TOJSAT
The Online Journal of Science and Technology

ISSN 2146-7390

The Online Journal of Science and Technology

Volume 7 Issue 4
October 2017

www.tojsat.net
October 2017

Published in TURKEY

Contact Address:

Prof. Dr. Mustafa Şahin Dündar - TOJSAT, Editor Sakarya-Turkey

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TOJSAT will organize ISTEC-2018 - International Science & Technology Conference (www.iste-c.net) between July 18-20, 2018 in Paris, France. This conference is now a well-known science and technology event. It promotes the development and dissemination of theoretical knowledge, conceptual research, and professional knowledge through conference activities. Its focus is to create and disseminate knowledge about science and technology. ISTEC-2017 conference book has been published at **http://www.iste-c.net/istecpubs**

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October 01, 2017
Prof. Dr. Aytekin ISMAN
Sakarya University

Message from the Editor

Dear Tojsat Readers,

Today, we have reached to the end of seventh volume of the journal. With the seventh volume seven years past from the journals' first issue published on-line. Our goal is to rewiev and accept multi disciplinary research papers, rewiev articles, etc. for the journal from scientific World such as *"Heavy Metal Removal By Polymer-Zeolite Based Adsorbent","Evaluation of Arastas and Bazaars of Ottoman Cities within the Context of Construction Materials and Architectural Typologies*" in this issue of journal.

I will thank to the readers all around the World for their supports by sending valuable scientific studies to publish in The Online Journal of Science and Technology.

Prof.Dr. Mustafa Ş. Dündar

Editor

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A NEW MICROWAVE ASSISTED SYNTHETIC METHOD FOR THE SYNTHESIS OF 2-(1H-BENZO[D]IMIDAZOL-1-YL)-1-PHENYLETHAN-1-ONE OXIMES: AN EXPERIMENTAL AND COMPUTATIONAL STUDY

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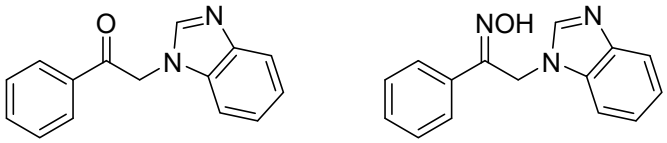
Abstract: This study consists of two parts. In the first part, we have studied on a new microwave assisted synthetic method for the synthesis of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oximes from corresponding ketones. The results showed that the proposed microwave assisted method is efficient and time and energy saving. In the second part of our study some density functional theory (DFT) calculations have been performed on the selected molecules and compared with the experimental results. In the computational part of the study; single point energy calculations, geometry optimizations, frequency analysis, NMR spectral analysis, molecular electrostatic potential map calculations, frontier molecular orbital calculations, determination of some global reactivity descriptors and Mulliken atomic charge calculations have been performed. All DFT calculations were carried out at the B3LYP/6-31G(d), B3LYP/6-311G(d,p) and B3LYP/6-311+G(2d,p) level of theories.

Keywords: Microwave synthesis, oximes, benzimidazole, DFT calculation, computational chemistry

Introduction

Oximes and related compounds are important compounds in organic chemistry. This type of organic compounds can be very useful for the synthesis of wide range of organic molecules. Additionally, especially with the integration of some certain groups, like imidazole, benzimidazole, triazole, benzotriazole etc. this organic compounds exhibit broad spectrum of biological activities (Jiang, 2011). They can act as antibacterial (Kaplancikli, 2004), antifungal (Madkour, 2006) and antiviral (Beaulieu, 2006) agents etc. Figure 1 represents a typical 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and its oxime form.



ketone oxime

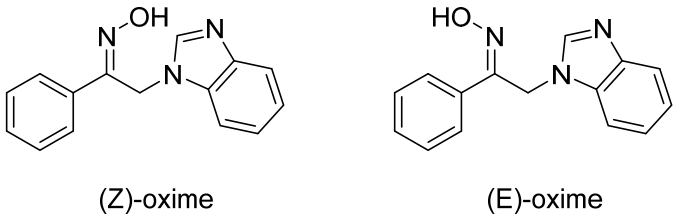
Figure 1. A typical 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and its oxime form.

Miconazole is an important antifungal agent. It is the active ingredient of some commercially available pharmaceuticals. Oxiconazole is the oxime ether form of miconazole and it is also an important commercially available antifungal agent.

Literature contains various methods for the synthesis of oximes. Oximes can be prepared by the addition of hydroxylamine to aldehydes or ketones (Smith, 2007). This reaction is generally carried out in the presence of bases, and ethyl alcohol is commonly used as solvent. But some other methods also can be used, for example, refluxing in pyridine without using additional base (Abdel-Megid, 2002). Phase transfer reactions also can be used in this type of conversion and PEG-600 and high carbon number phenols, for example, nonyl phenol or dodecylphenol, can increase reaction rate as phase transfer catalysts (Liu, 1997; Krbechek, 1994). Microwave energy can also be used in the transformation of ketones to the corresponding oximes (Puciova, 1992; Mitra, 1999; Hajipour, 1999).

Oxime can be obtained either (E)- or (Z)- isomers. It is related to the relative stability of the isomers which will be the major product. In some cases (E)- isomer is more stable and becomes the major product but in some cases the (Z)- isomer is the major one. Figure 2 represents (E)- and (Z)- forms of 2-(1H-benzo[d]imidazol-1-yl)-1-

phenylethan-1-one oxime.



(Z)-oxime (E)-oxime

Figure 2. (E)- and (Z)- forms of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

One of the methods for the synthesis of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime is reported by Abdel-Megid (2002). In this method ketone was refluxed in pyridine for 6 hours in the presence of hydroxylamine. The yield was reported as 55%. Another method is reported by Özel Güven (2007). In this method, the reaction was carried out at room temperature in 24 hours. Methanol and water were used as solvents. The reported yield is 65%.

Materials and Methods

This study consists of two parts. In the first part, we have studied on a new microwave assisted synthetic method for the synthesis of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime from corresponding ketone. However the literature contains various methods for the conversion of this type of ketones to their oxime forms (Abdel-Megid, 2002, Ozel Guven, 2007, Rad, 2009, Roeintan, 2015), the results showed that the proposed microwave assisted method is efficient and time and energy saving. Microwave assisted ketone to oxime conversion reactions was carried out in pyridine in the presence of hydroxylamine hydrogenchloride under 200 W of microwave energy in 30 minutes. Prior to ketone to oxime conversion reaction we have used a two step literature method for the synthesis of ketone (Özel Güven, 2007).

In the second part of our study some density functional theory (DFT) calculations have been performed on the synthesized molecules and compared with the experimental results. In the study; single point energy calculations, geometry optimizations, frequency analysis, NMR spectral analysis, molecular electrostatic potential map calculations, frontier molecular orbital calculations, determination of some global reactivity descriptors and Mulliken atomic charge calculations have been performed. All DFT calculations were carried out at the B3LYP/6-31G(d), B3LYP/6-311G(d,p) and B3LYP/6-311+G(2d,p) level of theories using Gaussian 09W Rev.D.01 Program Package (Frisch, 2013). GaussView 5 Program Package (Dennington, 2009) was used for the visualization of the computational results.

Results and Discussion

In the synthesis of oxime from corresponding ketone, optimal ketone to hydroxylamine hydrogenchloride molar ratio was found to be 1:1.5. The reaction yield was found to be nearly 65%. The optimal microwave energy and microwave irradiation time was found to be 200W and 30 minutes, respectively.

In computational studies, firstly, calculations on the relative stability of the (E)- and (Z)- isomers of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime was carried out. Energies for the (Z)- and (E)- isomers and the energy differences between two isomers are given in Table 1. Results showed that the (Z)-isomer is more stable than the (E)- isomer.

Table 1: Relative stability of the (E)- and (Z)- isomers of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

Isomer	6-311G(d,p) (hartree)	6-311+G(2d,p) (hartree)	6-311G(d,p) (eV)	6-311+G(2d,p) (ev)
Z	-819.05482657	-819.08865299	-22287.62533962	-22288.54580374
E	-819.05307601	-819.08814267	-22287.57770444	-22288.53191722
ΔE	0.00175056	0.00051032	0.04763518	0.01388652

For a comparison, the same calculation was carried out on the imidazole substituted oxime. Results for the calculations on the relative stability of the (E)- and (Z)- isomers of 2-(1H-imidazol-1-yl)-1-phenylethan-1-one oxime are given in Table 2. It can be seen that the energy differences between (E)- and (Z)- isomers for the imidazole substituted oxime is bigger than the benzimidazole substituted oxime. The (Z)- isomer is again the more

stable isomer.

Table 2: Relative stability of the (E)- and (Z)- isomers of 2-(1H-imidazol-1-yl)-1-phenylethan-1-one oxime.

Isomer	6-311G(d,p) (hartree)	6-311+G(2d,p) (hartree)	6-311G(d,p) (eV)	6-311+G(2d,p) (ev)
Z	-665.37104241	-665.39952978	-18105.67500978	-18106.45019089
E	-665.36881286	-665.39858609	-18105.61434061	-18106.42451177
ΔE	0.00000941	0.00094369	0.06066917	0.02567912

Calculated and experimentally obtained selected geometric parameters for the 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime was given in Figure 3 and Table 3. Calculated values were obtained at the B3LYP/6-311+G(2d,p) level of theory. Experimental geometric parameters are literature values (Özel Güven, 2007). The results show that there is a good agreement between the experimental and computational results.

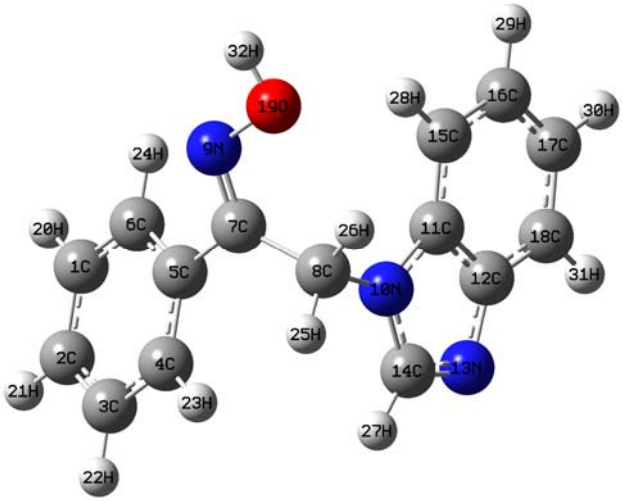


Figure 3. Calculated molecular structure for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime at the B3LYP/6-311+G(2d,p) level of theory.

Table 3: Calculated and experimental geometric parameters for the 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

Bond Angle	Calculated	Literature	Bond Length	Calculated	Literature
6C-5C-7C	120.2	120.2	**19O-32H**	0.964	0.870
5C-7C-9N	116.0	115.3	**9N-19O**	1.407	1.383
7C-9N-19O	113.7	111.4	**9N-7C**	1.279	1.300
9N-19O-32H	102.2	107.0	**7C-5C**	1.484	1.491
9N-7C-8C	124.0	124.0	**7C-8C**	1.521	1.478
7C-8C-10N	112.9	111.5	**8C-10N**	1.454	1.479
7C-8C-10N	127.1	127.5			

Molecular electrostatic potential maps for the 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime were given in Figure 4 and Figure 5, respectively.

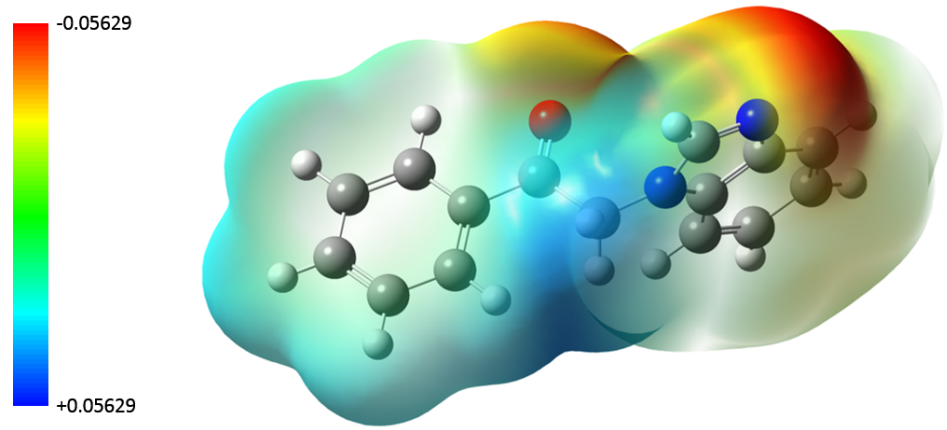


Figure 4. Molecular electrostratic potential map for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one.

