102%. The parameters of operation for the heavy metals were set according to manufacturer's recommendations. Analyses of metal concentrations in the fractions and blank digests were carried out at specific wavelengths: Cd – 228.9 nm, Cr – 357.9 nm, Cu – 324.8 nm, Pb – 283.3 nm and Ni – 341.5 nm.

Table 1: Physicochemical parameters of dumpsite soils for wet season

Sites	WET			
	pH	TN (%)	OC (%)	OM (%)
Dumpsite A	6.60 ± 0.14 ^a	0.42 ± 0.03 ^a	1.65 ± 0.04 ^b	2.85 ± 0.02 ^b
Dumpsite B	5.95 ± 0.21 ^b	0.33 ± 0.03 ^b	1.92 ± 0.11 ^a	3.32 ± 0.19 ^a
Control	6.30 ± 0.10 ^b	0.24 ± 0.02 ^c	1.62 ± 0.28 ^b	2.80 ± 0.05 ^b

NB: values are shown as mean ± Standard Deviation (SD); n=2 and values with different letters on the same column are significantly different at $p < 0.05$
 TN- Total Nitrogen, OC- Organic Carbon, OM- Organic Matter, Dumpsite A- old Ilisan- Ikenne road, Dumpsite B- Ilisan-Iperu road

Table 2: Physicochemical parameters of dumpsite soils for dry season

Sites	DRY			
	pH	TN (%)	OC (%)	OM (%)
Dumpsite A	7.35 ± 0.21 ^a	0.29 ± 0.02 ^a	2.34 ± 0.13 ^b	4.06 ± 0.11 ^b
Dumpsite B	7.50 ± 0.12 ^a	0.24 ± 0.03 ^a	2.73 ± 0.08 ^a	4.72 ± 0.14 ^a
Control	7.60 ± 0.10 ^a	0.18 ± 0.01 ^b	2.29 ± 0.13 ^b	3.97 ± 0.24 ^b

NB: values are shown as mean ± Standard Deviation (SD); n=2 and values with different letters on the same column are significantly different at $p < 0.05$
 TN – Total Nitrogen, OC – Organic Carbon, OM – Organic Matter, Dumpsite A – old Ilisan-Ikenne road, Dumpsite B – Ilisan-Iperu road.

Statistical analysis

Data were analysed using statistical package for social sciences (SPSS) version 22.0 and were reported as mean ± standard deviation (SD). Means were compared using analysis of Variance (ANOVA) at 5% significance level, and were separated using least significant difference (LSD).

RESULTS AND DISCUSSION

Soil Characteristics

pH

Soil pH has a significant outcome on metal dynamics. This is due to the mechanism of metal retention in soil, which includes precipitation and adsorption based on hydrogen ion activity (Abdulhamid et al., 2015). The mean pH values of the dumpsites soils ranged from 5.95 ± 0.21 to 6.60 ± 0.14 for wet season and 7.35 ± 0.21 to 7.50 ± 0.12 for dry season, while the control site had a mean pH of 6.30 ± 0.10 for wet season and 7.60 ± 0.10 for dry season (Table 1 and Table 2). These values show that some of the soils were slightly acidic whereas others were slightly alkaline. The values reported from this study are within the range of those previously

reported – Yahaya et al., (2009) – 6.3-7.1, Iyaka and Kakulu (2009) – 5.0-7.5 and Parth et al., (2011) – 5.7-8.9. At low pH (acidic), metals are more soluble and bioavailable in the soil. The range of values obtained from the study site soils during wet season will favour plant uptake of heavy metals and hence there is possibility of toxicity problem (Osakwe et al., 2015). The higher pH of the study site soils, especially during the dry season, could be due to the presence of liming materials and microbial activities, which are sources of calcium carbonate (Ideriah et al., 2006; Yahaya et al., 2009).

Total nitrogen

The mean percentage (%) of total nitrogen ranged from 0.33 ± 0.03 (dumpsite B) to 0.42 ± 0.03 (dumpsite A) for wet season and 0.24 ± 0.03 to 0.29 ± 0.02 for dry season in the dumpsite soils, while the control site soil was 0.24 ± 0.02% for wet season and 0.18 ± 0.01% for dry season.

The results were similar to 0.12 – 0.21% reported by Akinbile (2012) for % N of soil samples within a landfill in Akure, Nigeria and 0.05 – 0.98% reported by Ideriah et al., (2017).

Organic carbon

The mean percentage (%) organic carbon (OC) of soil samples ranged from 1.65 ± 0.04 to 1.92 ± 0.11 for wet season and 2.34 ± 0.13 to 2.73 ± 0.08 for dry season at the dumpsites. The mean values for the control site soil had OC ranging from $1.62 \pm 0.28\%$ for wet season to $2.29 \pm 0.13\%$ for dry season. The OC values obtained were lower than 12–18% reported (for organic soils), by Troeh and Louis (2005). They were however similar to those reported by Abdulhamid *et al.*, (2015) – 0.95–2.25% and Akinnusotu and Arawande (2016) – 1.00–1.93%. On another hand, they were higher than values reported by Ideriah *et al.*, (2017) – 0.63–1.05%.

Organic matter

The organic matter (OM) value of the dumpsite soils ranged from 2.85 to 3.32% and 4.06 to 4.72% for wet and dry seasons, respectively while the control site soils had OM of 2.80% and 3.97% for wet and dry seasons, respectively. These values show that the dumpsite and control site soils had high organic matter according to the classification by Brady and Weil (2008), who classified OM level of soil into <0.4% OM as very low, 1.0 – 1.5% OM as moderate and >2.0% OM as high. The result obtained from this study could be attributed to deposition and decomposition of large amount of organic wastes and sewage sludge at the dumpsites. Organic matter is important in soil structure, water retention, formation of complexes and cation exchange (Alloway and Ayre, 1997). These values agree with those reported by Akinnusotu and Arawande (2016) – $0.69 \pm 0.01\%$ to $3.35 \pm 0.02\%$. However, they are higher than 0.025 to 0.707% reported for OM by Abdulsalam *et al.*, (2011) for soil from a dumpsite in Lokoja, Nigeria. These values are lower than those reported by Tefera *et al.*, (2018) – $13.83 \pm 0.48\%$ to $16.60 \pm 0.90\%$ and Olayinka *et al.*, (2014) – 14.78%.

Particle size of soil

The dumpsite soils particle size and texture are represented in Table 3. The soil particle size distribution were 80.8% sand, 17.2% clay, and 2% silt for the dumpsite soils and 82.8% sand, 15.2% clay and 2% silt for control site soil. The soil textural class was loamy sandy for the two dumpsite soils and the control site soil for wet and dry seasons. The particle size distribution showed that the soil had higher sand composition than clay and silt in all the sites. The low clay percentage implies a low cation exchange capacity, since clay in the soil determines its water retention capacity. More so, the volume of water is directly proportional to the pore spaces in any given soil. The sandy nature of the soil could be due to break down of humus from the soil (Tefera *et al.*, 2018). Similar soil texture (loamy sandy) and particle sizes (83% sand, 11% clay and 5% silt) have been previously reported by Obianefo *et al.*, (2017).

Metal concentration using sequential extraction

Tables 4 and 5 show the result of cadmium, chromium, copper, lead, and nickel concentrations, in each fraction of soils, for both wet and dry seasons. The total concentrations of most of the heavy metals in the soils collected from the two dumpsites were significantly higher ($p < 0.05$) than those found in the soil obtained from the control site.

Cadmium

Cadmium had a highest mean value of 3.77 ± 0.47 mg/kg (73.2% - Fig. 2) associated with the carbonate fraction of soil from dumpsite A, during dry season (Tables 4 and 5). This is in agreement with the study carried out by Yusuf (2007). The next predominant fraction of cadmium was found with Fe-Mn fraction during wet season, with concentrations of 1.72 ± 0.25 mg/kg at dumpsite A and 2.18 ± 0.32 mg/kg at dumpsite B (Table 4). On another hand, only

Table 3: Particle size distribution and textural class of studied site soils

Site	Season	% sand	% clay	% silt	Textural class
Dumpsite A	Wet	80.8	17.2	2	Loamy-sandy
Dumpsite B		80.8	17.2	2	
Control		82.8	15.2	2	
Dumpsite A	Dry	80.8	17.2	2	Loamy-sandy
Dumpsite B		80.8	17.2	2	
Control		82.8	15.2	2	

Dumpsite A – old Ilisan-Ikenne road, Dumpsite B – Ilisan-Iperu road.

Bioavailability of some heavy metals on dumpsite soils

Table 4: Heavy metal concentrations (mg/kg) of sequential extraction (wet season)

	Cd	Cr	Cu	Pb	Ni
SITE A					
Water soluble	ND	ND	ND	ND	ND
Exchangeable	ND	ND	ND	ND	ND
Carbonate bound	ND	ND	ND	ND	ND
Fe-Mn Oxide	1.72 ± 0.25	4.55 ± 0.85	5.36 ± 0.84	20.04 ± 1.85	6.22 ± 0.63
Organic matter bound	ND	ND	17.06 ± 1.95	8.28 ± 0.41	ND
Residual	0.65 ± 0.12	26.16 ± 1.61	3.67 ± 0.51	12.40 ± 1.34	ND
Sum of extracted metals	2.37 ± 0.37 ^b	30.71 ± 2.46 ^a	26.09 ± 3.30 ^a	40.72 ± 3.60 ^a	6.22 ± 0.63 ^b
SITE B					
Water soluble	ND	ND	ND	ND	ND
Exchangeable	ND	ND	ND	ND	ND
Carbonate bound	ND	ND	ND	ND	ND
Fe-Mn Oxide	2.18 ± 0.32	5.39 ± 0.63	6.29 ± 0.41	16.67 ± 1.96	8.24 ± 0.78
Organic matter bound	ND	ND	5.76 ± 0.57	8.28 ± 0.41	ND
Residual	1.20 ± 0.07	23.10 ± 1.97	3.00 ± 0.29	14.11 ± 1.44	ND
Sum of extracted metals	3.38 ± 0.39 ^a	28.49 ± 2.60 ^a	15.05 ± 1.27 ^b	39.06 ± 3.81 ^a	8.24 ± 0.78 ^a
CONTROL					
Water soluble	ND	ND	ND	ND	ND
Exchangeable	ND	ND	ND	ND	ND
Carbonate bound	ND	ND	ND	ND	ND
Fe-Mn Oxide	ND	4.05 ± 0.31	2.43 ± 0.38	ND	4.11 ± 0.36
Organic matter bound	ND	ND	ND	3.16 ± 0.47	ND
Residual	1.88 ± 0.14	15.80 ± 2.05	1.98 ± 0.28	11.40 ± 2.10	ND
Sum of extracted metals	1.88 ± 0.14 ^b	19.85 ± 2.36 ^b	4.41 ± 0.66 ^c	14.56 ± 2.57 ^b	4.11 ± 0.36 ^c

Values represent mean ± standard deviation (SD); ND – not detected. Values of the same total heavy metal with different superscripts are significantly different from each other at $p < 0.05$.

dumpsite A had a mean value of 1.38 ± 0.21 mg/kg cadmium associated with Fe-Mn fraction, during dry season. Percentage of cadmium in Fe-Mn fraction was in the range of 26.8 to 72.5% at both dumpsites. This was followed by the residual fraction with cadmium concentration of 0.65 ± 0.12 mg/kg at dumpsite A and 1.20 ± 0.07 mg/kg at dumpsite B. The percentage of cadmium in the residual fraction was 27.4% and 35.5% at dumpsites A and B, respectively, during wet season (Fig. 2). The result obtained in this fraction agreed with those presented by *Naji et al., (2010)* and *Anegebe et al., (2014)*. Cd was not detected in water soluble and exchangeable fractions; hence it would not be bioavailable for plants uptake. The order of cadmium in the different fractions was: Fe-Mn oxide > residual for wet season and carbonate > Fe-Mn oxide for dry season.

Chromium

High level of chromium was mostly found in the residual fraction with mean values of 26.16 ± 1.61 mg/kg at dumpsite A, 23.10 ± 1.97 mg/kg at dumpsite B and 15.80 ± 2.05 mg/kg at the control site during wet season (Table 4). However, during dry season, the mean levels (mg/kg) at dumpsite A, dumpsite B and control site were 36.83 ± 2.70 , 26.83 ± 1.57 , and 14.07 ± 1.89 , respectively (Table 5). This was followed by Fe-Mn oxide fraction with concentrations (mg/kg) of 4.55 ± 0.85 , 5.39 ± 0.63 , and 4.05 ± 0.31 at dumpsite A, dumpsite B and control site, respectively during wet season only (Table 4). The result obtained in this study, was of similar trend with studies carried out by *Tukura et al., (2007)* and *Iwegbue et al., (2009)*. Chromium in the residual fraction is less mobile compared with Cd and are often connected with the geogenic phase.

Table 5: Heavy metal concentrations (mg/kg) of sequential extraction (dry season)

	Cd	Cr	Cu	Pb	Ni
SITE A					
Water soluble	ND	ND	ND	ND	ND
Exchangeable	ND	ND	ND	ND	ND
Carbonate bound	3.77 ± 0.47	ND	6.35 ± 0.35	70.45 ± 4.07	ND
Fe-Mn Oxide	1.38 ± 0.21	ND	1.50 ± 0.12	30.51 ± 3.36	ND
Organic matter bound	ND	ND	28.37 ± 2.69	21.80 ± 1.89	ND
Residual	ND	36.83 ± 2.70	13.24 ± 0.98	18.20 ± 1.91	5.33 ± 0.47
Sum of extracted metals	5.15 ± 0.68 ^a	36.83 ± 2.70 ^a	49.46 ± 4.14 ^a	140.96 ± 11.23 ^a	5.33 ± 0.47 ^a
SITE B					
Water soluble	ND	ND	ND	ND	ND
Exchangeable	ND	ND	ND	ND	ND
Carbonate bound	1.86 ± 0.22	ND	11.98 ± 0.45	19.68 ± 1.69	ND
Fe-Mn Oxide	ND	ND	ND	ND	ND
Organic matter bound	ND	ND	10.72 ± 0.73	ND	ND
Residual	ND	26.83 ± 1.57	3.20 ± 0.21	64.00 ± 4.16	ND
Sum of extracted metals	1.86 ± 0.22 ^b	26.83 ± 1.57 ^b	25.90 ± 1.49 ^b	83.68 ± 5.85 ^b	ND ^b
CONTROL					
Water soluble	ND	ND	ND	ND	ND
Exchangeable	ND	ND	ND	ND	ND
Carbonate bound	0.59 ± 0.14	ND	2.23 ± 0.08	ND	ND
Fe-Mn Oxide	ND	ND	ND	ND	ND
Organic matter bound	ND	ND	1.17 ± 0.00	ND	ND
Residual	ND	14.07 ± 1.89	1.87 ± 0.11	71.82 ± 4.74	ND
Sum of extracted metals	0.59 ± 0.14 ^c	14.07 ± 1.89 ^c	5.27 ± 0.19 ^c	71.82 ± 4.74 ^b	ND ^b

Values represent mean ± standard deviation (SD); ND – not detected. Values of the same total heavy metal with different superscripts are significantly different from each other at $p < 0.05$.

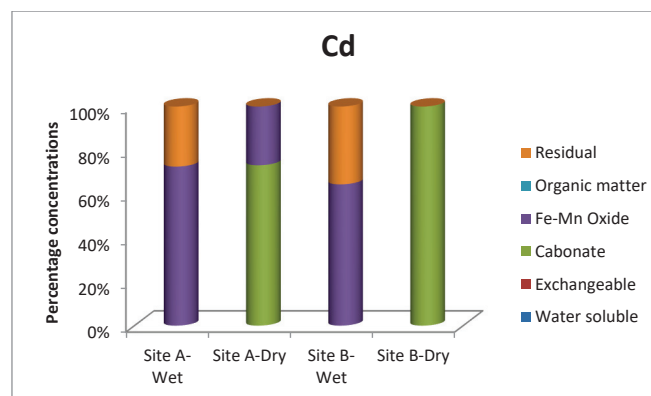


Fig. 2: Percentage concentrations of Cd in the soil Fraction for wet and dry seasons

Chromium was predominantly in the residual fraction, having a percentage of 100%, during dry season (Fig.

3). The availability of chromium is in the order of residual > Fe-Mn oxide for wet and dry seasons.

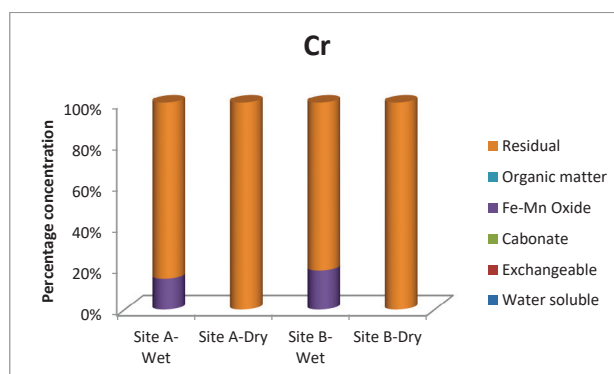


Fig. 3: Percentage concentrations of Cr in the soil for wet and dry seasons

Copper

A high level of copper was found in most of the organic matter fractions with a mean concentration of 17.06 ± 1.95 mg/kg at dumpsite A, 5.76 ± 0.57 mg/kg at dumpsite B for wet season, whereas, during dry season, copper had a concentration of 28.37 ± 2.69 mg/kg and 10.72 ± 0.73 mg/kg at dumpsite A and dumpsite B, respectively (Tables 4 and 5). These high contents of copper in organic matter fractions were also reported by Harrison *et al.* (1981), Ma and Rao (1997) and Segarra *et al.*, (2008). Copper has a high concentration owing to Cu-organic complexes being formed. Moreover, the high copper level in this fraction would bring about its immobility in soils, because copper is bound so tightly to organic matter to the extent that its bioavailability from organic soils can be very minimal (Kotoky *et al.*, 2003). Similarly, in the residual fraction, a high level of copper was obtained with concentrations (mg/kg) of 3.67 ± 0.51 , 3.00 ± 0.29 and 1.98 ± 0.28 at dumpsite A, dumpsite B and control site, respectively during wet season. And during dry season, the mean concentrations (mg/kg) were 13.24 ± 0.98 , 3.20 ± 0.21 , and 1.87 ± 0.11 at dumpsite A, dumpsite B and control site, respectively. This was comparable to those reported by Adano *et al.*, (1996) and Anegebe *et al.*, (2018). High content of copper in this fraction may be as a result of mineral and organic materials, which are acid resistant, present in the dumpsite soils. In addition, because the soil is sandy in nature, co-precipitation of copper with other silicate materials could have taken place (Manceau *et al.*, 1996; Manceau *et al.*, 1999). The content of copper in the Fe-Mn Oxide fraction was 5.36 ± 0.84 mg/kg at dumpsite A, 6.29 ± 0.41 mg/kg at dumpsite B, and 2.43 ± 0.38 mg/kg at control site for wet season, while during dry season, dumpsite A had a mean value of 1.50 ± 0.12 mg/kg. The copper levels (mg/kg) bound to carbonate were

6.35 ± 0.35 , 11.98 ± 0.45 , and 2.23 ± 0.08 at dumpsite A, dumpsite B and control site, respectively. Site A has the very high percentage of copper, 65.4% and 57.4%, in organic matter fractions for wet and dry seasons, respectively (Fig. 4).

Lead

The major fraction of lead was detected in the residual fraction with a mean value of 12.40 ± 1.34 mg/kg at dumpsite A, 14.11 ± 1.44 mg/kg at dumpsite B for wet season as well as 18.20 ± 1.91 mg/kg at dumpsite A and 64.00 ± 4.16 mg/kg at dumpsite B for dry season (Tables 4 and 5). The next was found in the carbonate fraction for dry season with mean concentration of 70.45 ± 4.07 mg/kg at dumpsite A and 19.68 ± 1.69 mg/kg at dumpsite B. Meanwhile, the high level of Pb in this fraction poses a threat to the ecosystem because carbonate dissolves readily with changes in soil characteristics like pH (Osakwe *et al.*, 2012). The next fraction with lead was Fe-Mn oxide at dumpsite A with a mean concentration of 20.04 ± 1.85 mg/kg, and 16.67 ± 1.96 mg/kg at dumpsite B for wet season, while in the dry season Pb had a concentration of 30.51 ± 3.36 mg/kg only at dumpsite A. Moreover, the association of lead and its high contents with Fe-Mn oxide is ascribed to stable complexes formation (Lopez-sandez *et al.*, 1996). A similar mean value of lead in Fe-Mn oxide fraction was previously reported (Karczewska, 1996; Ramos *et al.*, 1997). This was followed by affinity of lead with organic fraction in dry season, with a value of 21.80 ± 1.89 mg/kg at dumpsite A, and 8.28 ± 0.41 mg/kg for wet season in both dumpsite soils. This pattern of result was also reported by Tyler (1978) and Livette *et al.*, (1979). The occurrence of lead in different fractions is as follows: Fe-Mn oxide > residual > organic matter fraction for