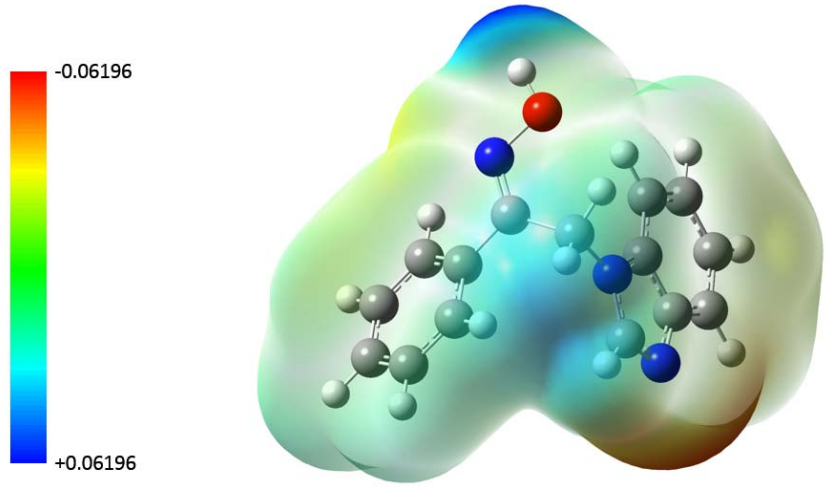
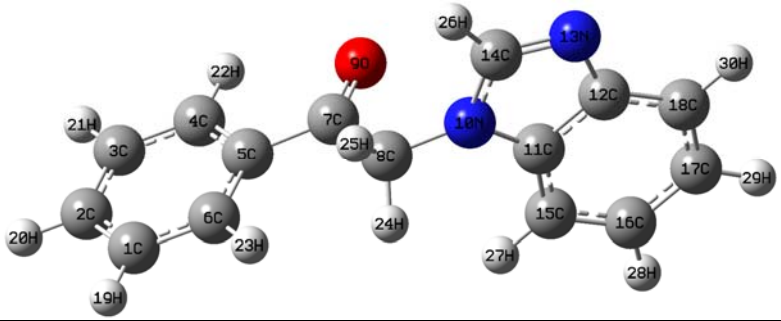


Figure 5. Molecular electrostatic potential map for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

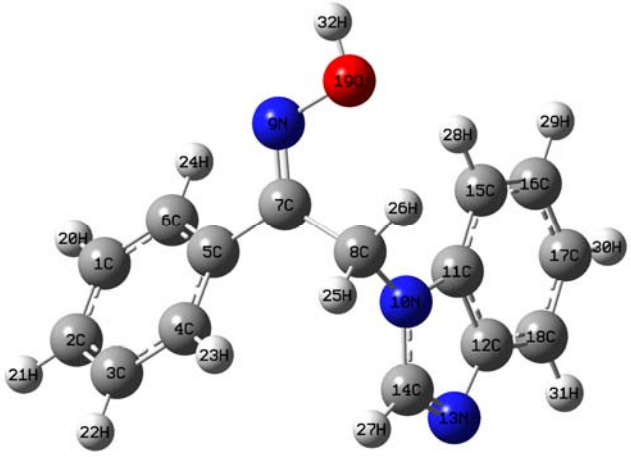
In computational studies, NMR shielding tensor prediction calculations also have been performed. Calculated ^{1}H NMR chemical shifts at the B3LYP/6-31G(d), 6-311G(d,p) and 6-311+G(2d,p) level of theories using both CSGT and GIAO methods and for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one were given in Table 4 and for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime were given in Table 5. Table 4 and Table 5 also includes experimental ^{1}H NMR chemical shifts obtained from the literature (Wen-lin, 2013; Abdel-Megid, 2002). In Table 4 and Table 5, Exp. denotes experimental values obtained from literature, csgt1 denotes B3LYP/6-31G(d) CSGT, csgt2 denotes B3LYP/6-311G(d,p) CSGT, csgt3 denotes B3LYP/6-311+G(2d,p) CSGT, giao1 denotes B3LYP/6-31G(d) GIAO, giao2 denotes B3LYP/6-311G(d,p) GIAO, giao3 denotes B3LYP/6-311+G(2d,p) GIAO.

Table 4: ^{1}H NMR Chemical Shifts for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one.



	Exp.	csgt1	csgt2	csgt3	giao1	giao2	giao3
22-H	7.94-7.97	4.77	6.82	8.10	7.70	8.51	8.74
23-H	7.94-7.97	4.77	6.82	8.10	7.70	8.51	8.74
30-H	7.79-7.83	4.73	6.83	7.82	7.36	8.25	8.33
20-H	7.56-7.61	4.65	6.57	7.58	7.23	7.98	8.17
19-H	7.43-7.48	4.59	6.52	7.47	7.18	7.90	8.06
21-H	7.43-7.48	4.59	6.52	7.47	7.18	7.90	8.06
26-H	8.15	3.80	6.45	7.40	6.85	7.74	8.05
29-H	7.32-7.37	4.31	6.18	7.16	6.90	7.65	7.75
28-H	7.25-7.28	4.25	6.12	7.08	6.84	7.58	7.68
27-H	7.25-7.28	3.96	6.01	6.94	6.55	7.33	7.47
24-H	6.08	2.61	4.12	5.34	4.73	5.49	5.85
25-H	6.08	2.61	4.12	5.34	4.73	5.49	5.85

Table 5: ^{1}H NMR Chemical Shifts for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.



	Exp.	csgt1	csgt2	csgt3	giao1	giao2	giao3
28-H	6.8-7.6	4.60	6.78	7.61	7.16	7.87	7.99
31-H	6.8-7.6	4.57	6.68	7.60	7.15	7.84	7.88
23-H	6.8-7.6	4.29	6.48	7.47	6.91	7.73	7.77
24-H	6.8-7.6	4.29	6.48	7.47	6.91	7.73	7.77
27-H	6.8-7.6	3.59	6.41	7.38	6.65	7.59	7.73
21-H	6.8-7.6	4.47	6.31	7.24	6.92	7.46	7.55
20-H	6.8-7.6	4.46	6.33	7.22	6.91	7.46	7.53
22-H	6.8-7.6	4.46	6.33	7.22	6.91	7.46	7.53
29-H	6.8-7.6	4.32	6.15	7.11	6.86	7.38	7.47
30-H	6.8-7.6	4.29	6.14	7.08	6.85	7.36	7.43
32-H	11.0	2.74	5.91	6.98	6.09	6.96	7.15
25-H	5.6	2.55	4.16	5.27	4.75	5.42	5.60
26-H	5.6	2.55	4.16	5.27	4.75	5.42	5.60

Results show that calculated ^{1}H NMR chemical shifts at the B3LYP/6-311G(d,p) GIAO (giao2) and especially B3LYP/6-311+G(2d,p) CSGT (csgt3) level of theories show good agreement with the experimental results.

Figure 6 represents the vibrational spectra calculated at the B3LYP/6-311+G(2d,p) level of theory for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

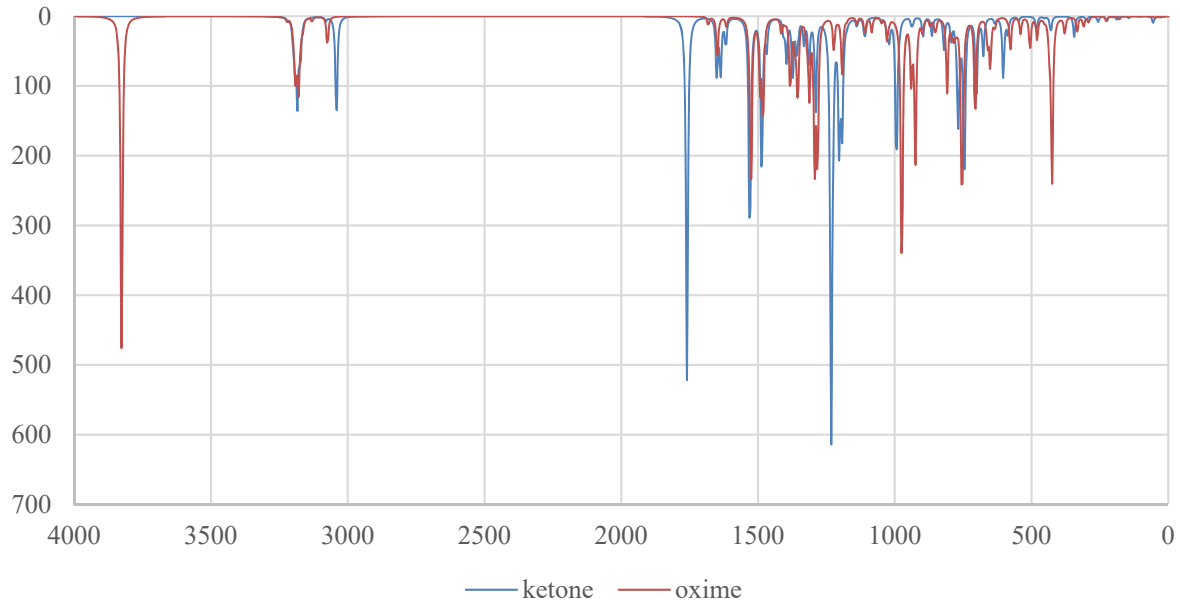


Figure 6. Calculated vibrational spectra for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime at the B3LYP/6-311+G(2d,p) level of theory.

Figure 7 represent HOMO and LUMOs of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime calculated at the B3LYP/6-311+G(2d,p) level of theory.

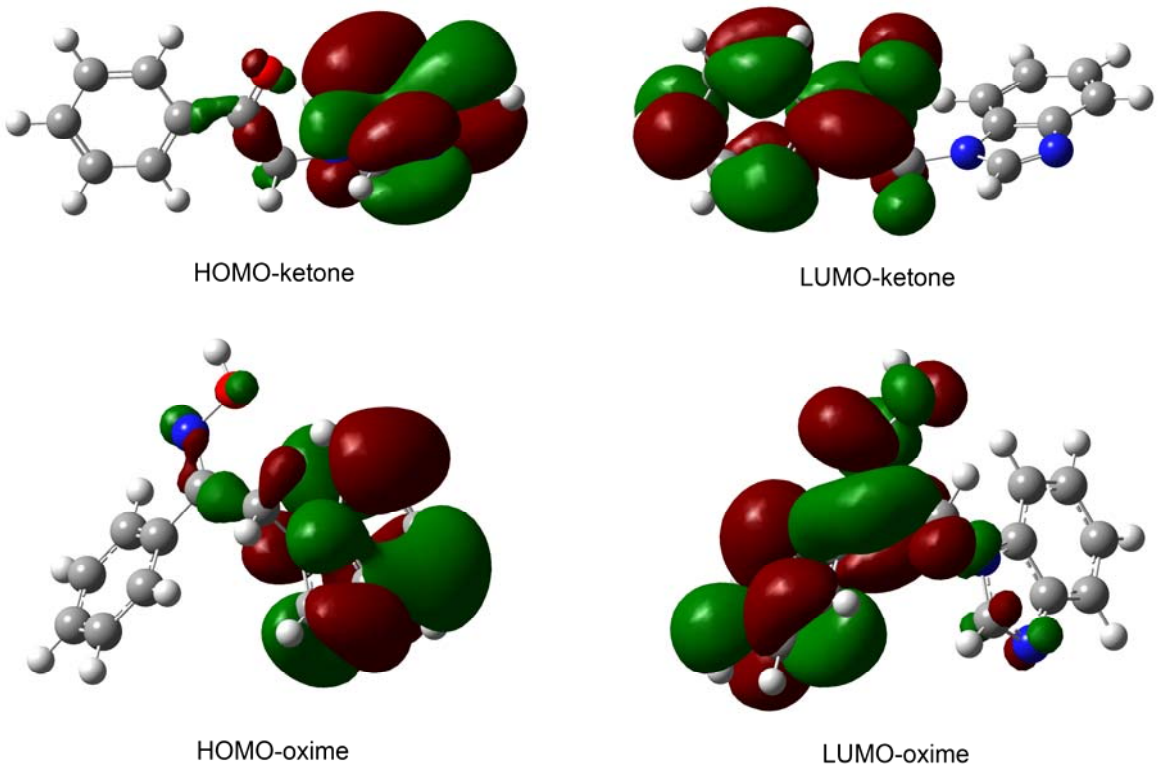


Figure 7.Highest Occupied and Lowest Unoccupied Molecular Orbitals for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

Table 6: Calculated global reactivity descriptors for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime at the 6-311+G(2d,p) level of theory.

	ketone		oxime	
	6-311+G(2d,p)	6-311+G(2d,p)	6-311+G(2d,p)	6-311+G(2d,p)
LUMO	-0.08601	-2.32227	-0.05937	-1.60299
HOMO	-0.22951	-6.19677	-0.22959	-6.19893
HOMO-LUMO Gap	0.14350	3.87450	0.17022	4.59594
I	0.22951	6.19677	0.22959	6.19893
A	0.08601	2.32227	0.05937	1.60299
χ	0.15776	4.25952	0.14448	3.90096
η	0.07175	1.93725	0.08511	2.29797
S	6.96864	0.25810	5.874750323	0.217583345
μ	-0.15776	-4.25952	-0.14448	-3.90096
ω	0.17344	4.68280	0.122632302	3.311072147

Figure 8 represents Mulliken atomic charges for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one and Figure 9 represents for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime.

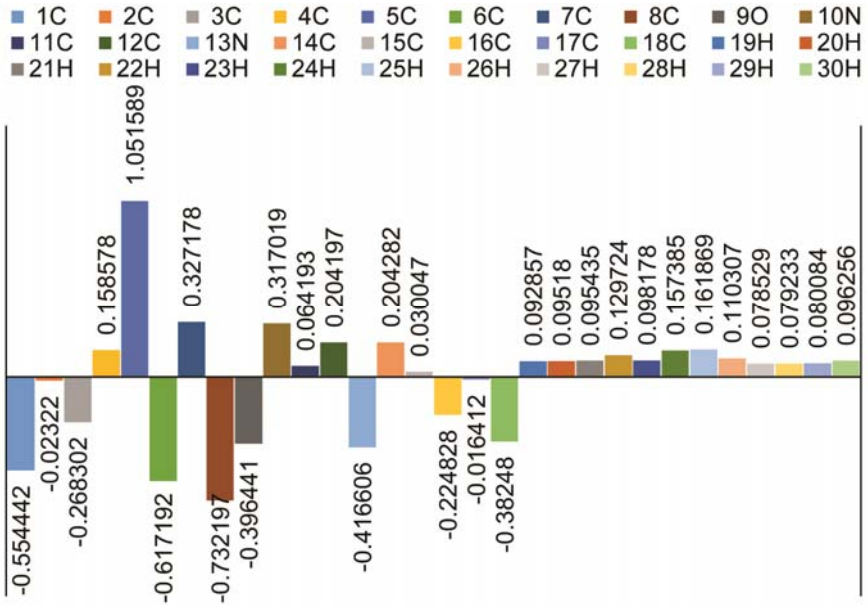


Figure 8. Mulliken atomic charges for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one calculated at the B3LYP/6-311+G(2d,p) level of theory.

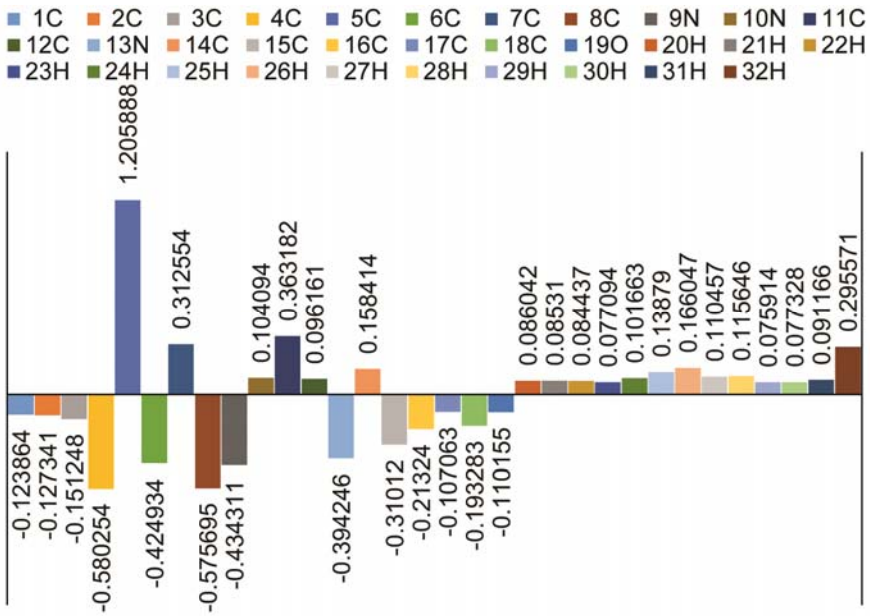


Figure 9. Mulliken atomic charges for 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime calculated at the B3LYP/6-311+G(2d,p) level of theory.