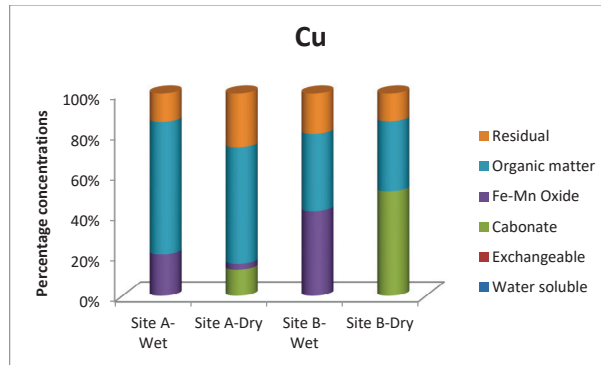


Fig. 4: Percentage concentrations of Cu in the soil for wet and dry seasons

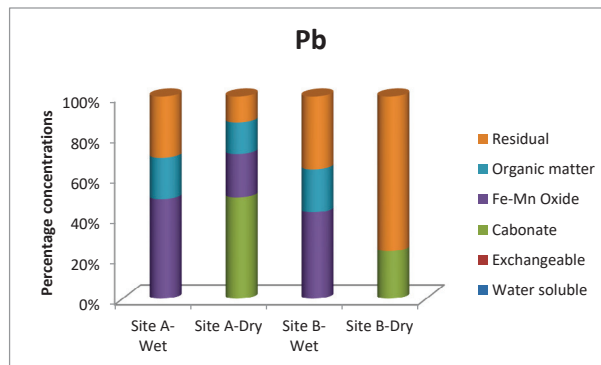


Fig. 5: Percentage concentrations of Pb in the soil for wet and dry seasons

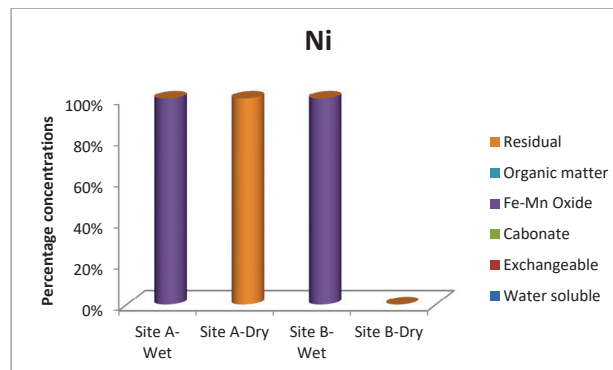


Fig. 6: Percentage concentrations of Ni in the soil for wet and dry seasons

the wet season. The levels of lead were highest in carbonate and residual fractions for dumpsite A and dumpsite B, respectively for the dry season (Fig. 5).

Nickel

Nickel was predominantly found in Fe-Mn oxide

at dumpsite A, dumpsite B, and control site with concentrations (mg/kg) of 6.22 ± 0.63 , 8.24 ± 0.78 , and 4.11 ± 0.36 , respectively for wet season and Nickel was associated with only residual fraction on dumpsite A during dry season, with mean concentration of 5.33 ± 0.47 mg/kg (Tables 4 and 5). This was agreeable with

the work reported by Olafisoye *et al.*, (2016). Nickel was not found in other fractions and was also not found in dumpsite B, during dry season; hence Nickel is not bioavailable for plant uptake (Fig. 6).

CONCLUSION

Bioavailability of heavy metals extracted using sequential extraction was carried out in this study. The soil characteristics were also determined as studying of physicochemical properties of soil is quite crucial for management of soil and growth of plants. From this study, the results obtained show that the soils were slightly acidic (during wet season) and slightly alkaline (during dry season), loamy sandy, and were found to be higher in organic matter content. The soil acidic nature is not so good for agricultural activities; but the organic content showed clearly that it can be a good source of manure for plant cultivation. The speciation results revealed that heavy metals were found more in the residual fractions for both seasons. Metals associated with these fractions are the least extracted; less mobile and not bioavailable. The water soluble, exchangeable and carbonates which are the mobile fractions were not detected especially during wet season, hence the dumpsites do not have metals which could be bioavailable and mobile. More so, the dumpsites do not pose any environmental problem as at the time of sample collection. The high concentration and mobility of copper, cadmium and lead in dry season, could bring about their bioavailability in the soil, which could pose a risk to food chain through plants uptake. Conclusively, metals were bound mainly to the residual fraction; hence these metals are not mobile and bioavailable as at the time of sample collection. However, the dumpsites should be continuously monitored by appropriate Government agency for strict control of wastes being disposed.

AUTHORS' CONTRIBUTIONS

Oluwatosin S. Shokunbi, collected the soil samples that were mainly analyzed by her, compiled and revised the manuscript. D.O. Jegede supported during sample collection, sequential extraction and design of graphical abstract. O.O. Ajayi supervised the study and reviewed the manuscript. Olutayo S. Shokunbi assisted during sample collection, recovery experiment, and did the final review of manuscript. All authors approved the manuscript for publication.

ACKNOWLEDGEMENTS

The authors showed their appreciation to the Leadership of the Departments of Basic Sciences, Microbiology, and Agriculture & Industrial Technology of Babcock University, Ilisan Remo, Ogun State, for provision of facilities for this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

ABBREVIATIONS

$^{\circ}\text{C}$	Celsius degree
%	Percentage
ANOVA	Analysis of variance
Cd	Cadmium
CH_3COOH	Acetic acid
Cr	Chromium
Cr	Chromium
Dumpsite A	Ilisan-Ikenne road
Dumpsite B	Ilisan-Iperu road
FAAS	Flame atomic absorption spectroscopy
Fe-Mn	Iron-manganese
FeSO_4	Ferrous sulphate
Eq	Equation
Fig.	Figure
g	Gram
h	Hour
HCl	Hydrochloric acid
HNO_3	Nitric acid
H_2O_2	Hydrogen peroxide
H_2SO_4	Sulphuric acid
$\text{K}_2\text{Cr}_2\text{O}_7$	Potassium dichromate
LSD	Least significant difference
M	Molarity
MgCl_2	Magnesium chloride
mg/kg	Milligram per kilogram
mL	Milliliter
n	Number of samples
nm	Nanometer
NaOAc	Sodium acetate
NaOH	Sodium hydroxide

ND	Not detected
NH ₂ OH.HCl	Hydroxylamine hydrochloride
NH ₄ OAc	Ammonium acetate
Ni	Nickel
OC	Organic carbon
OM	Organic matter
Pb	Lead
s	Seconds
SD	Standard deviation
SPSS	Statistical package for social sciences
TN	Total nitrogen
v/v	Volume per volume

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HOW TO CITE THIS ARTICLE

Shokunbi, O.S.; Ajayi, O.O.; Jegede, O.D.; Shokunbi, O.S., (2020). Sequential extraction and bioavailability of some heavy metals on dumpsite soils in a semi-urban community. *Int. J. Hum. Capital Urban Manage.*, 5(4): 339-352.

DOI: 10.22034/IJHCUM.2020.04.06

url: http://www.ijhcum.net/article_44457.html



CASE STUDY

Greenhouse gasses emission in the highly urbanized city using GIS- based analysis

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ARTICLE INFO

Article History:

Received 29 May 2020

Revised 11 June 2020

Accepted 05 September 2020

Keywords:

Emission sites (ES)

Environmental pollution (EP)

Geographic information system (GIS)

Greenhouse gases (GHG)

Polluted areas (PA)

ABSTRACT

BACKGROUND AND OBJECTIVES: As the population grows on the earth, transport and industrial sector have become the main parameters whose emissions increase pollutants like greenhouse gasses that have a snowballing impact on urban air quality and life in the area. This study aims to analyze the emission of greenhouse gases in the highly urbanized city of Karachi through Geographic information technique.

METHODS: This study used Inverse distance weighted technique of Geographic information system to highlight the emission of greenhouse gases in ten different sites of Karachi, Pakistan. Target areas include, Baloch colony, Clifton, Civic center, Garden police headquarter, II Chundrigar, Karimabad, Korangi, Nazimabad, SITE area and SUPARCO.

FINDINGS: Results showed that Baloch colony, Korangi, Nazimabad, SITE area and Garden police headquarter lies in the highly polluted areas among these ten sites of Karachi city. Karimabad with moderate pollution, II Chundrigar and SUPARCO with low pollution rate and Clifton had very low pollution.

CONCLUSION: As all of the observed ten sites of the city have dense population with heavy traffic and industrial pollution, there is a need to take serious steps towards areas indicated in this study to safeguard the people from the effects of GHG emission. With the help of this study the general population and all concerned authorities with highly polluted areas, can be familiarized so that efficient and different ways to overcome the pollution, like plantation, can be applied.

DOI: [10.22034/IJHCUM.2020.04.07](https://doi.org/10.22034/IJHCUM.2020.04.07)

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NUMBER OF REFERENCES

37



NUMBER OF FIGURES

6



NUMBER OF TABLES

1

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

Both Developed and developing countries are faced with the pollution crisis (Niaz et al., 2015). Annually, urban passenger transportation in USA, China and India, causes 670, 200 and 70 megatons CO₂ emission respectively (Sajjad et al., 2010). In Karachi, due to rapid increase in the rate of population, pollution of water, soil and air in the city has also increased. (Afzal et al., 2005). It has been demonstrated that urbanization and rapid population growth has created different adverse effects into the environment. (Arsalan et al., 2010). Regular growth in transportation sector which is among the major sources of air pollution, accounted for 14.3% of the world and 25.73% of Pakistan greenhouse gas (CO₂) emission as of 2010 (Duduta et al., 2010). Gaseous composition of clean, dry air by volume, is 78% nitrogen, 21% oxygen, inert gases 1.0% and CO₂ up to 0.1% to 0.3% (Wikipedia (2014). But disturbance in the gaseous mixture of earth's air may give rise to many health related consequences in humans (Afzal et al., 2005). In 2018, human, animal and plant diseases were reported to have developed due to the pollutants found in water and air (Neethirajan et al., 2018). Moreover, a number of allergic reactions were developed as a consequence of fungal spores present in the air (Sanches et al., 1999). From the atmosphere of Karachi, different fungal species were isolated such as *Aspergillus*, *Saccharomyces cerevisiae*, *Cladosporium*, *Alternaria* and *Penicillium* Afzal et al., (2004) which are the causative agents of many opportunistic infections. Whereas, a number of respiratory illnesses and skin infections were also reported to develop in Karachi, due to the contamination of both air and water (Arsalan et al., 2010). Air pollution may arise by both anthropogenic and non-anthropogenic activities. Natural proceedings like volcanic activity, wildfires and sand/dust storms are included as non-anthropogenic activities (Hutton, 2011). While industrialization and transportation are the two main sources of anthropogenic activities which are responsible for the increase in levels of Sulphur, carbon, nitrogen, lead, ozone and other hazardous contaminants into the environment. *Sulphur dioxide* is one of the manmade air pollutants which is causing extensive spreading and damage. The combustion of fossil fuel, coke ovens, metal smelting, wood and pulp production, petroleum refining and brick