Conclusion

As a result, in this study we have been studied on 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one oxime. The study consist of two parts. In the first part we have been studied on a new microwave assisted synthetic method for the conversion of 2-(1H-benzo[d]imidazol-1-yl)-1-phenylethan-1-one to its oxime form. The results showed that the proposed microwave assisted method is efficient and time and energy saving. In the second part of our study we have performed some density functional theory calculations on the selected molecules and compared them with the experimental results obtained from the literature. In the synthesis of oxime from corresponding ketone, the major product is the (Z)- isomer. This is not a surprising result because of the more stable structure of the (Z)- isomer than the (E)- isomer. Computational results also support this experimental results. There is a considerable energy difference between the (E)- and (Z)- isomers and the (Z)- isomer is the more stable one. In ^{1}H NMR chemical shift calculations there is a good agreement between the calculated values and the experimental values obtained from the literature. The best results have been obtained from the calculations performed at the B3LYP/6-311+G(2d,p) CSGT and B3LYP/6-311G(d,p) GIAO.

Acknowledgements

This work was supported by Kocaeli University Scientific Research Projects Unit. Project No: 2011/062. The authors acknowledge Kocaeli University for the financial support.

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A SHOT IN THE ARM FOR HANDLING CONSUMER DISPUTES ACROSS THE EU: ALTERNATIVE DISPUTE RESOLUTION SYSTEM

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Abstract: The handling of disputes between consumers and traders is now evolving on a more consumer-friendly ground across Europe. Following the steadily stronger consumer protection laws, the growth of online mechanisms for alternative dispute resolution (ADR) bodies is further swinging the legal pendulum from the judicial protection to developing out-of-court structures that provide cheaper and effective relief. In this regard, the recent launch of a new online dispute resolution (ODR) platform by the European Commission is quite likely to contribute to the effort to avoid disputes reaching court, providing settlement of the millions of both domestic and cross-border e-commerce disputes using online technologies, as well as strengthening the EU's Digital Single Market Strategy. The disputes will be channelled to national ADR bodies in each Member State that are related to the platform of which online traders are required to provide notice.

Keywords: Alternative dispute resolution (ADR), Online dispute resolution (ODR), Consumer disputes, E-commerce

INTRODUCTION

Due to the growing use of the Internet across the Europe, the number of disputes arising from the Internet has increased exponentially. Becoming a new realm of commerce, the Internet has enabled businesses to expand their markets and offer a vast selection of products and services to cross-border customers. Geographical distance, time and language ceased to prevent trade, and, as a result, gave rise to e-disputes. In this regard, ensuring a safer participation of all parties in e-commerce transactions requires e-disputes be resolved in sufficiently certain ways. The reason is that the lack of legal certainty and online consumer trust may prevent consumers from entering into online transactions, as well as companies from participating in the electronic markets (Morris et. al., 2000).

Online dispute resolution (ODR) refers to the Alternative Dispute Resolution (ADR) mechanisms that use technology to facilitate the resolution of disputes between the parties. It mainly involves negotiation, mediation or arbitration, as well as a combination of all these alternative methods. Thus, it can be concluded that the ODR corresponds to the online version of the ADR. It can, however, expand these traditional ADR methods by using various online technologies during the process.

ODR covers vast fields of law, ranging from the disputes between private parties involving consumer to consumer (C2C) and business to consumer (B2C) disputes or marital separation, to court disputes and interstate conflicts (National Centre for Technology and Dispute Resolution, 2011). Without prejudice to having such a wide scope of application, the ODR is most importantly tailor-made for the resolution of B2C online transactions. The reason for the suitability of the ODR in the resolution of e-commerce disputes is that, the use of the Internet which is the same medium giving rise to disputes is ideal when parties reside in different countries (Bygrave, 2002).

ONLINE DISPUTE RESOLUTION

As abovementioned, ODR represents an innovative means for handling disputes, particularly those with the underlying contracts concluded between consumers and businesses in virtual space. Lacking the expertise and resources for the resolution of cross-border disputes, traditional courts may not be suitable in e-commerce. Moreover, where transactions are of low value and the parties are located in different countries, litigation is quite an unattractive option with disproportional costs and long proceedings.

As a collective term, the ODR covers different combinations of online dispute settlements by using the ADR methods. To put it simply, the ODR refers to the assistance of certain computer networks and applications to the settlement of disputes with the ADR methods. Depending on the extent of control over the process and outcome the parties and/or Information and Communication Technology (ICT) have, dispute resolution techniques vary (Cortes, 2009). Based on the cooperation of the ADR and ICT, the ODR requires the resolution process to be conducted mainly online.

Information management in the ODR is carried out by physical persons as well as computers and software. The complementation of the traditional ADR methods with the ICT was referred to as the so-called "fourth party",

since the ODR was considered as an additional party in the resolution process (Katsh and Rifkin, 2001). In addition to the two disputants and the neutral third party, addressing technology as the fourth party emphasizes its growing importance in a traditional trilateral dispute. Despite having the entitlements and capabilities of the third party, the fourth party will rather serve as a tool for assisting the process. Nevertheless, the fourth party may replace the third party as in automated negotiation. The fourth party may also manage information, send automatic responses, reorganize written communications in a politer manner, monitor performance, and organize meetings. The more technology enhances, the more the fourth party stands out, thereby diminishing the significance of the neutral third party (Gaitenby, 2006; Katsh and Wing, 2006).

Similar to the ADR, companies involved in the ODR process agree upon the out-of-court settlement with the difference of using the Internet. To contribute to this settlement process on the Internet, professionals lead the way by utilizing their ADR experiences. In order to best suit the needs of the Internet, the ADR rules and practices are adjusted when necessary. To this end, software tools are utilized and enhanced. Moreover, new web-based services have been developed to enable parties and arbitrators to meet online and work in secure, joint workspaces, access precedents, attain and manage important documents, and organize meetings with the services of voice and video conferencing, and with translation services as well (Katsh and Rifkin, 2001).

ONLINE DISPUTE RESOLUTION METHODS

1.1. Consensual Online Dispute Resolution

1.1.1. Automated Negotiation

Also known as the so-called “blind-bidding” method, automated negotiation involves the methods mostly used for the claims of monetary value, i.e. personal injury or a worker’s compensation claim. It is based on a software program to which the parties submit their offers and demands for settlement and determine a percentage range. The program organizes the communications between the parties. However, the offers, demands, and percentages concerned are not revealed to the other party. The offering party refers to the party who makes the offer or the party who is going to pay, whereas the demanding party makes the demand or seeks for the relief as the payment of a sum of money. The ODR algorithm calculates a settlement amount between the offer and demand ranges of the parties. When offer and demand match or fall within the determined range, the dispute is settled at the defined amount and the parties are informed. Parties are allowed to try to settle until their offers and demands match (Kaufmann-Kohler and Schultz, 2004).

1.1.2. Assisted Negotiation

Assisted negotiation is a dispute resolution process to which technology assists in an evaluative manner, i.e. providing communication facilities. The role of technology here is similar to that of the mediator in mediation, with the difference that the former is based on only technological tools while the latter may also use different electronic communication tools, ranging from e-mail and chat rooms to video conferencing. Unlike arbitration, the third party maintains its neutrality and does not give a binding decision on the parties through an enforceable award. Using information management skills and enabling more efficient communication by paraphrasing the arguments concerned, mediators help the parties reach an amicable settlement. Though the procedural similarity of conciliation to mediation, councillors can provide solutions for the parties before reaching a settlement. The primary objective of assisted negotiation is to enhance the communications of the parties with the assistance of a third party or software technology (Jacobs, 2007). When used online, these processes are informal, simple and user-friendly (Motion, 2005).

1.1.3. Mediation with Online Technologies

In order to facilitate the resolution of disputes, some websites such as Internet Neutral or SquareTrade have been established. These websites are equipped with online technologies, i.e. e-mail, instant messaging, chat rooms, as well as traditional communication methods. First, a party goes to the website and fills in an online form including the problem and potential resolutions. After reviewing this form, a mediator asks the other party whether or not he will participate in the mediation. If the response is affirmative, the other party can fill in a new form or answer the former form through e-mail. Thus, parties are more likely to grasp the dispute and reach a settlement.

1.2. Adjudicative Online Dispute Resolution

1.2.1. Online Arbitration

Arbitration is referred to the dispute resolution mechanism whereby parties agree to submit their disputes to an independent third party (arbitrator or arbitral tribunal), who in turn delivers a final and binding award on both parties. Arbitration relies on party autonomy, beginning as a private agreement and continuing with private proceedings as planned by the parties. Nevertheless, it is still characterized as a quasi-judicial process as the arbitral award substitutes for a judicial decision. Arbitration is less formal than litigation, yet it includes the most formal process compared to all other ADR methods. Confidentiality and fastness are key features of arbitration that attract

especially business parties in choosing arbitration over litigation. Another advantage of arbitration is the easy enforceability on the ground of the 1958 New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards.

In order to limit the scope of application, online arbitration is assumed to cover only disputes that arise online. For a more efficient and broader resolution mechanism, however, disputes that arise offline may also be submitted to online arbitration with diverse online techniques, ranging from e-mail, chat groups or video conferencing. This wider approach relies on the qualification of online arbitration on the ground that submissions to the arbitral tribunal and the conduct of all proceedings takes place over the Internet, regardless of partly covering offline disputes. In doing so, disputes both in virtual and online medium can be handled efficiently via online arbitration (Piers, 2014).

ONLINE DISPUTE RESOLUTION IN THE EUROPEAN UNION

After the Recommendation 12/1986 of the Committee of Ministers at the Council of Europe on Measures to Prevent and Reduce the Workload of the Courts, the EU attempted to introduce the out-of-court dispute resolution mechanisms concerning civil matters. The European Commission Communication on Consumer Redress in 1985 and the Supplementary Communication from the Commission on Consumer Redress in 1987 illustrate these attempts. Publishing the Green Paper on Consumer Access to Justice and Dispute Resolution in Consumer within the Single Market in 1993, the EU Commission urged the Member States for collaboration to improve the settlement of disputes in cross-border commerce. The following enactments of various action plans, communications, and the Stockholm Program contributed to the current position of alternative dispute resolution mechanisms concerning consumer law in the EU.

Moving on, the EU has issued Directive 2013/11 of 21 May 2013 on Alternative Dispute Resolution for Consumer Disputes (the ADR Directive) and Regulation No 524/2013 of 21 May 2013 on Online Dispute Resolution for Consumer Disputes (the ODR Regulation), which is applicable since 15 February 2016.

The ODR Regulation is to be read in conjunction with the ADR Directive, which functions as a complement to the Regulation. It is, thus, appropriate to touch upon the main features of the ADR Directive. Laying down minimum standards, it does not impede the consumers to apply for a more extensive consumer protection. The scope of application of the Directive is both domestic and cross-border disputes arising from the contracts concluded between a trader established in the EU and a consumer resident in the EU. On the other hand, it does not stipulate an enforcement mechanism for recognition and enforcement of binding ADR decisions in the other Member States. The Directive requires the Member States to ensure that consumer disputes with a trader established in their countries can be submitted to an "ADR entity" that meets the conditions in the Directive, i.e. sufficient accessibility, effectiveness, fairness, transparency, impartiality, and expertise.

Moreover, each Member State is required to designate a "competent authority" that will determine, on the ground of the information received from entities wishing to become an ADR entity, whether they meet the abovementioned conditions in the Directive. Then approved entities are notified to the Commission, which in turn will publish and keep updated the list of them with their contact details, fees, languages they use, the disputes they handle. Each competent authority in the Member States will demonstrate in its website the link to this list of entities.

Building on the structure of the ADR Directive, the ODR Regulation is related to the out-of-court settlement of disputes based on contractual obligations arising from online sales or service contracts concluded between a consumer resident in the EU and a trader established in the EU. Such settlement is conducted through the intervention of an ADR entity approved and listed according to the criteria in the ADR Directive. Similar to the ADR Directive, the ODR Regulation covers cross-border e-commerce disputes. However, the Regulation applies only to the disputes arising from the contracts concluded online, where the trader or the trader's intermediary offers the goods or services on a website or other electronic means by which the consumer makes an order. Therefore, whether the Regulation covers certain disputes depends on the online conclusion of the contract, but not the online performance.

The key feature of the Regulation is the establishment of an online platform, which is an interactive website to provide access to the consumers and traders free of charge, and to facilitate contacting with an approved ADR entity under the ADR Directive. The Commission will be in charge of the establishment and development of the platform, which will in turn provide an electronic complaint form to be filled and submitted online, inform the other party of the complaint, assist the parties to determine the competent ADR entities and transmit the complaint to the agreed entity, and offer a free of charge electronic case managing tool that enables the parties and the ADR

entity to conduct the dispute resolution online. The platform will give assistance in all official languages of the EU, including the electronic translation of the exchanged information required for the settlement of the dispute. The relative link about the platform is to be provided in the general terms and conditions and on the websites of all traders established in the EU and dealing with online sales of goods and services. This requirement is also sought for the contract offers made by e-mails.

The Regulation stipulates, among the detailed provisions on the submission, transmission, and processing of a complaint, that "only data which are accurate, relevant and not excessive in relation to the purpose for which they are collected shall be processed through the electronic complaint form and its attachments." As parties are disputants, they are likely to have different views on the relevance and accuracy of the submitted data. Therefore, leaving the decision of whether the submitted data meet the abovementioned criteria to the electronic ODR platform would not serve to the purpose of this provision. Another interesting point is that, after determining the competent ADR entity, the ADR procedure does not necessarily have to be conducted through the online ODR platform. In other words, the ADR entity can proceed with traditional methods under its national law. Nevertheless, it would undermine the online nature of the procedure if it requires the physical presence of the parties. The Regulation also highlights the significance of a user-friendly platform appealing to everyone, particularly the vulnerable consumers. In line with this approach, the Member States are required to provide an "ODR contact point" with at least two advisors giving assistance to the parties who are resident in different countries and wish to use the platform.