manufacture are the major source of the sulphur dioxide (Katsouyani, 1995). High short-term level of SO₂ may increase disturbance in lung function, respiratory diseases and mobility rates in children and adult (Mentz et al., 2018). Furthermore, various epidemiological studies have shown that variation in exposure to major air pollutants on daily basis, such as ozone, particulate matter and SO₂ are related with health defects ranging from increased hospital admissions and mortality to subtle change in lung function at low to very low concentration (McClellan et al., 2009). *Carbon monoxide* is almost entirely a manmade pollutant. The incomplete burning of fuel produces carbon monoxide. At concentration of 100 ppm or more it is the most hazardous to humans, if experienced over a period of several hours (Sax et al., 2020). Most people experience headache and dizziness at 100 ppm. Cigarette smoke contains 400 to 450 ppm of CO. Death may occur after a short period of time (few minutes) when the CO concentration exceeds 750 ppm, while people may experience less consciousness at 250 to 500 ppm. Approximately about one million tons of CO is released into the atmosphere each year, half of which is due to human activities. In photochemical reaction 90% of CO is consumed in the air and produces ozone (Katsouyani, 1995). Moreover, automobiles contribute to manmade global CO emission by more than 80%, with a smaller amount resulting from other combustion processes (Zhong et al., 2017). Ozone is generated more significantly, as a result of chemical reactions involving the absorption of solar radiation by *nitrogen dioxide* (NO₂) in the presence of volatile organic compounds (VOCs) and carbon monoxide. In Los Angeles, the environmental impact of photo-chemically derived ozone was first studied during smog in 1950 (Kundu et al., 2010). *Nitrogen oxides* are extremely reactive gases and are formed when Nitrogen in fuel or combustion air is heated in the presence of oxygen to temperatures above 650 C. The initial product, nitric oxide (NO) is oxidized further in the atmosphere to nitrogen dioxide (NO₂), which is an active compound in the formation of photochemical smog. Because of low emission heights, Vehicular emissions are of particular significance. 70% of NO₂ concentration is found in ambient air environmental pollutants (Sindha, 2018; Lippmann, 2020). Mixing ratios of GHG in Atmosphere, e.g. CO₂ have increased by a

factor of 1.4, compared to pre-industrial times (Hartmann *et al.*, 2013). Developed countries' CO₂ emissions can be accurately estimated due to the available fossil fuel consumption data (Bréon *et al.*, 2015). The rising trends of increasing emission of Carbon dioxide are significant, the CO₂ emission rate is not only rapid but without any considerable down fall it is representing a positive and regular trend throughout the computed time. In 2006 emission of CO₂ in atmosphere has reached up to 151 million metric tons that was, in 1980, 39 million metric tons. This 287% increase in CO₂ during 1980 to 2006 is the result of energy consumption and mass urbanization in Karachi (Sajjad *et al.*, 2010). Additionally, high energy consumption and demand was also increased due to industrialization and over population throughout the world (World Development Indicators 2016). This high energy consumption and demand indicates the threatening fact that reserves of all conventional forms of energy (e.g. natural gas, coal, oil etc.) are fast depleting, causing atmospheric pollution and global warming particularly due to CO₂ emission (World Development Indicators 2016; IPCC 2014). Currently less than 3% of earth's terrestrial surface is covered by urban areas (Liu *et al.*, 2014), while it accommodates more than half of the population of the world, with growing trends (UN, 2018). From urban areas, many studies have performed on the estimation of GHG emissions (e.g. CO₂, CH₄ etc.). Air quality assessment demonstrate that natural gas and landfills are the two major sources of CH₄ emission in the United State (Plant *et al.*, 2019; Ren *et al.*, 2018; Cambaliza *et al.*, 2015). These gases are taking part in the global warming by causing outgoing infrared radiation absorption. The aim of Paris Agreement is, with comparison to pre-industrial levels, to maintain the global temperature rise below 2°C (UNFCCC, 2015). In present study, GHG emission which is badly affecting the earth's temperature in the form of CO, CO₂, NO and SO₂ were analyzed and represented through GIS. GIS techniques have been used in recent years to study issues regarding pollution. GIS is an efficient computer mapping software, within a geographic platform that allows enormous information to be analyzed and understood (Vine *et al.*, 1997; Kulldorff, 1999). GIS is an incorporated system of components which consisting real world information that has been summarized and represented into non-spatial

and spatial features of digital database, that in combination with effective software, and together with the proficient judgment of the GIS analyst, find the solutions to spatial queries and problems. Utilization of GIS include disease diffusion analysis, risk assessments, exposure modeling, environmental analyses and investigations of various other environmental and health issues (Schulz *et al.*, 2002; Briggs *et al.*, 2000; Becker *et al.*, 1998; Kulldorff *et al.*, 1997; Bullen *et al.*, 1996; Chakraborty and Armstrong, 1995). This study may provide information to the planners and concerned authorities in order to make informed decisions in the city and improve the environmental conditions. The current study has been carried out in 2018 to highlight the emission of CO, CO₂, NO and SO₂ in ten different sites of Karachi. The basic intention of this study is to represent GHG emission in highly urbanized city of Pakistan.

MATERIALS AND METHODS

Study area and objectives

Karachi is the financial city of Pakistan, and in recent years it is growing rapidly in terms of financial importance. In its west the Indus River flows and it is adjacent to the Arabian Sea. Karachi has an urbanized area of 1,300 km² over its total area of 3,600 km² (Qureshi, 2010). 16 million people live in the city, while approximately 95% of population resides in urbanized areas (Khan *et al.*, 2010; Mehdi *et al.*, 2011). The study area constitutes of ten different GHG Emission Sites (ES) in Karachi City i.e., Baloch colony, Clifton, Civic center, Garden police HQ, Il Chundrigar, Karimabad, Korangi, Nazimabad, SITE area and SUPARCO. These ten ES reflect the massive environmental area of Karachi, such as its planned and unplanned residential localities, industrial and commercial areas, proximity to Arabian Sea, and the Malir River carrying waste water. Fig. 1 illustrates the ES of study area. These ES were basically taken as geographic analysis unit. In this study, these ES point's GHG emission data of Kazi (2014) was used to develop GIS based maps. This research has been performed using Geographic Information System (GIS) techniques based on the following main objectives.

- To represent the emission of greenhouse gases (GHG) in the study area.
- To target the polluted areas (PA) of the study area due to the combine effect of GHG.

Study of Polluted areas through GIS

Flow of data processing

Statistical data may be analyzed to extract valuable thematic information of the earth's surface. Then this raw data is changed into information. There is lot of information extraction techniques but Inverse distance weighted (IDW) is one of the most practiced methods. In this study four gases such as CO, CO₂, NO and SO₂ are used

as GHG emission in study area. IDW technique was used to represent the pattern (Figs. 2, 3, 4, and 5) of these four gases in ArcGIS software while the Table 1 is showing the range of observed gasses. The GHG emission pattern of ES is derived to analyze environmental quality. Then finally to find the polluted area (PA) of these four emission patterns are combined in ArcGIS.

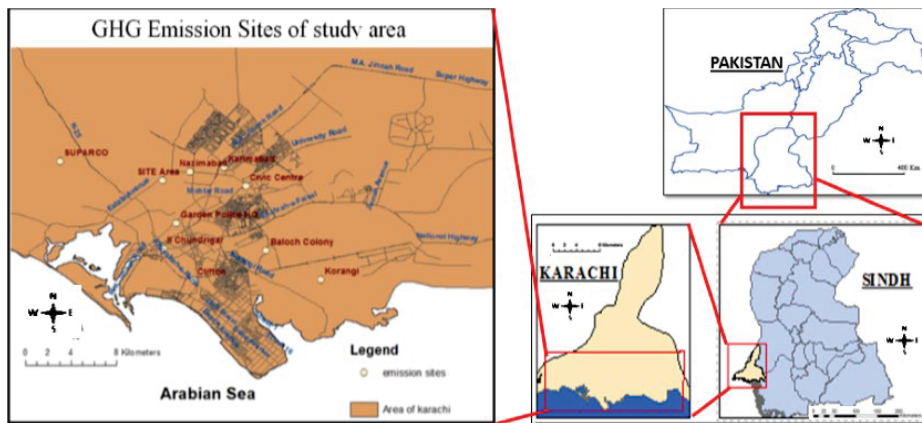


Fig. 1: Emission Sites (ES) of Karachi

Table 1: GHG emission range of study area (Kazi, 2014)

S.No.	GHG parameter	Values	Ref.
1	Carbon dioxide (CO ₂)	457.726 ppm to 286.98 ppm	Fig. 2
2	Carbon monoxide (CO)	3.91997 ppm to 2.95 ppm	Fig. 3
3	Nitrogen oxide (NO)	80.4022 ppb to 20.2712 ppb	Fig. 4
4	Sulphur dioxide (SO ₂)	35.1593 ppb to 15.6904 ppb	Fig. 5