CONCLUSION

The ICT has recently transformed traditional trade, leading to new terminology, actors and innovative ODR techniques. Equally important is ensuring confidence in e-commerce and the ODRs. The use of out-of-court means of settlement does not necessarily diminish legal certainty or protection. Contrary to litigation, these alternative methods provide more effective, fast, and generally free of charge resolutions to consumers. In order to promote the use of these extra-judicial means, the European legislators have been undertaking many initiatives, including the ADR Directive and the ODR Regulation. The assistance of technology to the ADR proceedings as a fourth party in the ODR Regulation diminishes the burden of secretarial management and facilitates the submission, transmission, and processing of a complaint. Furthermore, the ODR contact points will make the platform more user-friendly.

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AN ANALYTIC VELOCITY AND ACCELERATION ANALYSIS OF A PLANAR PARALLEL 3-RRR MECHANISM

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Abstract: This paper focusses on the velocity and acceleration analysis of a planar parallel kinematic chain by an analytic method. The velocity analysis reveals that there are poses with either no pole configuration or an infinite number of pole configurations. These poses are called singular or twice singular, respectively. It turns out that in general the singular poses are those where the cranks need to reverse the rotation in order to perform the full motion. At twice-singular poses, bifurcations can take place. The analytic method reduces the local velocity and acceleration analysis to systems of linear equations. Their rules for solvability confirm again the results on singular and twice singular poses. Both can be geometrically characterized by the concurrency of triples of lines. The analytic and algorithmic treatment of the global constrained motion leads to an algebraic problem of degree 6.

Keywords: Planar mechanism, planar parallel 3-RRR-robot, velocity analysis, acceleration analysis.

INTRODUCTION

The planar parallel kinematic chain under consideration is a 3-RRR robot as given by Can & Stachel (2014), however with synchronous drives. Therefore, it is in fact a mechanism; we call it, in short, a 3-RRR mechanism. It has with eight links $\Sigma_0, \ldots, \Sigma_7$ and nine revolute joints $A_0, B_0, C_0, A_1, \ldots, C_2$ with the following properties (see Figure 1):

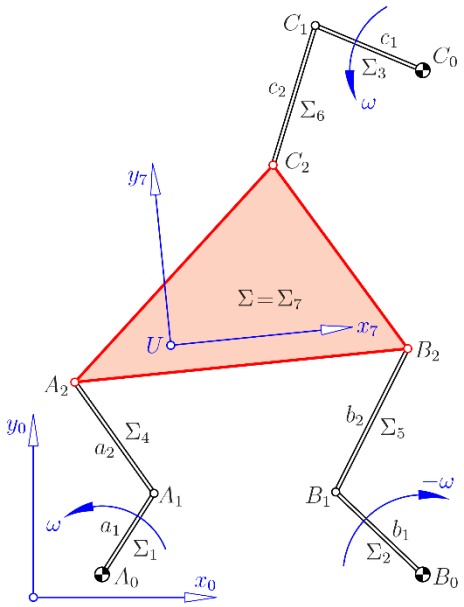

Figure 1. A planar parallel 3-RRR-robot with simultaneously driven cranks

1) There are three driving cranks $A_0A_1 \subset \Sigma_1$, $B_0B_1 \subset \Sigma_2$, and $C_0C_1 \subset \Sigma_3$. They rotate with the same angular velocity ω about the respective anchor points A_0, B_0 and C_0, all fixed in the frame Σ_0. The links Σ_1 and Σ_3 rotate counter-clockwise; Σ_2 rotates either counter-clockwise (direct mechanism) or clockwise (indirect mechanism).

2) The bars $A_1A_2 \subset \Sigma_4$, $B_1B_2 \subset \Sigma_5$ and $C_1C_2 \subset \Sigma_6$ connect the active cranks with the moving frame Σ_7. The points A_2, B_2, C_2 are attached to Σ_7.

3) The lengths of the cranks are denoted by $a_1 = \overline{A_0A_1}$, $b_1 = \overline{B_0B_1}$ and $c_1 = \overline{C_0C_1}$. The bars' lengths are $a_2 = \overline{A_1A_2}$, $b_2 = \overline{B_1B_2}$ and $c_2 = \overline{C_1C_2}$.

General 3-RRR robots control the moving plane via three dyads, i.e., via three RRR mechanisms $A_0A_1A_2$, $B_0B_1B_2$ and $C_0C_1C_2$ by defining the angles of rotation of the active links A_0A_1, B_0B_1 and C_0C_1. Many papers deal with such planar robots, which can be seen as forerunners of spatial parallel robots. Here is a short survey on references:
The forward and reverse kinematics of planar parallel 3-RRR robots has been studied, e.g., by Dijksman (1976), Staicu (2008), Can & Stachel (2014) or by Mahmoodinia, Kamali & Akbarzadeh (2008). Reference Kamali & Akbarzadeh (2011) focuses on the Dynamics of such robots. The singularity analysis is addressed, e.g., by Mohammadi, Zsombor-Murray & Angeles (1995), Bonev & Gosselin (2001), Yang, Chen & Chen (2002), Bonev, Zlatanov & Gosselin (2003) or Di Gregorio (2009). Reference Cha, Lasky & Velinsky (2009) treats the problem of avoiding singularities by the insertion of a redundant parameter. The behavior of the motion in the neighborhood of singularities is studied, e.g., by Voglewede & Ebert-Uphoff (2002). Paper Stan, Maties, Balan & Lapusan (2007) focusses on an algorithmic work space analysis of planar parallel 3-RRR robots.

References on planar parallel 3-RRR robots with synchronously coupled drives are Chen, Angeles & Theingi and Can & Stachel, which were published 2003 and 2014 respectively. The first one focuses mainly on the influence of the driving velocities on the singularities, and in the second one particular attention is laid on a mechanism, i.e., on the case of equal angular velocities for all three active links.

ANALYTICAL GEARS ANALYSIS

In order to describe a movement of the moving space Σ_i with respect to (`w.r.t.', in brief) the fixed space Σ_0 in the d-dimensional Euclidean space $\mathbb{E}^d$, we need Cartesian coordinate systems in both spaces. Then, there is at any instant a transformation between the coordinate vector $\mathbf{x}$ of any point X attached to the moving space Σ_i and the coordinate vector $\mathbf{x_0}$ of the point $X_0 \in \Sigma_0$ which is instantaneously coincident with X. This vector equation is of the type

$$\mathbf{x}_0 = \mathbf{u}_0 + A\mathbf{x}.$$

The matrix $A \in \mathbb{R}^{dxd}$ is directly orthogonal, i.e.

$$AA^T = I_d \text{ und } \det A(t) = 1$$

where $I_d \in \mathbb{R}^{dxd}$ is the identity matrix. Vector $\mathbf{u}_0$ is the coordinate vector of the origin of the moving coordinate frame w.r.t. the coordinate frame in the fixed space Σ_0. We speak in the following "point $\mathbf{x}$" instead of "point X with the coordinate vector $\mathbf{x}$".

Let a twice continuously differentiable one-parameter (=constrained) motion Σ_i/Σ_0 be given. This means, for a parameter t traversing an interval $I \subset \mathbb{R}^d$, there are twofold continuously differentiable functions

$$I \longrightarrow \mathbb{R}^d,\ t \longrightarrow \mathbf{u}_0(t) \text{ and } I \longrightarrow \mathbb{R}^{dxd},\ t \longrightarrow A(t),$$

such that

$$\Sigma_i/\Sigma_0\colon \mathbf{x}_0 = \mathbf{u}_0(t) + A(t)\mathbf{x} \text{ with } A(t)A(t)^T = I_d,\ det\ A(t) = 1. \quad (1)$$

For any constant vector $\mathbf{x} \in \mathbb{R}^d$ the function $\mathbf{x}_0(t)$ describes in the fixed coordinate frame of Σ_0 the parametrized trajectory of the point $\mathbf{x}$ which is attached to the moving space Σ_i. The parameter t is usually assumed as time.

Velocities

The first derivative $\dot{\mathbf{x}}_0 = \frac{d\mathbf{x}_0}{dt}$ at each instant gives the fixed coordinates of the instantaneous velocity vector $\mathbf{v}_x^{i0}$ of the point $\mathbf{x}$ in Σ_i, i.e., the vector of the *vehicular velocity* $\mathbf{v}^f$. When, in addition, a relative movement $\mathbf{x} = \mathbf{x}(t)$ of the point $\mathbf{x}$ w.r.t. Σ_i, is admitted then follows after differentiation

$$\mathbf{v}_x^{i0} = \dot{\mathbf{x}}_0 = \left(\dot{\mathbf{u}}_0 + \dot{A}\mathbf{x}\right) + A\dot{\mathbf{x}}.$$

The last term yields the fixed coordinates of the vector $\mathbf{v}_0^r$ of the *relative velocity* $\mathbf{v}^r$. The vector on the left-hand side represents the *absolute velocity* $\mathbf{v}_0^a$. That makes altogether

$$\mathbf{v}_0^a = \mathbf{v}_0^f + \mathbf{v}_0^r. \quad (2)$$

We replace in the expression $\mathbf{v}_0^f = \dot{\mathbf{u}}_0 + \dot{A}\mathbf{x}$ for the fixed coordinates of the vehicular velocity vector the coordinate vector $\mathbf{x}$ w.r.t. Σ_i by its instantaneous coordinate vector $\mathbf{x}_0$ w.r.t. Σ_0 according to

$$\mathbf{x} = A^T(\mathbf{x}_0 - \mathbf{u}_0).$$

Thus, we obtain

$$\mathbf{v}_x^{i0} = \mathbf{v}_0^f = \dot{\mathbf{u}}_0 - \dot{A}A^T\mathbf{u}_0 + \dot{A}A^T\mathbf{x}_0.$$

Now we summarize the summands, which are independent of $\mathbf{x}_0$ in

$$\mathbf{v}_0 = \dot{\mathbf{u}}_0 - \dot{A}A^T\mathbf{u}_0. \tag{3}$$

Furthermore, we note that for orthogonal matrix A the product $\dot{A}A^T$ is skew-symmetric, since of $A(t)A(t)^T = I_d = const.$ follows by differentiation

$$\dot{A}A^T + A\dot{A}^T = \dot{A}A^T + \left(\dot{A}A^T\right)^T = I_d = O_d$$

with $O_d \in \mathbb{R}^{dxd}$ as the zero matrix. Hence, $S = \dot{A}A^T$ satisfies

$$S^T = \left(\dot{A}A^T\right)^T = -\dot{A}A^T = -S.$$

Finally, we obtain for the vehicular velocity

$$\mathbf{v}_x^{i0} = \mathbf{v_0} + S\mathbf{x}_0, \text{ where } S^T = -S, \tag{4}$$

with $\mathbf{x}_0$ as instantaneous coordinates of the moving point $\mathbf{x} \in \Sigma_i$ and $\mathbf{v_0}$ as a vector of the vehicular velocity of the origin of Σ_i, both with respect to the fixed coordinate frame in Σ_0.

Theorem 1. At any given instant of a constrained motion Σ_i/Σ_0 in $\mathbb{E}^d$, there is a vector $\mathbf{v_0}$ and a skew-symmetric matrix S such that, w.r.t. the fixed coordinate in Σ_0, the vehicular velocity $\mathbf{v}_\mathbf{x}^{i0}$ of the moving point $\mathbf{x} \in \Sigma_i$ with instantaneous coordinates $\mathbf{x}_0$ satisfies

$$\mathbf{v}_\mathbf{x}^{i0} = \mathbf{v}_0 + S\mathbf{x}_0.$$

As the difference of the vehicular velocity vectors of two points $\mathbf{p}, \mathbf{q} \in \Sigma_i$ we obtain the "*velocity vector of* $\boldsymbol{q}$ *about* $\boldsymbol{p}$"

$$\mathbf{v_{qp}} = \mathbf{v_q} - \mathbf{v_p} = S(\mathbf{q} - \mathbf{p}).$$

Since, because of the skew-symmetry of S, *the quadratic form* $\mathbf{x}^T S\mathbf{x}$ is the zero form, we obtain

$$(\mathbf{q} - \mathbf{p}).\left(\mathbf{v_q} - \mathbf{v_p}\right) = (\mathbf{q} - \mathbf{p})^T\, S\, (\mathbf{q} - \mathbf{p}) = 0.$$

This means, the vector $\mathbf{v_{qp}}$ is orthogonal to the line connecting the points $\mathbf{p}$ and $\mathbf{q}$. Thus, we have proved

Theorem 2. (Projection theorem) For any two points $\mathbf{p}$, $\mathbf{q}$ of the same moving system Σ_i the vehicular velocity vectors $\mathbf{v}_\mathbf{p}^{i0}$ and $\mathbf{v}_\mathbf{q}^{i0}$ have equal components in direction of the connecting line, i.e., in direction of $\mathbf{q} - \mathbf{p}$ (see Figure 2).

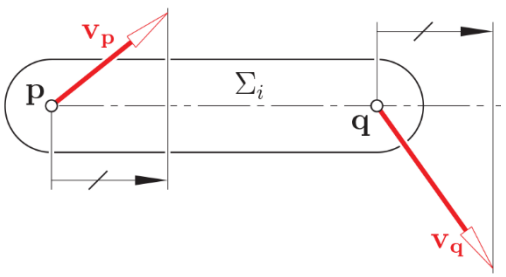

Figure 2. Projection theorem

Remark 1. In case of planar constrained motions, this theorem is equivalent to the so-called graphical *rotated velocities method* from Wunderlich 1970, p. 23.