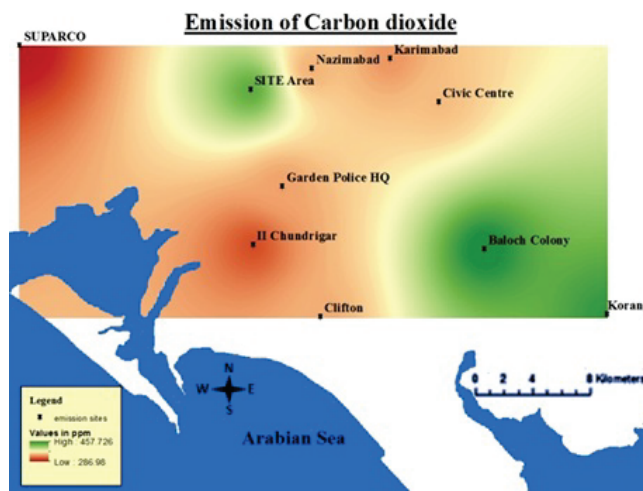


Fig. 2: CO₂ emission

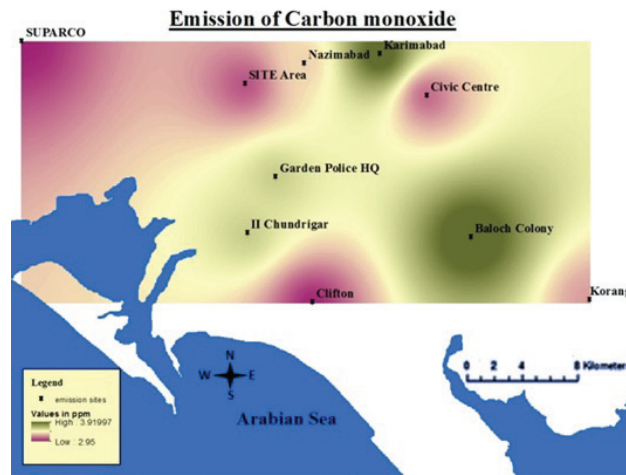


Fig. 3: CO emission

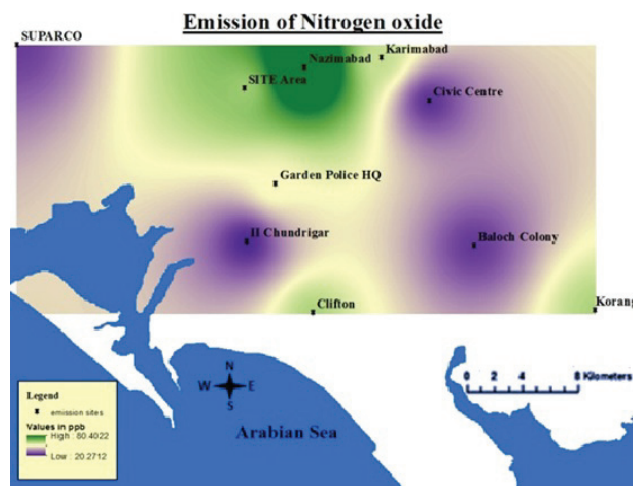


Fig. 4: NO emission

RESULTS AND DISCUSSION

As literature says that the previous studies have been done to estimate the GHG emission, finding the trend of GHG, many others analyzed the effect of GHG on the environment (Sun *et al.*, 2018) or discussed the diseases caused by its emission for the specific area or at country level (Crippa *et al.*, 2018), researchers also have performed the comparative study of GHG emission (Brown *et al.*, 2017) while this study is entirely different from previous researches because it's focus is to create awareness among the common people with the help of PA highlighted in the pictorial or mapped form so that they may understand the significance of this issue and take safety measures and

work towards finding a solution for the pollution in Karachi city. Pollution of this mega city is increasing day by day due to the various factors which include traffic and industrial growth. In this study, PA results (Fig. 6) which is the combined emission effect of CO₂, CO, NO and SO₂ which were also individually mapped in Fig. 2, 3, 4, and 5 respectively. All ten ES are highly populated, industrialized and have dense traffic. PA categorized the PA into five different categorizes, namely, very high, high, moderate, low and very low. According to the PA category, rate of pollution in Baloch Colony is very high. Garden police HQ, Korangi, Nazimabad and SITE area lie in high PA. Karimabad has moderate, II Chundrigar and SUPARCO has low pollution rate

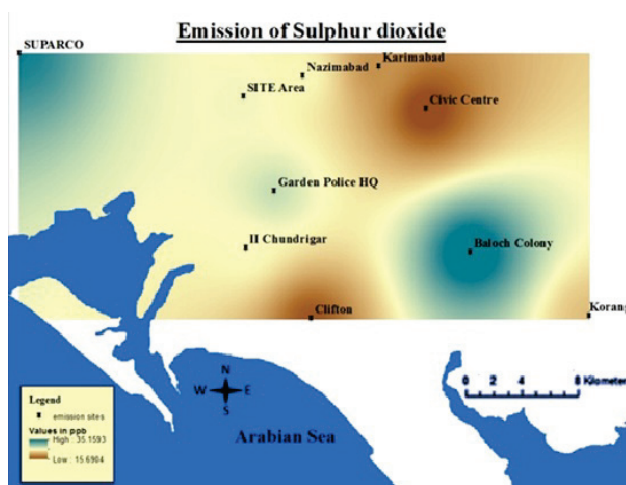


Fig. 5: SO₂ emission

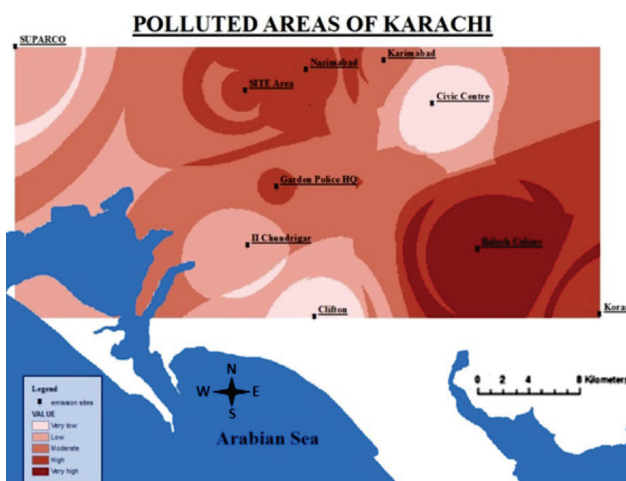


Fig. 6: Final result of PA in Karachi

however, Clifton has very low pollution. As Karachi is one of the most urbanized city of Pakistan where rate of population is increasing rapidly and along with it the industrialization and traffic burden of the city is also increasing which ultimately induces the air pollution, especially the emission of GHG into the environment. High GHG levels may cause hazardous effects on human health such as, inhaling these toxic contaminants may cause different infections dermal and lungs infections.

CONCLUSION

In conclusion, air quality was disrupted by the presence of a number of hazardous contaminants, the present study shows the concentrations of CO, CO₂,

NO and SO₂ that were analyzed and then highlighted the PA of Karachi, Pakistan through GIS. This study declared that GHG emission were high in the densely populated areas of Karachi or where traffic burden was high. Moreover, in the industrial areas of Karachi GHG emission were also high and it makes the air quality objectionable and potentially dangerous. Increase of air pollution at this rate will have great consequences on all life in that area, from lung and skin diseases in humans to complications in plant and animal life. The study highlights these areas so that concerned authorities and the general population in these highly polluted areas can be educated about the disastrous amounts of GHG emissions. If concerned

authorities and general population are made aware then proper steps can be taken towards improving the quality of air in these ES by adopting proper strategies and with careful planning. Such strategies may include, plantation which is one of the best options for controlling the air pollution and purifying the pollutant dense air. Furthermore, use of biofuels in the vehicles and industries will not only reduce the air contaminants but it also helps to overcome the energy crises. Many steps can also be taken on individual level by the general population which will contribute to reducing air pollution or preventing it from increasing in the PA. Limiting the usage of personal transport and walking, taking a bicycle, opting to carpool or using public transport are a few ways by which pollution can be minimized. With time the health of engines in all vehicles deteriorates which increases the amount of harmful emissions that are released. With proper and timely maintenance, we can decrease the amount of GHG emissions by the transport sector. The general population can also urge all concerned authorities to take proper steps towards decreasing GHG emissions by boycotting companies that fail to maintain low GHG emissions and starting petitions.

AUTHOR CONTRIBUTIONS

S. Arsalan Performed the literature review, experimental design and GIS work, compiled the data, I. Alishbah, K. Areeba and S.R. Erum prepared the manuscript text, and manuscript edition. I. Fizza, F. Zainab and S.R. Saima helped in the literature review and GIS working.

ACKNOWLEDGEMENT

Authors are extremely grateful to Army Public Degree College, Malir Cantt for providing motivational support especially to Mr. Muntazir Rizvi (Acting Principal) and Ms. Khaula Shahid (Section Head).

CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

ES	Emission sites
GHG	Greenhouse gases
GIS	Geographic information system
PA	Polluted areas
CO ₂	Carbon dioxide
CO	Carbon monoxide
NO	Nitric oxide
SO ₂	Sulphur dioxide

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HOW TO CITE THIS ARTICLE

Arsalan, S.; Imran, A.; Khawar, A.; Imran, F.; Faiz, Z.; Razaq, S.E.; Razaq, S.S., (2020). Greenhouse gasses emission in highly urbanized city using GIS based analysis. *Int. J. Hum. Capital Urban Manage.*, 5(4): 353-360.

DOI: 10.22034/IJHCUM.2020.04.07

url: http://www.ijhcum.net/article_44695.html



CASE STUDY

The impact of entrepreneurial skills on manager's job performance

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ARTICLE INFO

Article History:

Received 01 May 2020

Revised 29 July 2020

Accepted 12 August 2020

Keywords:

Entrepreneurship skills

Hormozgan province municipality

Job performance

Managerial skills

ABSTRACT

BACKGROUND AND OBJECTIVES: Entrepreneurship has become mandatory for different societies because not only does entrepreneurship make it possible for individuals to access the financial resources generated by the idea but it also facilitates the development of a country by solving problems in a new way. Accordingly, the purpose of this study is to explore and determine the relationship between entrepreneurial skills on job performance of managers and deputies working in the municipalities of Hormozgan province located in the south of Iran.

METHODS: The present study is a descriptive-practical correlation in terms of how data was collected. The collected data were based on the quantitative research method used to measure job performance by means of the Standard 15 Questionnaire. For evaluating the entrepreneurship skills, the 20 researcher-made questionnaire with 20 statements was used based on the research literature. The statistical population of the study consisted of 350 managers and deputy mayors of Hormozgan province. By applying the Cochran's formula, 182 people were selected as the statistical sample. Data analysis was performed by means of SmartPLS3 software.

FINDINGS: The results of the research indicate positive relationships among entrepreneurial (3.695), managerial (5.680) and technical (7.369) skills concerning job performance. Therefore, these hypotheses were confirmed and, on the contrary, the hypothesis related to the relationship between personal skills and job performance (1.774) was rejected.

CONCLUSION: According to the findings, the development of the relationship between entrepreneurial skills on job performance of managers and deputy mayors of Hormozgan province improves the competitive performance of organizations.

DOI: [10.22034/IJHCUM.2020.04.08](https://doi.org/10.22034/IJHCUM.2020.04.08)

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NUMBER OF REFERENCES

37



NUMBER OF FIGURES

3



NUMBER OF TABLES

3

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Note: Discussion period for this manuscript open until January 1, 2020 on IJHCUM website at the "Show Article."

INTRODUCTION

Organizations are social systems that aim to meet social and individual needs and they require efficient members to survive. One of the important responsibilities of organizational leaders is to increase the job performance of their human resources. Job performance is defined as a set of employees' behaviors which contribute positively or negatively in achieving organizational goals. Job performance has also always been an important factor in employee management (Shaw et al., 2013). This is because entrepreneurship plays an important role in the social change of developing countries (Tajpour et al., 2015). Every organization depends on employee performance to achieve its goals and make optimal use of resources. Accordingly, job performance is defined as the organizational value of employees' job behaviors at work times and careers (Borman and Motowidlo, 2014). In general, the performance is a set of job-related behaviors that people demonstrate. In fact, performance is a concept that consists of activity for doing job and it is the result of working together (Gomez-Mejia et al., 2014). Job performance has attracted the attention of many organizations due to the high importance of productivity. A lot of studies and research done by industrial and organizational psychologists have been concerned with identifying, evaluating, or improving job performance. Not only is it vital for the private companies but it is also important for the governmental and non-governmental organizations since the poor performance of an organization's employees causes dissatisfaction with the organization's clients and, therefore, it leads to unfulfilled goals set for that organization before. Optimal job performance of an organization's employees increases the organization's productivity which, in turn, improves the organization's service level and improves the economy (Gomez-Mejia et al., 2014). Today, entrepreneurship is a crucial factor for the development and economic well-being of countries because it is considered as a new investment and a dominant source of employment, innovation in organizations and markets, and economic growth. Entrepreneurship plays the role as a catalyst in the development and promotion of organizations and institutions, and it is one of the factors that trigger economic, social and industrial changes in countries. Therefore, if entrepreneurial skills are taught to those who are interested in

promoting them, it will accelerate the growth of that country as soon as possible and, consequently, it will prevent them from lagging behind other countries in the international arena (Montoro-Sanchez et al., 2014). In fact, while solving their previous and past problems, they will be able to deal with new issues and continue to be efficient and up-to-date by applying new policies and solutions. Organizations also need to face new challenges. In order to meet the growing expectations of entrepreneurship, these challenges are addressed through the interaction between education and entrepreneurship (Ziyae and Tajpour, 2016). It is essential to find out which factors increase the performance of managers in different organizations. Thus, in this study the municipalities of Hormozgan province were selected as the statistical population of the study. For justifying the reason for selecting the managers and deputies of this office as a selected society, it can be said that the municipalities of Hormozgan province in part of their annual performance have been involved in improving the proposed system in order to reform and create change(s) in the administrative system as a tool to achieve the goals of the Islamic Republic of Iran. In order to achieve the goals, the selected sample has focused on features such as entrepreneurial skills. Due to the importance and merits of entrepreneurship, different countries, including Iran, seek to establish and expand entrepreneurial centers in municipalities to identify and train entrepreneurs in their fields. Establishing entrepreneurial opportunities in Iran can create a bright future for the country in economic, political and social fields. Although entrepreneurial skills play an important role in advancing organizational activities, especially job performance, unfortunately, limited research has addressed the issue of entrepreneurial skills. Reflections on relevant research show that entrepreneurial skills in the municipality have not yet been considered and cultivated well. Considering the mentioned issues and the fact that various research on job performance and entrepreneurial skills have been done separately in this paper, the aim of this study is to evaluate the impact of entrepreneurial skills on job performance in Hormozgan Municipality. Finally, the theoretical foundations and background of entrepreneurship skills and job performance have been discussed in this study. In the following sections, after theoretical foundations, the research method has been stated

and the research questions and objectives have been mentioned. At the end, the research model has been analyzed by means of Smart PLS 3 software, and the results, discussions, and suggestions have been elaborated on.

Theoretical Foundations

Job Performance

Job performance is the expected value of organizations of individual behavioral events that individuals perform over a worktime. After completing the work and representing a superficial level of achievement of a job, performing organizational rules, it can be said that job results are fulfilling expectations or requirements for each employee (Campbell, 1990). Today, the role and importance of human resource is not neglected by anyone. Among the factors of production (land, human capital, technology, capital), human resource is the most valuable and rare factor. Being careless about the human resource efficiency and productivity and paying more attention to the other factors, not only does it decrease efficiency and productivity in the organization, but also it increases the wastes and accidents and, consequently, it causes dissatisfaction in human resources. In this case, in order to achieve the goals of the organization and prevent the possible damages, the results of the organization's performance can be evaluated and assessed, because the evaluation of job performance shows the quantity, quality and losses of a job. When the productivity is high, it indicates the high level of performance of the organization, and this job performance expresses the results of the employee's performance, including efficiency, usefulness, and effectiveness (Yeh and Hong, 2012). If properly evaluated and properly controlled, job performance can be considered an instrument that is appropriate for achieving the individual and organizational goals, as well as a tool for the efficient use of the organization's human resources (Jiang et al., 2012). Job performance improves the quality of service and production of organizations (Beheshtifar and Moghadam, 2016). Peterson et al., (2011) state that job performance is the degree to which a person is assigned to perform his / her duties. In other words, employees' job performance means how much they benefit from the resources used. In order to improve the job performance of employees, organizations need to be aware of their efficiency so that they

can improve their human resources and increase the volume of their products and services and make positive changes in their movement process (Jiang et al., 2012). Burman and Motoedlaw (1993, 1997) divide job performance into task performance and contextual performance. Task performance is the ability to solve problems and technical information and perform assigned tasks according to rules and expectations. Contextual performance implies that employees are willing to work for the organization, regardless of the rules and control system. This type of performance can improve the organization's performance or activity and improve job performance (Yeh and Hong, 2012). Recently, performance metrics have become an important and widely used concept in management research, especially in research in which scholars have studied and delved into the issues related to the organization such as structure, strategy and planning (Azevedo et al., 2011). In order to improve the job performance of employees, organizations must be aware of their efficiency (Darban Astaneh et al., 2012) so that they can improve the condition of their human resources and, therefore, increase the volume of production and service delivery and move forward. Accordingly, they can make positive changes in yourself (Jiang et al., 2012). Different criteria have been proposed for measuring job performance. Although organizations have recognized the importance of entrepreneurship and higher performance in today's competitive world, they have not yet achieved considerable success due to the lack of proper infrastructure for entrepreneurship (Zheng et al., 2010). In better words, job performance has been related to technical and entrepreneurial skills of employees and it prevents them from performing incorrect behaviors in the organization (Beng and Muthuveloo, 2019).

Motives for Attention to Organizational Entrepreneurship

Today, entrepreneurship is one of the factors influencing the development and employment of organizations because entrepreneurship can play an effective role in improving the economic and living conditions of countries by creating new employment and income opportunities (Ziyae and Tajpour, 2016; Salamzadeh et al., 2019). Also, because of the numerous events that have taken place at the social, cultural and business levels, special attention is paid to

entrepreneurship in different countries. Additionally, strengthening organizational entrepreneurship in current organizations and creating a suitable environment for its development are considered as the main tools for economic development. (Acs and Virgill, 2010). Entrepreneurship development in organizations can also pave the way for their success and it help organizations to perform strategic change (Tajpour and Salamzadeh, 2019; Chitsaz et al., 2019). In any organization, entrepreneurs are potentially available, and efforts must be made to increase their ability, and most importantly, conditions must be created for entrepreneurs to be able to express themselves and actually realize their potential. People who have a lot of faith in their talents often tend to create things that are their own. They demand responsibility, a strong need for self-expression, and greater freedom in the current organizational structure. Organizational entrepreneurship is a way of motivating and, then, exploiting individuals within an organization (Hjorth, 2005). In most cases, when organizational entrepreneurs are not supported by the organization, with the encouragement and support of venture capitalists, they leave the organization and decide to become independent entrepreneurs. The external motivation is one of the elements that influences the entrepreneurial motivation and action during the start-up of the new ventures. High external motivation _as a result of interacting with environment _ will give confidence to the entrepreneurs in their decision- making. The results of interacting with customers, family members and industries have increased their motivation and, as a result, it ensures the success of entrepreneurs' businesses in the future as opposed to those who are in a negative surrounding atmosphere (Fadzil et al., 2019). Therefore, in order to prevent the departure of entrepreneurs and talent people from the organization, paying attention to organizational entrepreneurship and providing a suitable platform for it in the strategy of companies are highly emphasized (Natarajan, 2014). However, in order to achieve innovation and growth, it is important to maintain or establish an entrepreneurial mentality in an organization. Entrepreneurial morale can be a valuable competitive advantage, especially for companies that have useful human resources and the ability to encourage and expand it in the organization. Through the development of the entrepreneurial

mentality within the organization which is called organizational entrepreneurship the obstacles to flexibility, growth and innovation can be overcome (Cooper, 2003).

The Importance of Organizational Entrepreneurship

Today's world is undoubtedly characterized by certain characteristics such as rapid changes and developments, complexity and competition (Nikraftar and Hosseini, 2017). Today's organizations operate in a dynamic, ambiguous, and evolving environment. One of the most prominent features of the present era is the dramatic changes that take place in thinking, ideology, social values, ways of doing things, and many other life phenomena (Hjorth and Steyaert, 2010). In addition, the speed of innovation and the introduction of new products have increased drastically that changes and initiatives have become commonplace in the market and what companies consider as a competitive advantage over other competitors is quickly imitated by others and reduced its importance (Windrum and Koch, 2008). Organizations should try to produce and offer more of their customers' desired product or service with all the features they want, and to continuously provide new competitive advantages with a new combination of available resources. That is why the importance of creative and innovative human resources, that is to say, organizational entrepreneurs in companies, is becoming more prominent. Only with such human resources can a company be able to innovate and survive in the realm of competition, and ultimately be recognized as a leading and entrepreneurial company (Brown and Ulijn, 2004).

Suitable Environment for Organizational Entrepreneurship

First, the organizations must work based on the superiority of industrial technology and encourage and support new ideas instead of cutting them out like what happens to companies that need immediate benefits for investment and high sales volume. Second, experience ought to be encouraged. The organization that seeks to create an entrepreneurial mentality within itself must provide an environment in which mistakes and failures in the development and growth of new innovative products are allowed, although it is created by the work and the traditional organizational promotion system.