Accelerations
The second derivative of the parameterized trajectory $\mathbf{x}_0(t)$ of $\mathbf{x} \in \Sigma_i$ gives the acceleration vector

$$\mathbf{a}_x^{i0} = \ddot{\mathbf{x}}_0 = \frac{d^2\mathbf{x}_0}{dt^2}.$$

From $\dot{\mathbf{x}}_0 = \dot{\mathbf{u}}_0 + \dot{A}\mathbf{x} + A\dot{\mathbf{x}}$ we obtain

$$\ddot{\mathbf{x}}_0 = (\ddot{\mathbf{u}}_0 + \ddot{A}\mathbf{x}) + 2\dot{A}\dot{\mathbf{x}} + A\ddot{\mathbf{x}}.$$

The last term gives the fixed coordinates $\mathbf{a}_0^r$ of the vector $\mathbf{a}^r$ of the *relative acceleration*, thus the acceleration of the point $\mathbf{x}$ relative to the moving space Σ_i. The expression in brackets arises at acceleration if $\dot{\mathbf{x}} = \mathbf{0}$; this component is called *vehicular acceleration* $\mathbf{a}_0^f$. The remaining summand

$$\mathbf{a}_0^c = 2\dot{A}\dot{\mathbf{x}} = 2\dot{A}\mathbf{v}^r$$

yields the *Coriolis acceleration*. In total, we obtain as the vector of the *absolute acceleration*

$$\mathbf{a}_0^a = \mathbf{a}_0^f + \mathbf{a}_0^c + \mathbf{a}_0^r. \tag{5}$$

Now we focus on the vehicular acceleration. We replace the moving coordinates of the point $\mathbf{x}$ by its fixed coordinates according to $\mathbf{x} = A^T(\mathbf{x}_0 - \mathbf{u}_0)$ and obtain

$$\mathbf{a}_0^f = \ddot{\mathbf{u}}_0 + \ddot{A}A^T(\mathbf{x}_0 - \mathbf{u}_0) = (\ddot{\mathbf{u}}_0 - \ddot{A}A^T\mathbf{u}_0) + \ddot{A}A^T\mathbf{x}_0. \tag{6}$$

The first term represents the vehicular acceleration of a point in Σ_i, which currently coincides with the origin of the fixed frame ($\mathbf{x_0} = \mathbf{0}$). Differentiation of the skew-symmetric matrix $S = \dot{A}A^T = -S^T$ yields, $\dot{S} = \ddot{A}A^T + \dot{A}\dot{A}^T$, hence

$$\ddot{A}A^T = \dot{S} - \dot{A}\dot{A}^T = \dot{S} - (\dot{A}A^T)(A\dot{A}^T) = \dot{S} - SS^T = \dot{S} + S^2.$$

Theorem 3. At any instant of a constrained motion Σ_i/Σ_0 in $\mathbb{E}^d$, there is a vector $\mathbf{a_0}$ and a skew-symmetric matrix S, the derivation of the matrix provided in Theorem 1, such that for the vehicular acceleration $\mathbf{a}_x^{i0}$ of any point attached to the moving space Σ_i satisfies in the fixed coordinate frame

$$\mathbf{a}_x^{i0} = \mathbf{a_0} + (\dot{S} + S^2)\mathbf{x}_0.$$

Remark 2. In the special case $d = 2$, the matrix $\dot{S} + S^2$ is a scalar multiple of an orthogonal matrix, because

$$S = \begin{pmatrix} 0 & s \\ -s & 0 \end{pmatrix} \text{ is } \dot{S} + S^2 = \begin{pmatrix} -s^2 & \dot{s} \\ -\dot{s} & -s^2 \end{pmatrix}.$$

The same holds for the sum $I_2 + \dot{S} + S^2$ with the identity matrix.
This is the basis for the second theorem of Burmester: In any graphic representation, there is an orientation preserving similarity between the points in the moving plane Σ_i and the tips of the corresponding acceleration vectors, when protracted from a fixed point. Similarly, the second Theorem of Mehmke states that there is also a direct similarity between the points in the moving plane and the tips of the acceleration vectors when represented as arrows with the respective points as initial points.

The difference of acceleration vectors of two points, $\mathbf{q}$, $\mathbf{p} \in \Sigma_i$ gives the "*acceleration vector of* $\mathbf{q}$ *about* $\mathbf{p}$". According to eq. (6) we obtain

$$\mathbf{a_{qp}} = \mathbf{a_q} - \mathbf{a_p} = (\dot{S} + S^2)(\mathbf{q} - \mathbf{p}) = \dot{S}(\mathbf{q} - \mathbf{p}) + S\mathbf{v_{qp}}.$$

This results in a decomposition of $\mathbf{a_{qp}}$ into two orthogonal components

$$\mathbf{a_{qp}} = \mathbf{a_{qp}^t} + \mathbf{a_{qp}^n}.$$

Because of the skew-symmetry of $\dot{S}$, the first term $\mathbf{a_{qp}^n} = \dot{S}(\mathbf{q} - \mathbf{p})$ is orthogonal to the connection of two points. The second component $\mathbf{a_{qp}^n}$ is parallel to $(\mathbf{q} - \mathbf{p})$.

By virtue of $S^2 = -S^T S$, the component of $\mathbf{a_{qp}}$ in direction of $(\mathbf{p}-\mathbf{q})$ has the signed lenth

$$\frac{(\mathbf{p}-\mathbf{q})^T(\dot{S}+S^2)(\mathbf{q}-\mathbf{p})}{\|(\mathbf{q}-\mathbf{p})\|} = \frac{[(\mathbf{q}-\mathbf{p})^T S^T][S(\mathbf{q}-\mathbf{p})]}{\|(\mathbf{q}-\mathbf{p})\|} = \frac{\mathbf{v}_{\mathbf{qp}}^T \mathbf{v}_{\mathbf{qp}}}{\|(\mathbf{q}-\mathbf{p})\|} = \frac{\|\mathbf{v}_{\mathbf{qp}}\|^2}{\|(\mathbf{q}-\mathbf{p})\|}$$

This explains the relation between the vehicular accelerations of the points $\mathbf{p}$ and $\mathbf{q}$ of Σ_i, is displayed in Figure 3.

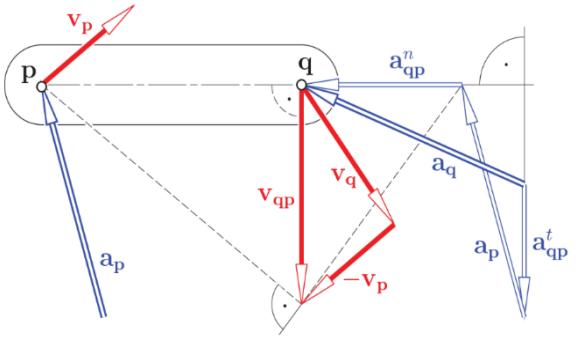

Figure 3. Construction of vehicular acceleration by virtue of $\mathbf{a_{qp}} = \mathbf{a}_{\mathbf{qp}}^t + \mathbf{a}_{\mathbf{qp}}^n$.

Theorem 4. For any two points $\mathbf{p}$, $\mathbf{q}$ of the same moving space Σ_i the difference of their vehicular acceleration vectors $\mathbf{a}_{\mathbf{p}}^{i0}$ and $\mathbf{a}_{\mathbf{q}}^{i0}$ has the representation

$$\mathbf{a_{qp}} = \mathbf{a_q} - \mathbf{a_p} = (\dot{S}+S^2)(\mathbf{q}-\mathbf{p}) = \mathbf{a}_{\mathbf{qp}}^t + \mathbf{a}_{\mathbf{qp}}^n,$$

where $\mathbf{a}_{\mathbf{qp}}^t$ is normal and $\mathbf{a}_{\mathbf{qp}}^n$ is parallel to $(\mathbf{q}-\mathbf{p})$. Furthermore (see Figure 3)

$$\mathbf{a}_{\mathbf{qp}}^n = -\frac{\|\mathbf{v_{qp}}\|^2}{\|(\mathbf{q}-\mathbf{p})\|^2}(\mathbf{q}-\mathbf{p}), \text{ hence } \|\mathbf{a}_{\mathbf{qp}}^n\| = \frac{\|\mathbf{v_{qp}}\|^2}{\|(\mathbf{q}-\mathbf{p})\|}.$$

ANALYTIC VELOCITY ANALYSIS OF THE MECHANISM

We now specify the results on the velocities and accelerations of constrained motions in $\mathbb{E}^d$ to the case $d = 2$ and analyze the mechanism, which has been introduced in section 1 (Figure 1). By Theorem 1, the distribution of the vehicular velocity vectors of the points $\mathbf{x} \in \Sigma_7$ defined by a vector $\mathbf{v_0} \in \mathbb{R}^2$ and a skew-symmetric matrix $S \in \mathbb{R}^{2x2}$. We set:

$$\mathbf{v_0} = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} \text{ and } S = \begin{pmatrix} 0 & x_3 \\ -x_3 & 0 \end{pmatrix}. \tag{7}$$

Let us identify all points A_i, B_j and C_k involved at the mechanism with their respective instant coordinate vectors $\mathbf{a}_i$, $\mathbf{b}_j$ and $\mathbf{c}_k$, w.r.t. the coordinate frame in Σ_0. Then the fixed coordinates the velocity vectors of $\mathbf{a}_2$, $\mathbf{b}_2$, $\mathbf{c}_2 \in \Sigma_7$ are

$$\mathbf{v}_{\mathbf{a}_2} = \mathbf{v_0} + S\mathbf{a}_2, \mathbf{v}_{\mathbf{b}_2} = \mathbf{v_0} + S\mathbf{b}_2, \mathbf{v}_{\mathbf{c}_2} = \mathbf{v_0} + S\mathbf{c}_2. \tag{8}$$

The given angular velocities ± ω of the cranks imply that the velocity vectors of their end points $\mathbf{a}_1$, $\mathbf{b}_1$ and $\mathbf{c}_1$ are

$$\begin{aligned} \mathbf{v}_{\mathbf{a}_1} &= \omega(\mathbf{a}_1 - \mathbf{a}_0)^\perp = \omega D(\mathbf{a}_1 - \mathbf{a}_0), \\ \mathbf{v}_{\mathbf{b}_1} &= \pm\omega(\mathbf{b}_1 - \mathbf{b}_0)^\perp = \pm\omega D(\mathbf{b}_1 - \mathbf{b}_0), \text{ with } D = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}. \\ \mathbf{v}_{\mathbf{a}_1} &= \omega(\mathbf{c}_1 - \mathbf{c}_0)^\perp = \omega D(\mathbf{c}_1 - \mathbf{c}_0) \end{aligned} \tag{9}$$

Here, the symbol ⊥ indicates a positive π/2-rotation; D is the corresponding (skew-symmetric) matrix. The Projection Theorem 2, applied to the arms, leads to

$$(\mathbf{a}_2 - \mathbf{a}_1)(\mathbf{v}_{\mathbf{a}_2} - \mathbf{v}_{\mathbf{a}_1}) = 0, (\mathbf{b}_2 - \mathbf{b}_1)(\mathbf{v}_{\mathbf{b}_2} - \mathbf{v}_{\mathbf{b}_1}) = 0, (\mathbf{c}_2 - \mathbf{c}_1)(\mathbf{v}_{\mathbf{c}_2} - \mathbf{v}_{\mathbf{c}_1}) = 0. \tag{10}$$

The substitution of the values from eqs. (8) and (9), therein yields a system of linear equations $M\ \mathbf{x} = \mathbf{s}$ for unknowns (x_1, x_2, x_3) which according to eq. (7) determine the instantaneous velocity of the moving system Σ_7.

There are three cases to distinguish: This linear system of equations has

(i) *a unique solution*, i.e., the rank of the coefficient matrix M is equal 3; or
(ii) *no solution*, i.e., the rank of M is smaller than 3 and also smaller than the rank of the extended coefficient matrix $M_{ext} = (M \mid \mathbf{s})$; or
(iii) *more than one solution*, i.e., the rank of M is smaller than 3 and equal to the rank of M_{ext}.

In order to figure out respective kinematic meaning of these three cases, we introduce the following terms.

Definition 1.
1. A pose of the mechanism is called *singular* if for vanishing driving velocities, i.e., for $\omega = 0$, at least one of the involved $\Sigma_i, i \in \{4, \ldots, 7\}$, is infinitesimally movable.
2. A pose of the mechanism is called twice singular if for given driving velocities $\pm\omega$ the local degree of freedom of one of the involved systems is ≥ 2.

Remark 3. The local degree of freedom of any system Σ_i equals the dimension of the vector space of possible velocities - independent of the driving velocity. The local degree of freedom of any mechanism is the maximum of the local degrees of freedom of all involved systems.

Obviously, at a non-singular pose we must have a unique solution for the velocity distribution of Σ_7, i.e., case (i), while at twice singular poses we must meet case (iii).

Theorem 5. Let any pose of the mechanism given. For the velocity distribution of Σ_7, the components (x_1, x_2) of $\mathbf{v_0}$ and non-trivial entry x_3 in the skew-symmetric matrix S solve a system $M\,\mathbf{x} = \mathbf{s}$ of linear equations with

$$M = \begin{pmatrix} (\mathbf{a}_1 - \mathbf{a}_2)^{\perp} & det(\mathbf{a}_1, \mathbf{a}_2) \\ (\mathbf{b}_1 - \mathbf{b}_2)^{\perp} & det(\mathbf{b}_1, \mathbf{b}_2) \\ (\mathbf{c}_1 - \mathbf{c}_2)^{\perp} & det(\mathbf{c}_1, \mathbf{c}_2) \end{pmatrix} \quad , \quad \mathbf{s} = \begin{pmatrix} \omega\, det(\mathbf{a}_2 - \mathbf{a}_1, \mathbf{a}_1 - \mathbf{a}_0) \\ \pm\,\omega\, det(\mathbf{b}_2 - \mathbf{b}_1, \mathbf{b}_1 - \mathbf{b}_0) \\ \omega\, det(\mathbf{c}_2 - \mathbf{c}_1, \mathbf{c}_1 - \mathbf{c}_0) \end{pmatrix}. \tag{11}$$

1. If the rank of the coefficient matrix M is then < 3 then the position is *singular*.
2. The system has more than one solution if and only if the pose is *twice singular*.

Proof. After plugging eqs. (8) and (9) into eq. (10), we obtain, -*we write only the second equation*-

$$(\mathbf{b}_2 - \mathbf{b}_1)^{\mathrm{T}} [\mathbf{v_0} + S\mathbf{b}_2 \pm \omega\, D\, (\mathbf{b}_1 - \mathbf{b}_0)] = 0.$$

This equation together with the other two contains bilinear forms with the skew-symmetric coefficient matrices S and D. Their coordinate expressions reveal

$$\mathbf{u}^{\mathrm{T}} S \mathbf{v} = x_3 (u_x u_y - u_y u_x) = x_3\, det(\mathbf{u}, \mathbf{v}), \quad \mathbf{u}^{\mathrm{T}} D \mathbf{v} = -det(\mathbf{u}, \mathbf{v}). \tag{12}$$

We can therefore write the second equation of eq. (10) as

$$(\mathbf{b}_2 - \mathbf{b}_1)^{\mathrm{T}} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + x_3\, det(\mathbf{b}_2, \mathbf{b}_1) = \pm\omega\, det(\mathbf{b}_2 - \mathbf{b}_1, \mathbf{b}_1 - \mathbf{b}_0) \tag{13}$$

since

$$det(\mathbf{b}_2 - \mathbf{b}_1, \mathbf{b}_2) = -det(\mathbf{b}_1, \mathbf{b}_2) = det(\mathbf{b}_2, \mathbf{b}_1).$$

Now we are looking for geometric characterizations of the cases (ii) and (iii).