Third, the organization must ensure that there are no initial obstacles to the production and development of new goods (Agboli and Ukaegbu, 2006). Fourth, according to Lowe and Marriott (2012), an intra-organizational entrepreneur, if s/he really wants to spend time, effort, and job risks creating a start-up entrepreneurial activity, the organization must also provide money and human resources. Fifth, the multiple methods of teamwork must be encouraged. With teamwork development in start-up entrepreneurial activity, the situation becomes more complex. In addition to pursuing teamwork, enterprise space must create a long-term horizon for evaluating the success of the whole project as well as the success of each entrepreneurial activity (Bradbury-Huang *et al.*, 2010). Sixth, the mentality of intra-organizational entrepreneurship should not be imposed on individuals; on the contrary, it should be voluntary. There is a difference between organizational thinking and intra-organizational entrepreneurial thinking. These differences are related to those people who perform better in one side or other side of the chain. Seventh, the other factor is the reward system. These rewards should be based on achieving the set goals. Equal opportunities in start-up entrepreneurship are one of the best ways to motivate and accomplish the work and effort required to succeed (Lipset, 2018). Eighth, the enterprise environment which is in line with intra-organizational entrepreneurship has founders and sponsors at the organizational level who both support the creative activities and the resulting fractures, and are flexible in planning to set new goals and paths based on what is needed. "If a new entrepreneurial and economic activity wants to be successful, its in-house entrepreneur must be able to change their design and plan according to his/ her needs and not worry about how close s/he is to the set goals," said one of the intra-organizational entrepreneurs (Drnovsek, 2002). In order to promote organizational entrepreneurship, there must be appropriate conditions within the organization. Factors that affect the scope of entrepreneurship are called the atmosphere or the entrepreneurial environment (Spilling, 1998). Management development in organizations is considered as a competitive advantage of the new era. In many organizations and institutions, one of the main problems is that there is not enough information about the level of wisdom

and knowledge of individuals (Sabokro *et al.*, 2018). Entrepreneurship is one of the most important and inexhaustible resources of all human societies_ a source that goes back to the ability of human resources of any organization. On the one hand, it is cheap and it is very valuable and inexhaustible, on the other hand. Any manager who can implements the culture of knowledge management in his/ her organization, s/he has made use of these resources appropriately. Formal law and accountability can be important dimensions for supporting and shaping entrepreneurship in any country (Kuratko, 2016). Nowadays, by neglecting entrepreneurship in an organization and relying only on previous resources, the organization will soon become obsolete and give way to rival and entrepreneurial organizations. Additionally, for improving job security and meeting social and economic needs, individuals must be equipped with entrepreneurial skills. In this regard, every person must have the skills to become an entrepreneur, which include:

A) Personal skills which include the following elements: internal control and discipline, risk-taking, innovation, ability to manage change, central change, persistence, resistance and perseverance, and far-sighted leadership (Hatch, 2018).

B) Managerial skills which include: planning and goal setting, human relations decision making, marketing, financial and accounting skills, management, control, negotiation and development management (Hisrich and Drnovsek, 2002).

C) Technical skills or expertise are the basis of creative work (Nikraftar and Hosseini, 2017) which includes: writing skills, oral/ verbal communication, monitoring or evaluation, environment, business management, technology, interpersonal skills, listening skills, organizational ability, creating management networks, coaching, acting, and role-playing in the team or team building skills (Hatch, 2018).

D) Entrepreneurial Skills in which Lyon (2002) described them as the skills needed to develop innovative products and services and create solutions for emerging market needs. Entrepreneurial skills are highly dependent on two important elements: the past experiences in which computers are used and the personal communication skills that greatly influence personal judgment and decision to start a new venture (Fadzil *et al.*, 2019).

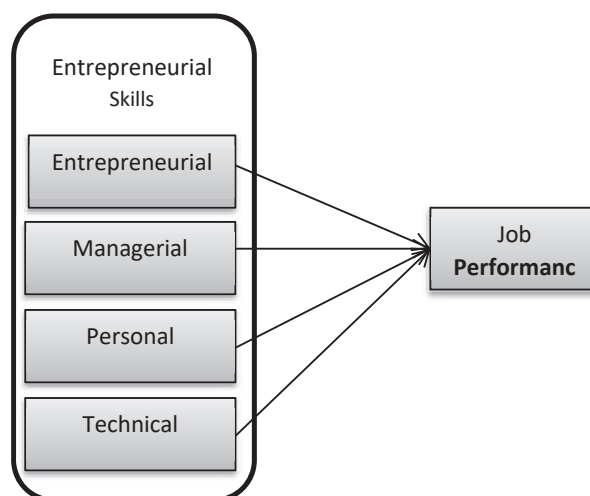


Fig. 1. Conceptual Research Model

Some research has shown that when there are entrepreneurial tendencies and motivations that make an organization more entrepreneurial, that organization will perform better (Filser et al., 2014; Jalali et al., 2014). According to the research literature, the conceptual research model (Fig. 1) was designed as follows:

Based on the conceptual research model, the hypotheses were formulated as follows:

Main hypothesis: The components of entrepreneurial skills have a significant relationship with job performance.

Sub-hypothesis 1: Entrepreneurship skills have a significant relationship with job performance.

Sub-hypothesis 2: Managerial skills have a significant relationship with job performance.

Sub-hypothesis 3: Personal skills have a significant relationship with job performance.

Sub-hypothesis 4: Technical skills have a significant relationship with job performance.

The purpose of this study is to find any possible relationship between entrepreneurial skills concerning job performance of managers and deputies working in the municipalities of Hormozgan province located in the south of Iran. The current study has been carried out in Hormozgan province in 2018-2019.

METHOD AND MATERIALS

The statistical population of the present study included managers and deputies who were active

in the municipalities of Hormozgan province in 2018-2019, amounted to 350 people. By applying the Cochran's formula, 182 people were selected as the statistical sample. In the current study, a questionnaire was used to collect data so as to measure job performance, a standard questionnaire of 15 Petterson statements (1989) was used and to measure entrepreneurial skills, a questionnaire of 20 researcher-made statements was used according to the research literature. Finally, the 35-item questionnaire was scaled through a 5-point Likert scale. For determining the validity, the experts' opinions were taken into account. Their content and literary corrections helped to clear up some ambiguous points and complete or correct some of the questions. The suggestions made in the final version of the questionnaire were taken into account and the dependability of the questionnaire showed its reliability in measuring variables. The Cronbach's alpha was used to validate the questionnaire. Smart PLS3 was used for inferential statistics to analyze data. This method is a statistical model for examining the relationships between latent variables and observed variables. In order to evaluate the fit, the model was studied at three levels of measurement, structural and general. In order to ensure the accuracy of the research results, the technical characteristics of the questionnaire were evaluated by means of validity and reliability by applying different criteria. Structural and content validity have been used in this study to investigate the validity of the questionnaire. For

Table 1. Relationship between Variables and Questionnaire Items

Row	variable	Items	Cronbach's alpha	Composite reliability	Reliability	Convergent validity	R ^{2*}
1	Entrepreneurial	1-5	0.905	0.929	0.928	0.720	-
2	Managerial	6-10	0.919	0.946	0.939	0.754	-
3	Personal	11-15	0.919	0.951	0.938	0.752	-
4	Technical	16-20	0.756	0.750	0.771	0.707	-
5	Job Performance	21-35	0.913	0.939	0.932	0.511	0.652

* R² is a measure of the effect of exogenous variables on an endogenous variable

Table 2. Divergent Validity

variables	1	2	3	4	5
Personal	0.867				
Job performance	0.453	0.715			
Technical	0.653	0.791	0.838		
Managerial	0.869	0.415	0.652	0.888	
Entrepreneurial	0.847	0.368	0.608	0.846	0.849

this purpose, first, a copy of the questionnaire was provided to 5 experts and educational experts to measure the content validity of the questionnaire, and finally, their comments and views were applied in the questionnaire. Cronbach's alpha coefficient and composite reliability index have been used to evaluate the reliability of the research variables. As can be seen in Table 1, the value of Cronbach's alpha coefficients and the composite reliability of all variables are more than the minimum acceptable, i.e. 0.7; therefore, it can be said that the tool for measuring variables has an acceptable reliability.

In order to check the reliability of the questionnaire, the criteria of the partial least square method have been used. In this method, reliability is measured with two reliability and composite reliability. The load factor is between 0 and 1 which indicates the observed variable power (question) in the measurement of the latent variable (main variable). The closer the number is to 1, the stronger the question. The criterion for the correctness of the factor load factors is 0.4 (Hulland, 1999). In this study, all load factors are above 0.4 and 99% confidence level are significant, which indicates that the indexes (index variables) appropriately explain the conceptual variables. The validity and reliability of the measurement model are represented in Table 1.

Studies show that the Cronbach's alpha coefficient and the composite reliability of all constructs are greater than the minimum acceptable of 0.7; therefore, the constructs of this study are desirable. Also, the study of the mean of extracted variance (AVE) and common reliability shows that the value of the whole construct is higher than the minimum acceptable, i.e. 0.5; as a result, the constructs of this study have convergent validity. According to the results of Table 1, since all indexes have average values of extracted variance higher than 0.5, convergent validity is established in all indexes. In order to evaluate convergent validity, the mean variance index has been extracted and the mean square index of extracted variance has been used to assess divergence. As Table 2 shows, the mean values of the extracted variance are more than the minimum acceptable 0.5. Thus, research variables have convergent validity. Also, given that the mean values of the extracted mean variance are greater than the correlation of the variable with the other variables, a divergent validity is acceptable if the numbers in the original diameter are greater than their sub-values (Fornell and Larcker, 1981). So, it can be stated that the variables are valid and their divergent validity is also confirmed.

Based on the above and the results of SmartPLS3 software output given in Tables 2 and 1, the validation

measurement models (convergent and divergent) and reliability (composite reliability coefficient and Cronbach's alpha) are at satisfactory level.

RESULTS AND DISCUSSION

Demographic Information

According to the descriptive statistics of this study, the demographic characteristics of the respondents are as follows: 49% of participants were female and 51% of them were male. Regarding their education, 35% had BA, 23.6% had MA, and 41.7% had associate degree. It can be claimed that the sample was appropriate in terms of demographic variables. Next, several criteria are used to evaluate the fit of the structural model of the research by using the least partial quadratic method which is the first and most basic criterion of significant coefficients or t-statistic values. The fit of the structural model using t-coefficients must be greater than 1.96 to be able to confirm their significance at 95% confidence level. The Fig 2 shows that all paths between model variables are validated and significant.

The second criterion for assessing the suitability of the structural model in a R^2 coefficient study is related to the latent endogenous variables of the model. R^2 is a measure of the effect of exogenous variables on

an endogenous variable, and three values of 0.19, 0.33, and 0.67 are for weak, moderate, and strong R^2 values (Fornell and Larcker, 1981).