1. Case (ii): The coefficients of x_1, x_2 and x_3 in the linear equation (13) are -up to the order and the signs- identical with the coefficients in the equation of the line connecting $\mathbf{b}_1$ and $\mathbf{b}_2$, hence, of the carrier line of the arm B_1B_2 since in homogeneous notation holds

$$\mathbf{b}_1 \times \mathbf{b}_2 = \begin{pmatrix} 1 \\ b_{1x} \\ b_{1y} \end{pmatrix} \times \begin{pmatrix} 1 \\ b_{2x} \\ b_{2y} \end{pmatrix} = \begin{pmatrix} det(\mathbf{b}_1, \mathbf{b}_2) \\ b_{1y} - b_{2y} \\ b_{2x} - b_{1x} \end{pmatrix}.$$

Thus, any rank deficiency of the matrix M in eq. (11) is equivalent to the linear dependence of three linear equations, i.e., to the existence of a common point of the lines spanned by the arms A_1A_2, B_1B_2 and C_1C_2.

2. Case (iii): With the help of eq. (13) we analyze the extended 3 × 4 coefficient matrix

$$M_{ext} = \left(\begin{array}{cc|c} (\mathbf{a}_1 - \mathbf{a}_2)^{\perp} & det(\mathbf{a}_1, \mathbf{a}_2) & \omega\, det(\mathbf{a}_2 - \mathbf{a}_1, \mathbf{a}_1 - \mathbf{a}_0) \\ (\mathbf{b}_1 - \mathbf{b}_2)^{\perp} & det(\mathbf{b}_1, \mathbf{b}_2) & \pm\omega\, det(\mathbf{b}_2 - \mathbf{b}_1, \mathbf{b}_1 - \mathbf{b}_0) \\ (\mathbf{c}_1 - \mathbf{c}_2)^{\perp} & det(\mathbf{c}_1, \mathbf{c}_2) & \omega\, det(\mathbf{c}_2 - \mathbf{c}_1, \mathbf{c}_1 - \mathbf{c}_0) \end{array} \right), \tag{14}$$

and compare the second row with the coefficients in the equation of the line g_2 through B_0 parallel to B_1B_2 (see Figure 4)

$$g_2: \quad \mathbf{b}_0 \times (\mathbf{b}_2 - \mathbf{b}_1) = \begin{pmatrix} 1 \\ b_{0x} \\ b_{0y} \end{pmatrix} \times \begin{pmatrix} 0 \\ b_{2x} - b_{1x} \\ b_{2y} - b_{1y} \end{pmatrix} = \begin{pmatrix} det(\mathbf{b}_0, \mathbf{b}_2 - \mathbf{b}_1) \\ b_{1y} - b_{2y} \\ b_{2x} - b_{1x} \end{pmatrix}.$$

We obtain an analogue equation for the line g_1 (through A_0 parallel A_1A_2) and for g_3 (through C_0 parallel C_1C_2). The concurrence of the three lines g_1, g_2 and g_3 is equivalent to

$$det\, G = 0 \text{ with } G = \begin{pmatrix} (\mathbf{a}_2 - \mathbf{a}_1)^{\perp} & det(\mathbf{a}_0, \mathbf{a}_2 - \mathbf{a}_1) \\ (\mathbf{b}_2 - \mathbf{b}_1)^{\perp} & det(\mathbf{b}_0, \mathbf{b}_2 - \mathbf{b}_1) \\ (\mathbf{c}_2 - \mathbf{c}_1)^{\perp} & det(\mathbf{c}_0, \mathbf{c}_2 - \mathbf{c}_1) \end{pmatrix}$$

If the bars of the three arms already concurrent, that means, if $det\, M = 0$ with the matrix M of eq. (11), then the singularity of the matrix G is equivalent to that of G - M, since due to the coincidence of the first two columns of G and M we have $det\,(G - M) = det\, \mathrm{G} - det\, M$. In detail, we obtain

$$G - M = \begin{pmatrix} (\mathbf{a}_2 - \mathbf{a}_1)^{\perp} & det(\mathbf{a}_0, \mathbf{a}_2 - \mathbf{a}_1) - det(\mathbf{a}_1, \mathbf{a}_2) \\ (\mathbf{b}_2 - \mathbf{b}_1)^{\perp} & det(\mathbf{b}_0, \mathbf{b}_2 - \mathbf{b}_1) - det(\mathbf{b}_1, \mathbf{b}_2) \\ (\mathbf{c}_2 - \mathbf{c}_1)^{\perp} & det(\mathbf{c}_0, \mathbf{c}_2 - \mathbf{c}_1) - det(\mathbf{c}_1, \mathbf{c}_2) \end{pmatrix}$$

Therein - we write again the second row-

$$\begin{aligned} det\,(\mathbf{b}_0, \mathbf{b}_2 - \mathbf{b}_1) - det(\mathbf{b}_1, \mathbf{b}_2) &= det\,(\mathbf{b}_0, \mathbf{b}_2 - \mathbf{b}_1) - det\,(\mathbf{b}_1, \mathbf{b}_2 - \mathbf{b}_1) \\ &= det\,(\mathbf{b}_0 - \mathbf{b}_1, \mathbf{b}_2 - \mathbf{b}_1) \\ &= det\,(\mathbf{b}_2 - \mathbf{b}_1, \mathbf{b}_1 - \mathbf{b}_0). \end{aligned}$$

Hence, under the condition $det\, M = 0$ we obtain,

$$det\, G = 0 \Leftrightarrow \mathrm{rg}(M_{ext}) < 3.$$

It can be verified that this is also true for indirect mechanisms if the line g_2 parallel to B_1B_2 passes through the reflection of B_0 w.r.t. B_1 (for details see Can, 2012).

Theorem 6. a. Any pose of the mechanism is singular if and only if the three lines spanned by the arms A_1A_2, B_1B_2 and C_1C_2 are concurrent.

b. Any pose of the mechanism is twice singular if and only if the lines A_1A_2, B_1B_2 and C_1C_2 meet at a point G and the three lines g_1, g_2 and g_3, as explained before, meet at a common point $\bar{G}$.

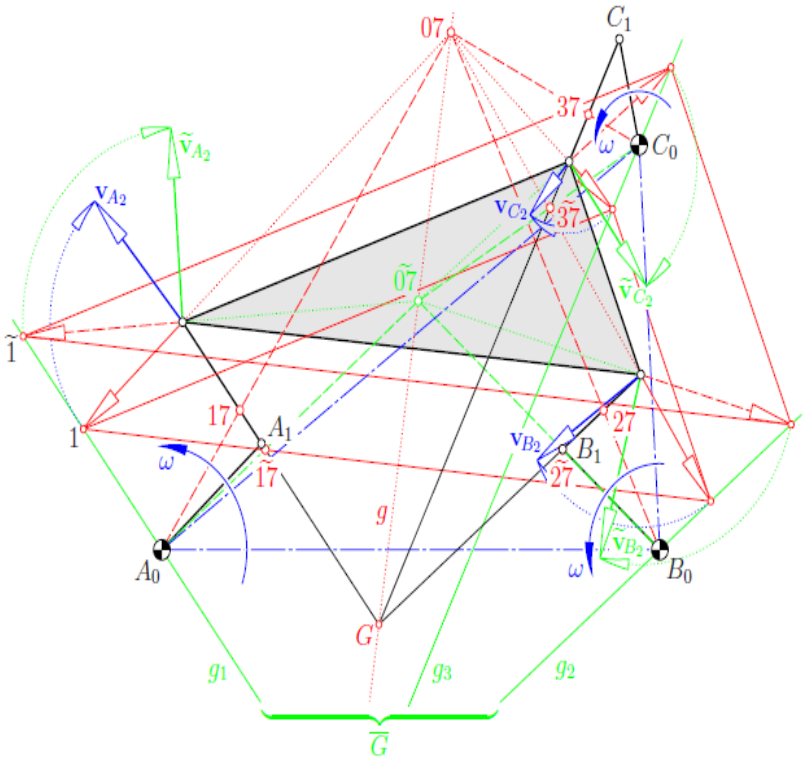

Figure 4. Twice singular pose of a direct mechanism (Theorem 6). All possible relative poles *07* of Σ_7/Σ_0 are located on the line *g,* which connects *G* and $\tilde{G}$. (Can, 2012)

Theorem 7. The moving system Σ_7 has a still stand if and only if each arm is aligned with the neighboring crank and these three lines are not concurrent (see Figure 5).

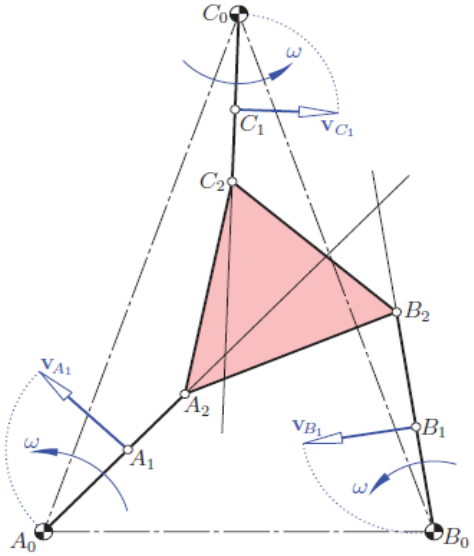

Figure 5. The moving plane has instantaneously still stand despite of $\omega \neq 0$.

Proof. By virtue of eq. (7), has a still stand is characterized by $(x_1, x_2, x_3) = (0, 0, 0)$. In this case the system (11) of equations $M\ \mathbf{x} = \mathbf{s}$ has only the trivial solution. Therefore, this system must be homogeneous with rk $M = 3$. Each entry in the absolute column -like det ($\mathbf{b}_2$ - $\mathbf{b}_1$, $\mathbf{b}_1$ - $\mathbf{b}_0$) - vanishes if and only if each driving crank is aligned with the subsequent arm.

ANALYTIC ACCELERATION ANALYSIS OF THE MECHANISM

The velocity analysis led to the system (11) of linear equations for the unknowns (x_1, x_2, x_3), which define the vector $\mathbf{v_0}$ and the skew-symmetric matrix *S* in eq. (7).

By Theorem 3, the vehicular acceleration of any point attached to Σ_7 is

$$\mathbf{a_x} = \mathbf{a_0} + \left(\dot{S} + S^2\right)\mathbf{x}_0,$$

where $\mathbf{x_0}$ is the fixed coordinate of the point under consideration. We set up

$$\mathbf{a_0} = \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} \text{ and } \dot{S} = \begin{pmatrix} 0 & y_3 \\ -y_3 & 0 \end{pmatrix}. \tag{15}$$

Thus, we obtain for vertices of the moving triangle in Σ_7 the acceleration vectors

$$\begin{aligned} \mathbf{a}_{\mathbf{a}_2} &= \mathbf{a_0} + \left(\dot{S} + S^2\right)\mathbf{a}_2 \\ \mathbf{a}_{\mathbf{b}_2} &= \mathbf{a_0} + \left(\dot{S} + S^2\right)\mathbf{b}_2 \\ \mathbf{a}_{\mathbf{c}_2} &= \mathbf{a_0} + \left(\dot{S} + S^2\right)\mathbf{c}_2 \end{aligned}$$

where

$$\left(\dot{S} + S^2\right) = \begin{pmatrix} -x_3^2 & y_3 \\ -y_3 & -x_3^2 \end{pmatrix} \tag{16}$$

For a constant driving speed ω of the cranks we obtain as accelerations of their endpoints

$$\begin{aligned} \mathbf{a}_{\mathbf{a}_1} &= -\omega^2(\mathbf{a}_1 - \mathbf{a}_0) \\ \mathbf{a}_{\mathbf{b}_1} &= -\omega^2(\mathbf{b}_1 - \mathbf{b}_0) \\ \mathbf{a}_{\mathbf{a}_1} &= -\omega^2(\mathbf{c}_1 - \mathbf{c}_0). \end{aligned}$$

According to theorem 4 - *we write again the second equation* –

$$\mathbf{a}_{\mathbf{b}_2} - \mathbf{a}_{\mathbf{b}_1} = \mathbf{a}^n_{\mathbf{b}_2\mathbf{b}_1} + \mathbf{a}^t_{\mathbf{b}_2\mathbf{b}_1}$$

where

$$\mathbf{a}^n_{\mathbf{b}_2\mathbf{b}_1} = -\frac{\|\mathbf{v}_{\mathbf{b}_2\mathbf{b}_1}\|^2}{\|(\mathbf{b}_2 - \mathbf{b}_1)\|^2}(\mathbf{b}_2 - \mathbf{b}_1).$$

The vector $\mathbf{a}^t_{\mathbf{b}_2\mathbf{b}_1}$ is orthogonal to the arm $\mathbf{b}_2 - \mathbf{b}_1$. These results in

$$\left(\mathbf{a}_{\mathbf{b}_2} - \mathbf{a}_{\mathbf{b}_1}\right).(\mathbf{b}_2 - \mathbf{b}_1) = \mathbf{a}^n_{\mathbf{b}_2\mathbf{b}_1}.(\mathbf{b}_2 - \mathbf{b}_1) = -\mathbf{v}^2_{\mathbf{b}_2\mathbf{b}_1} = -\left(\mathbf{v}_{\mathbf{b}_2} - \mathbf{v}_{\mathbf{b}_1}\right)^2.$$

After substituting the values from the equations (7), (8), (9) and (16) we obtain

$$\left(\mathbf{a_0} + \left(\dot{S} + S^2\right)\mathbf{b}_2 + \omega^2(\mathbf{b}_1 - \mathbf{b}_0)\right).(\mathbf{b}_2 - \mathbf{b}_1) = -\left(\mathbf{v_0} + S\mathbf{b}_2 \pm \omega D(\mathbf{b}_1 - \mathbf{b}_0)\right)^2.$$

This is a linear equation with the unknowns' y_1, y_2, and y_3. By virtue of eq. (12), it can be rewritten in matrix form as

$$\begin{aligned} &(\mathbf{b}_2 - \mathbf{b}_1)^{\mathrm{T}}\begin{pmatrix} y_1 \\ y_2 \end{pmatrix} + y_3\, det(\mathbf{b}_1, \mathbf{b}_2) - x_3^2\mathbf{b}_2^{\mathrm{T}}(\mathbf{b}_2 - \mathbf{b}_1) + \omega^2(\mathbf{b}_1 - \mathbf{b}_0)^{\mathrm{T}}(\mathbf{b}_2 - \mathbf{b}_1) \\ &= -\left(\mathbf{v_0} + S\mathbf{b}_2 \pm \omega D(\mathbf{b}_1 - \mathbf{b}_0)\right)^{\mathrm{T}}\left(\mathbf{v_0} + S\mathbf{b}_2 \pm \omega D(\mathbf{b}_1 - \mathbf{b}_0)\right). \end{aligned}$$

Furthermore, because of $S^{\mathrm{T}}S = x_3^2 I_2$, $D^{\mathrm{T}}D = I_2$ and $S^{\mathrm{T}}D = -x_3 I_2 = D^{\mathrm{T}}S$ follows

$$\begin{aligned} (\mathbf{b}_1 - \mathbf{b}_2).\mathbf{a_0} + y_3\, det(\mathbf{b}_1, \mathbf{b}_2) &= -x_3^2\mathbf{b}_2(\mathbf{b}_2 - \mathbf{b}_1) + \omega^2(\mathbf{b}_1 - \mathbf{b}_0)(\mathbf{b}_2 - \mathbf{b}_1) + [\mathbf{v_0}^2 + x_3^2\mathbf{b}_2^2 + \\ &\omega^2(\mathbf{b}_1 - \mathbf{b}_0)^2 + 2x_3\, det(\mathbf{v_0}, \mathbf{b}_2) \pm 2\omega\, det(\mathbf{v_0}, \mathbf{b}_1 - \mathbf{b}_0) \pm 2\omega\, x_3\, \mathbf{b}_2.(\mathbf{b}_1 - \mathbf{b}_0)]. \end{aligned}$$

We summarize all as fallows

Theorem 8. The instantaneous acceleration distribution of the system Σ_7, i.e., the components (y_1, y_2) of $\mathbf{a_0}$ and the non-trivial entry y_3 of the skew-symmetric matrix $\dot{S}$, solve the linear system $M\,\mathbf{y} = \mathbf{t}$ with the coefficient matrix M of eq. (11). The absolute column is reads

$$\mathbf{t} = \begin{pmatrix} \mathbf{v_0}^2 + x_3^2\mathbf{a_1}\mathbf{a_2} + 2x_3\, det(\mathbf{v_0}, \mathbf{a_2}) + 2\omega\, x_3\, \mathbf{a_2}.(\mathbf{a_1} - \mathbf{a_0}) + 2\omega\, det(\mathbf{v_0}, \mathbf{a_1} - \mathbf{a_0}) + \omega^2(\mathbf{a_1} - \mathbf{a_0})(\mathbf{a_2} - \mathbf{a_0}) \\ \mathbf{v_0}^2 + x_3^2\mathbf{b_1}\mathbf{b_2} + 2x_3\, det(\mathbf{v_0}, \mathbf{b_2}) \pm 2\omega\, x_3\, \mathbf{b_2}.(\mathbf{b_1} - \mathbf{b_0}) \pm 2\omega\, det(\mathbf{v_0}, \mathbf{b_1} - \mathbf{b_0}) + \omega^2(\mathbf{b_1} - \mathbf{b_0})(\mathbf{b_2} - \mathbf{b_0}) \\ \mathbf{v_0}^2 + x_3^2\mathbf{c_1}\mathbf{c_2} + 2x_3\, det(\mathbf{v_0}, \mathbf{c_2}) + 2\omega\, x_3\, \mathbf{c_2}.(\mathbf{c_1} - \mathbf{c_0}) + 2\omega\, det(\mathbf{v_0}, \mathbf{c_1} - \mathbf{c_0}) + \omega^2(\mathbf{c_1} - \mathbf{c_0})(\mathbf{c_2} - \mathbf{c_0}) \end{pmatrix}. \quad (17)$$

Theorem 9. If at a still stand of the moving plane Σ_7 with three collinear point triples (A_0, A_1, A_2), (B_0, B_1, B_2) and (C_0, C_1, C_2) also all accelerations vanish, then the pose has a permanent still stand (see Figure 6).

Proof. A still stand of Σ_7 with vanishing velocity vectors is characterized by $\mathbf{v_0} = \mathbf{0}$ and $x_3 = 0$. Under this assumption, in the entries of the absolute column $\mathbf{t}$ only the respective last summands are remaining. Therefore, we obtain zero accelerations if and only if beside $\det(\mathbf{a_1} - \mathbf{a_0}, \mathbf{a_2} - \mathbf{a_0}) = \ldots = 0$ we also have $(\mathbf{a_1} - \mathbf{a_0}).(\mathbf{a_2} - \mathbf{a_0}) = \ldots = 0$. The first condition means collinearity, the second orthogonality. Hence, the unique solution is $\mathbf{a_2} = \mathbf{a_0}$, $\mathbf{b_2} = \mathbf{b_0}$ and $\mathbf{c_2} = \mathbf{c_0}$. This results in the permanent still stand as displayed in Figure 6.

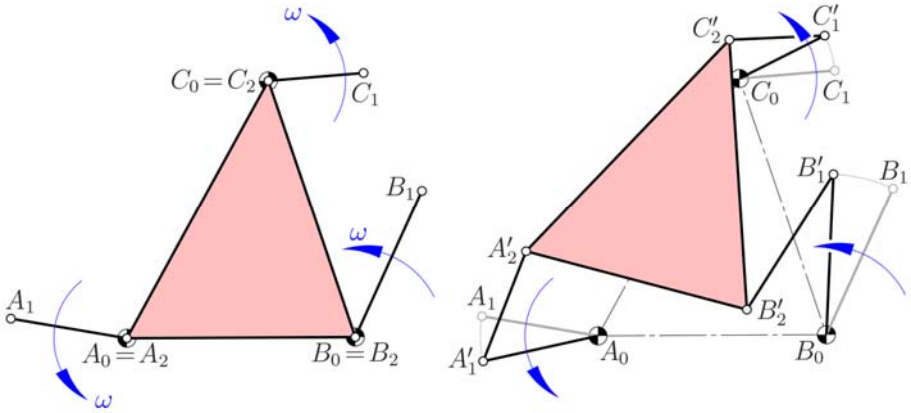

Figure 6. Vanishing velocities and accelerations for all points of Σ_7 result in a permanent still stand of the system. Nevertheless, this pose of Σ_7 admits a bifurcation to a constrained motion.

Remark 4. It is not surprising that in the system of linear equations $M\,\mathbf{y} = \mathbf{t}$, which defines the accelerations, the same coefficient matrix M shows up as for the velocities. We know this from the definition of infinitesimal flexibility of higher order (see Sabitov, 1992).

With regard to the set of solutions of the linear system addresses in Theorem 8, again the three cases **(i), (ii)** and **(iii)** can be distinguished, like for Theorem 5. Because of the identity of the coefficient matrices in equations (11) and (17), the case **(i)**, i.e., rk $(M) < 3$, is still characterized by the concurrence of the lines spanned by the three arms. However, for the cases **(ii)** and **(iii)** no simple geometric characterizations can be expected, since the unknowns x_1, x_2, x_3 of (11) show up on the right-hand side of eq. (17) in linear form and as squares.

CONCLUSIONS

This kind of mechanisms, i.e., planar parallel 3-RRR robots with three synchronously driven cranks, offer a broad variety of different periodical constrained motions, including a permanent still stand. On the other hand, these constrained motions can pass through poses with very special properties, as has been demonstrated before. We conclude with another strategy for obtaining special poses:

Let us, temporarily, remove the crank C_0C_1 and the arm C_1C_2. Then the moving triangle in Σ_7 can perform a two-parameter motion. Within this two-parameter motion, all constrained motions passing through a fixed pose have their instantaneous pole on a line, the *pole axis* (Blaschke and Müller, 1956 and Stachel, 1979). (In Figure 7 this pole axis is marked in thick blue). During this two-parameter motion the points X attached to Σ_7 sweep out two-dimensional regions. If any pose of X happens to lie on the boundary of this region then X must also lie on the pole axis of this pose, which is orthogonal to the boundary at X. In Figure 7 point C_2 is specified on the corresponding pole axis, but at the same time also on the boundary of the circular region, which the endpoint C_2 of the dyad $C_0C_1C_2$ sweeps out. By virtue of Theorem 6, this pose of the 3-RRR-mechanism is twice singular. When the region traced by C_2 under the two-parameter motion, as explained before, shares with the circular disk centered at C_0 only this boundary point, then this pose is isolated and only infinitesimally movable (see Figure 7). Otherwise it enables a bifurcation between two constrained motions. This can be figured out with the help of the (t, φ_{70})-diagram in

Figure 8, which covers the special choice $C_0 = 04$. With regard to this diagram, t is the driving angle of the cranks, and φ is the angle of rotation of Σ_7.
The bifurcation shows up at $t = 64.59^0$.

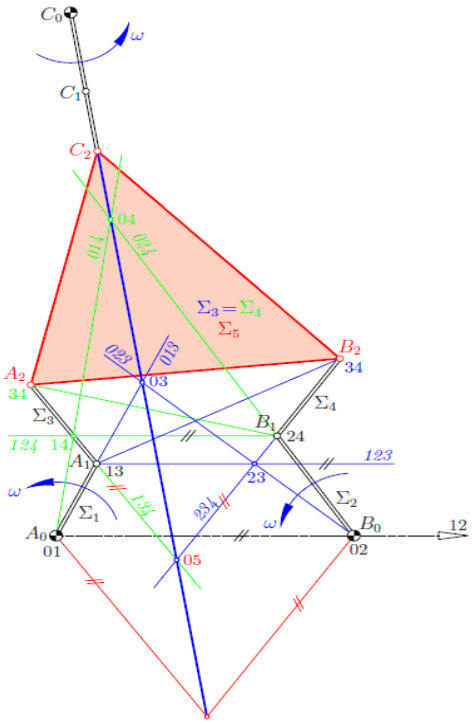

Figure 7. This is an isolated, only infinitesimally movable pose, which is twice singular.

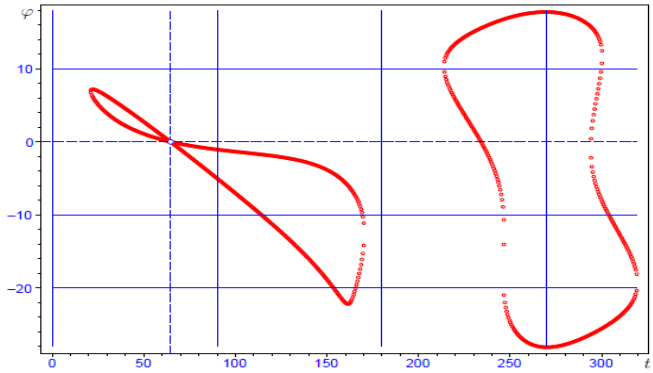

Figure 8. When in addition to the choice of C_2 on the instant pole axis (like in Figure 7) the anchor point C_0 is specified as $C_0 = 04$, then this pose is no more isolated, but enables a bifurcation.

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ANTI-SCALE MAGNETIC METHOD AS A PREVENTION METHOD FOR CALCIUM CARBONATE SCALING

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Abstract: The effect of anti-scale magnetic method (AMM) in retarding scaling deposition is confirmed by many researchers, to result in new crystal morphology, crystal which has the tendency to remain suspended more than precipitated. AMM is considered as an economic method when compared to other common methods used for scale prevention in desalination plant as acid treatment and addition of antiscalant. The current project was initiated to evaluate the effectiveness of AMM in preventing calcium carbonate scaling. The AMM was tested at different flow velocities (1.0, 0.5, 0.3, 0.1, and 0.003 m/s), different operating temperatures (50, 70, and 90°C), different feed pH and different magnetic field strength. The results showed that AMM was effective in retarding calcium carbonate scaling deposition, and the performance of AMM depends strongly on the flow velocity. The scaling retention time was found to be affected by the operating temperatures, flow velocity, and magnetic strength (MS), and in general, it was found that as the operating temperatures increased the effectiveness of the AMM in retarding calcium carbonate ($CaCO_3$) scaling increased.

Key Words: Magnetic field strength, flow velocity, scale retention time.

Introduction

Scaling is considered to be the biggest operating problem in desalination plants. The deposition of scales can lead to a decrease in the operating efficiency, and equipment life, as well as increase in the maintenance cost and energy consumption. Calcium carbonate ($CaCO_3$) scaling is considered as the most common scale in all desalination plants especially in reverse osmosis plant and in multistage flashing desalination plants. Therefore, it has received since special attention in desalination plant and at different operating temperatures (Segnit et al., 1962; ;Langmuir, 1968; Brecevic and Nielsen, 1989; Cubillas et al., 2005; Tarek et al., 2012; Chaussemier et al., 2015). $CaCO_3$ can be precipitated at three different polymorphs such as calcite, vaterite, and aragonite. Aragonite is considered as the easiest form of $CaCO_3$ and can be removed by flushing with water, because it is a soft scale; while calcite is a hard scale and it could usually be avoided by using antiscant or addition of acid. Aragonite is known with a unique morphology or crystal shape, which makes it be suspended more time than calcite scale. Furthermore, the solubility of aragonite is more than the solubility of calcite at the same temperature and condition (Morse et. al., 1980).

Acid addition is considered as a reliable method to prevent calcite scaling in desalination plants, where acid was added to the feed water, to consume part of the bicarbonate in feed water and convert it to a carbon dioxide.

$$H^+ + HCO_3^- \longleftrightarrow CO_2 \uparrow + H_2O \quad (1)$$

This type of treatment method will result in shifting reaction 2, which is responsible in the precipitation of $CaCO_3$ to the left side, and prevents precipitation of $CaCO_3$.

$$Ca^{+2} + HCO_3^- \longleftrightarrow H^+ + CaCO_3 \downarrow \quad (2)$$

However, acid addition treatment method is always accompanied with corrosion problems and requires special care and precautions. Furthermore, acid cleaning forces the operators to shut down the plant, which could lead to less productivity and low availability. Antiscalant is also considered as a reliable method to prevent calcite precipitation inside desalination plants.

Scale inhibitor can also be considered as a reliable method used for a long time in desalination plant to control $CaCO_3$ scaling. Antiscalant is a chemical impurity that could modify or change the shape, size, and morphology of crystal formed during crystallization or scale formation processes (Greenlee et. al., 2011).