These criteria are shown in circles related to the structural model of the research, and for the structural model of this research, given that there is a latent endogenous variable, it is common that the number within the rest of the other circles is zero. Fig 3 shows that in this study the R^2 criterion is above 0.33 (the criterion of average values), so the structural model is well-suited based on this criterion. The general model includes both measurement and structural model and with the approval of its fit, the model is completed. Therefore, the overall fit of the model is possible with the help of GOF fit criterion. According to the value of 0.767 for GOF, the overall fit of the research model is acceptable. According to the three values of 0.01, 0.25 and 0.36, the weak, medium and strong values for GOF are shown. The value of 0.767 for this criterion indicates a strong fit of the overall research model. At this stage, t-statistics have been used to investigate the assumed relationships between the variables. Four sub-hypotheses have been introduced in addition to the main hypothesis, and according to Table 3, the T-factor for the three existing relationships has been

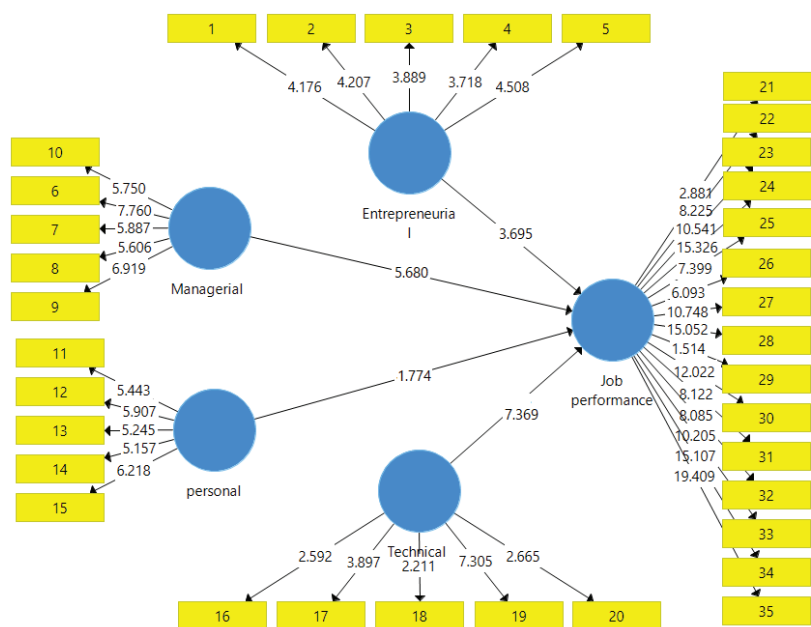


Fig. 2. T-statistics

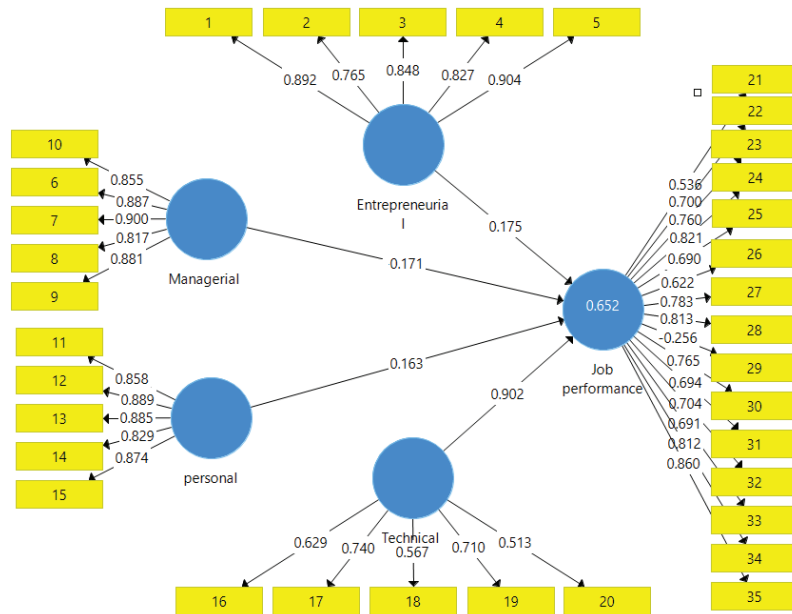


Fig. 3. Model of Standard Load Factor Mode

Table 3: t-statistics

Row	path	Influence coefficient	t-Value	Hypothesis testing
1	Entrepreneurial –job performance skill	0.175	3.695	confirmed
2	Managerial-job performance skill	0.171	5.680	confirmed
3	Personal-job performance skill	0.163	1.774	rejected
4	Technical-job performance skill	0.902	7.369	confirmed

confirmed. Of the four hypotheses, the first, second, and fourth hypotheses have been confirmed, and the third hypothesis has been rejected. In addition, other findings indicate that among the components of entrepreneurial skills, the “entrepreneurial skill, managerial skill and technical skill” affect the job performance of managers and deputies located in Hormozgan municipalities and the “personal skill” component related to job performance in Hormozgan municipalities has been rejected. To determine the effect of predictive variables on dependent variables, standardized factor load coefficients related to the pathways of each hypothesis have been explored. To some extent, the influence coefficients indicate that changes in dependent variables are directly related to independent variables.

The results show that the t-statistics for three of the four paths are higher than 1.96 and these scores confirm the hypotheses.

CONCLUSION

Nowadays, support for the creation of a work platform based on technical knowledge has surprisingly increased the success rate of the countries that concentrate on that economic and social development.

The world is now moving towards economic and entrepreneurship development. Entrepreneurs are, in fact, the champions of countries’ economic and trade development. Entrepreneurship is a multidimensional phenomenon which establishes good opportunities, trains people with the high degree of risk tolerance, and etc. Entrepreneurship is a dynamic process of producing wealth and value in society which is achieved by the entrepreneurs with the appropriate understanding and placement of resources and skills including personal skills, managerial skills and technical skills. According to the results of the first hypothesis_ that is to say, entrepreneurial skills have a positive and

significant effect on the job performance of managers and deputies, it can be said that the development of entrepreneurial skills is a new stage in the economic development of any country. Entrepreneurial skills increase a person's ability to perform job duties. By developing entrepreneurial skills, individuals will improve their knowledge in the relevant field and prepare themselves to face challenges and competitions. Given that municipalities play an active role in social progress and they are important for sustainable development of societies, managers have a very serious and decisive responsibility in this regard. For this reason, countries that prefer to achieve constructive development have realized that the need to create a healthy society depends on the existence of effective managers. Accordingly, it can be said that a person's personality traits such as extraversion, independence and success are among the entrepreneurial skills that affect job performance. These characteristics make a person do his/her job with high responsibility and motivation. The results of this hypothesis are consistent with the results of Lumpkin et al., (2010), Marriott (2012), Beng and Muthuveloo (2019) and Agboli and Ukaegbu (2006). Regarding the second hypothesis- that is to say, managerial skills have a positive and significant effect on job performance_ it can be said that managers and deputies should be able to coordinate and integrate the organization's efforts and activities, ability to understand the organization as a whole, understanding how the components of the organization communicate with one another and having the ability to predict the effects of a change in the organization. Management is also a process that helps organizations identify, select, organize, disseminate, and transmit important information and capabilities that are part of an organization's history and generally exist in an unorganized form in the organization. Therefore, in order to be successful in performing management tasks and playing management roles, managers must have some managerial abilities. Person's experience and management skills during working life have a considerable role on his/ her performance because they provide a useful source of information for entrepreneurs to be able to start new jobs in the future. Appropriate communicative skills as a result of effective interactions lead to better job performance. If managers are not able to interact effectively, the organization will not perform well. The results of this hypothesis are consistent with

the results of Lightweight et al., (2018), Fadzil et al., (2019) and Hisrich and Drnovsek (2002). Regarding the third hypothesis, that is to say, personal skills have a significant effect on job performance, considering the rejection of this hypothesis, it can be stated that the main reason for rejecting this hypothesis is the municipal educational level. Focusing on the development of personal features such as looking to the future in life, personal independence in decision making, etc. can be the basis for the development of entrepreneurial skills that should be considered. Therefore, by strengthening skills such as communication, it can be effective in reinforcing the fields of entrepreneurship in managers. In general, it can be inferred that in municipalities, while providing an interactive and participatory approach and the existence of an open environment for managers, it is necessary to provide the field for maintaining and continuing and strengthening entrepreneurship for municipal managers. In this regard, it is suggested to hold entrepreneurship training courses for managers and deputies to expand entrepreneurial activities. These trainings not only lead to a small growth of entrepreneurs, but also to a change in the generations of entrepreneurship and to an increase in the level of entrepreneurship and job performance. Regarding the fourth hypothesis - that is to say, the technical skills of managers and deputies have a positive and significant effect on their job performance_ it can be said that access to information resources, use of public knowledge, improving the information system to access information and technical knowledge about entrepreneurship are important issues. It impacts on the development of entrepreneurial skills that can lead to productivity performance. It also refers to the process of identifying sources, identifying, exploiting, and creating value from opportunities. Technical skills of managers and deputies are acquired through training and experience. Technical skills are used as a general and basic criterion for developing technical expertise in management. Also, the best and most transparent reward for managers and their promotion is their technical performance. Proper rewards lead to better job performance. There is also the role of technical skills in the performance of managers which explain why some researchers believe that technical skills are not much different from managerial skills. Sharing work issues and problems with the manager without considering the negative effects in the

field of work and technology can lead to positive performance of employees and the organization in the long run, on the one hand. Transparency of information by management in order to do the job can lead to improved performance, on the other hand. The results of this hypothesis are consistent with the findings of the research done by Hatch (2018), Beng and Muthueloo (2019) and Frederick *et al.*, (2006).

Suggestions

According to the findings of the current paper, it can be said that municipalities of Hormozgan province create appropriate environmental and cultural conditions and entrepreneurial space to encourage new ideas and experimental efforts, remove restrictions on the use of opportunities and provide the necessary resources. It is also suggested that the organizational entrepreneur should be creative, flexible, insightful and able to work within in the municipalities of Hormozgan province which can be created through the mandatory training. One of the most important reasons why creative people hide their strength is that many organizations are reluctant to change their system. In addition, very few resources are allocated to any new work, and it is not taken very seriously. As a result, creative people see no reason to be creative and look for new opportunities. Therefore, the formation of entrepreneurial teams in the municipalities of Hormozgan province should be encouraged and the members of the team should be supported. For the future research, it is suggested that similar research be done with regulatory variables such as organizational leadership, organizational agility, and so on. Given that there is no indigenous model for entrepreneurial skills among domestic research, it is recommended that a qualitative study be conducted.

AUTHOR CONTRIBUTIONS

M. Tajpour performed the conceptualization and literature review, compiled the data, manuscript preparation and editing references. E. Hosseini performed the Methodology, analyzed and prepared the manuscript text. M. Lashkarbooluki helped in the literature review and manuscript preparation.

ACKNOWLEDGEMENT

The authors would like to extend their gratitude

to the managers and deputies of the Municipalities of Hormozgan province who helped to complete the present study.

CONFLICTS OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

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HOW TO CITE THIS ARTICLE

Hosseini, E.; Tajpour, M.; Lashkarboluki, M., (2020). *The Impact of Entrepreneurial Skills on Manager's Job Performance.* *Int. J. Hum. Capital Urban Manage.*, 5(4) : 361-372.

DOI: 10.22034/IJHCUM.2020.04.08

url: http://www.ijhcum.net/article_44275.html



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