Polyelectrolytes as polycarboxylate, polyacrylates and polyphosphate have been reported as efficient inhibitors that could control $CaCO_3$ precipitation, by reacting with mineral nuclei to disrupt the crystallization process and keep the crystal particles dispersed in the scaling solution (Chauhan et. al., 2012). Other types of antiscalant have the ability to retard the crystal growth rate to suppress the scale formation, and then control the scaling processes. The threshold inhibitors are special additives, where threshold inhibitors can retard scale precipitation for a sufficiently long period of time, and the scale will precipitate outside the desalination system. The influence of antiscalant on the precipitation of $CaCO_3$ was investigated by many authors at different operating pH, and the result confirmed the relation between the functional group in the Antiscalant and increasing the induction time (ß), which is the time required for precipitation of $CaCO_3$(Amjad et al., 1994; Tarek et al., 2012).

Phosphonate antiscalant additives can be classified to be protonated phosphonate group (PO_3H^-) and fully dissociated group (PO_3^{2-}) that work according to adsorption model, where it can inhibit the growth of crystal by adsorption of the reactive surface site. At present, there are various types of phosphonate antiscalant chemicals, such as condensed polyphosphate, organo phosphate, and polyelectrolyte phosphate; however under neutral pH and low temperatures, linear polyphosphonates undergo relatively slow hydrolysis, and the rate of hydrolysis will increase as the operating temperature increases (Gryta, 2012). Furthermore, it is well-known, that special care must be taken to avoid hydrolysis of sodium hexameta phosphate (SHMP) antiscalant in dosing tank, where the hydrolysis process can be described in the following equation.

$$PO_3^- + H_2O \longrightarrow H_2PO_4^{2-} \longrightarrow PO_4^{3-}$$

the hydrolysis will result to losing the effectiveness of the antiscalant in preventing scaling deposition. Furthermore, hydrolysis process can create a phosphonate scaling risk as illustrated in the following equation

$$3Ca^{2+} + 2\,PO_4^{3-} \longrightarrow Ca_3(PO_4)_2 \qquad (4)$$

However, high cost is a problem. It has been calculated that the cost of antiscalant chemicals accounts for about 10% in the production of freshwater in Dalian (Li Hai Yan et. al., 2006). In Kuwait, the annual cost for using a low concentration (not exceeding 3 mg/l) of antiscalant chemicals, is about KD0.95 million (MEW, 2010). This annual cost is expected to increase as the production of desalination plant increases.

Even so, Antiscalant chemicals play an important role in preventing $CaCO_3$ precipitation in reverse osmosis system; they are prone to enhance biofilm growth on reverse osmosis membrane by either altering the membrane surface properties or by serving as nutritional source for microorganisms (Sweity et. al., 2013). In addition, many types of chemical antiscalants on the market are harmful to the environment, and could result to serious environmental influence (Chauhan et. al., 2012). Because of this, researchers have looked for a new promising treatment method referred to as anti-scale magnetic treatment method, which is a nonchemical treatment method, and it is expected to reduce the operating cost of desalination plant. Anti-scale magnetic method (AMM) is a physical pretreatment method, which has been applied as a controlling and/or preventing tool for several decades for the deposition of scale in the domestic and industrial water systems.

Although the operating cost of AMM is very low when compared to that of chemical antiscalant method, the AMM is still not totally accepted by the scientific research community. The main reason for that is the lack of repeatable data, where the AMM was reported to work in some applications and not in the others. Furthermore, until now a few and limited researchers have proposed a scientific theory, explaining the work of AMM. In the last few years, the attention to AMM had increased as an attractive, low cost, treatment method, to prevent scaling deposition in desalination plant. A literature survey has been conducted at KISR on the effectiveness of AMM in preventing $CaCO_3$ scaling. It was concluded that the AMM can be considered as an effective method in controlling $CaCO_3$ scaling (Ben Salah, 2015; Cefalas et. al., 2010; Alimi et. al., 2009; Eliassen et al. 1985; Hasson and Bramson, 1985; Baker et. al., 1997; Sohnel and Mullin, 1988; Barrett and Barsons, 1998). Moreover, the result of literature survey confirmed that the AMM cannot totally prevent the formation of $CaCO_3$ crystals, but it can affect the scale formation process by increasing the retention or conducting time, producing crystals with different morphology (aragonite morphology), higher tendency for suspension and smaller in sizes, which can be carried out away with the brine water flow without Antiscalant treatment. Furthermore, it was found that the effectiveness of the AMM method in preventing precipitation of $CaCO_3$ was strongly affected by the chemical properties of the scaling solution, magnetic field strength (MFS), water temperature, and flow velocity (Busch et. al., 1986; Biochenko et. al., 1977; Gryta, 2011; Cai et. al., 2009; Gabrielli et al., 2000). Because of the lower operating cost of AMM and the encouraging results obtained from the literature survey, AMM was tested at desalination research plant (DRP), to assess the effectiveness of the AMM in retarding CaCO3 scaling deposition or increasing the induction time ((ß) at different operating

temperatures, different feed water pH and different MFS to identify favorable operating conditions for effective $CaCO_3$ scale prevention. The chemical composition of Kuwait seawater used in the experiments is shown in Table 1, where about 51% of Kuwait seawater showed chloride ions and 29.4% sodium ions. Sulfate ions also compose a high percentage of Kuwait seawater. Scaling of $CaCO_3$ is the dominated scale expected to precipitate when Kuwait seawater is concentrated to one or more concentration factor, as expected by Staff and Davis saturation index, followed by scaling of calcium sulfate, barium sulfate, and strontium sulfate, but with less amount than $CaCO_3$ scaling.

Table 1. The Chemical Composition of Seawater at Doha Site

Parameter	Concentration (mg/l)	% of TDS
pH	8.28	
Temp (°C)	27.38	
Conductivity (ms/cm)	61.8	
TDS (mg/l)	48529	
Turbidity	0.54	
Na^+ (mg/l)	16353	29.408
Ca^{2+}(mg/l)	1030	1.25
HCO_3^- (mg/l)	130	0.327
Cl^-(mg/l)	25208	50.8
Mg^{2+}(mg/l)	1536	3.53
SO_4^{2-}(mg/l)	4429	9.49
Ba^{2+}(mg/l)	0.38	
K^+ (mg/l)	589	1.08
Sr^{2+}(mg/l)	13	0.0308
PO_4^{3-}(mg/l)	0.23	0.0005

Experimental Procedures Description

The AMM testing unit was shown in Fig. 1. The test unit primarily consists of two tanks, A and B, fabricated from glass sheets and located inside two water baths to control the temperature of the tested solution. The testing unit also contained a variable speed pump, needle valves to control the flow, thermometers, a pH adjustment section, and a magnetic field section. The magnetic field section contains a permanent antiscalant magnets treatment unit (AMT)) as shown in Fig. 1 with north and south facing each other, as a source for the magnetic treatment around the pipe. The magnets were positioned orthogonally to the direction of the flow of fluid inside the pipe. Pairs were changed according to the magnetic field strength required. A Tesla meter was used to measure the strength of the magnetic field in each experiment. An automatic titrator, ion chromatography, spectrophotometer DRL/2000, and other instruments were used for analyzing scaling ions such as Ca^{2+} and HCO_3^- ions at the Doha Research Plant (DRP).

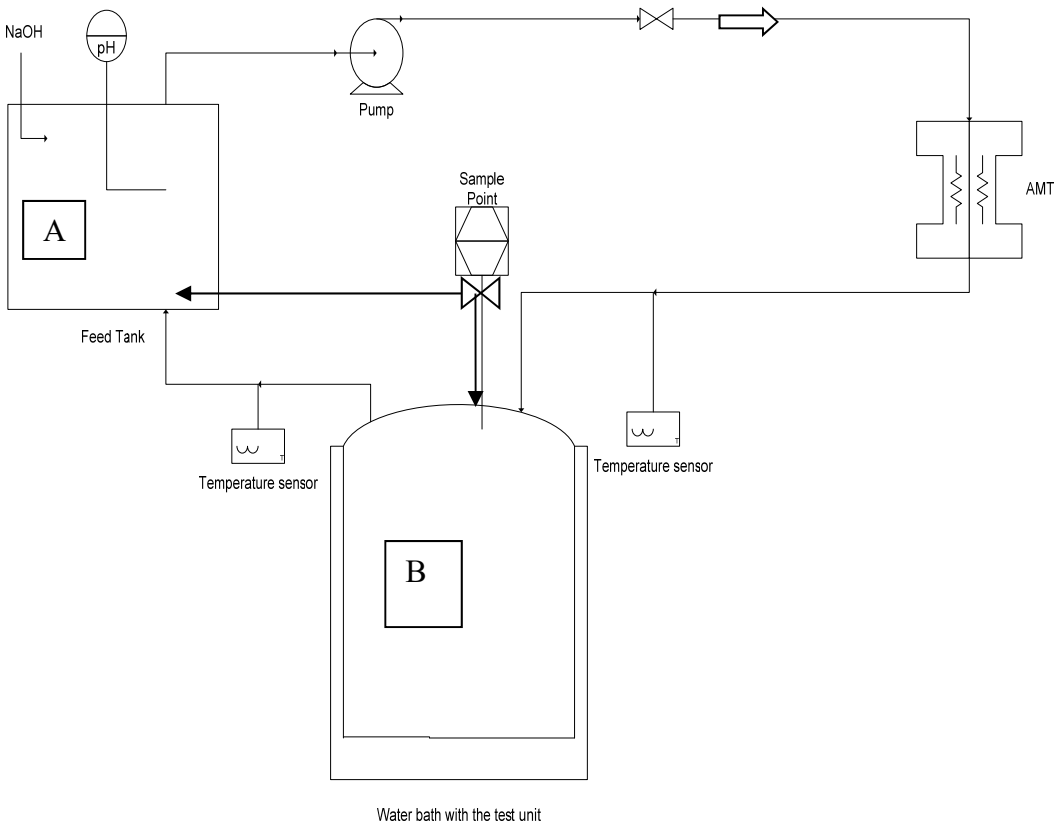

Fig.1. The antiscalant magnetic treatment testing unit.

The two tanks, A and B, are connected to each by a valve and a variable speed pump, which was used to pump the test solution from tank A to tank B, and to circulate the test solution through the magnetic fields at a controlled flow velocity. Both tanks A and B were installed inside a water bath to enable temperature controlling during the tests. Two types of solutions were mixed to prepare the required precipitated salt. Calcium carbonate precipitated scaling ($CaCO_3$) was prepared by mixing two solutions, which are 0.5 M of $CaCl_2$ and 0.5 M of Na_2CO_3. Na_2CO_3 solution was considered as the base solution for preparing $CaCO_3$ scaling. Hence, the base solution was prepared at tank A; while $CaCl_2$ was prepared at tank B. First, the pHs of both tested solutions were adjusted to a desirable value using acid. Then, the temperatures were heated to a required testing temperature before mixing the two solutions, using the water baths at both tanks A and B separately. Then, the base solution was circulated through the AMT unit to be magnetically treated without mixing with $CaCl_2$ solution in Tank B, using a controlled valve and variable speed pump, for almost one hour. Then, the solutions were mixed, and the mixing time was considered as time zero for scale formation, and then, the samples were drawn from tank B every minute for bicarbonate analysis to test the effectiveness of the AMT unit in retarding scale deposition and increasing ß. Thus, three MSF were tested (0T,0.48T and 0.96T) , three operating temperature (50, 70 and 90 ºC), two PH values (8.3 and 9.5) and different flow velocities (1.0, 0.5, 0.3, 0.1 and 0.03 m/s)

Results and Discussions

Calcium Carbonate Scaling

The performance of AMM in retarding $CaCO_3$ at a pH of 8.3 and variable magnetic field and operating temperatures, are shown in figs. 2 to 13. Figures 2, 3, and 4 shows the performance of AMM at 0.5 m/s flow velocity, while Figs. 5, 6 and 7 show the performance of AMM at a flow velocity of 0.3 m/s. However, the flow velocity of 0.1 and 0.03 is shown in Figs. 8 to 10 and Figs. 11 to 13 respectively.

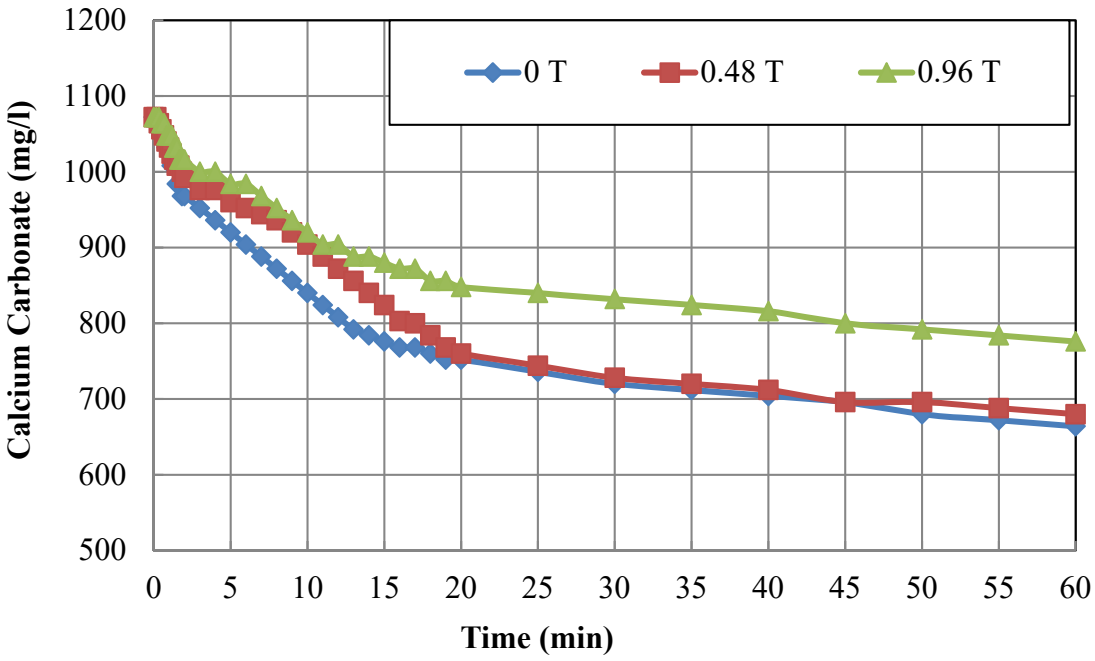

Fig. 2. Calcium carbonate concentration at 0.5 m/s velocity, pH 8.3 and 50°C at different magnetic field.

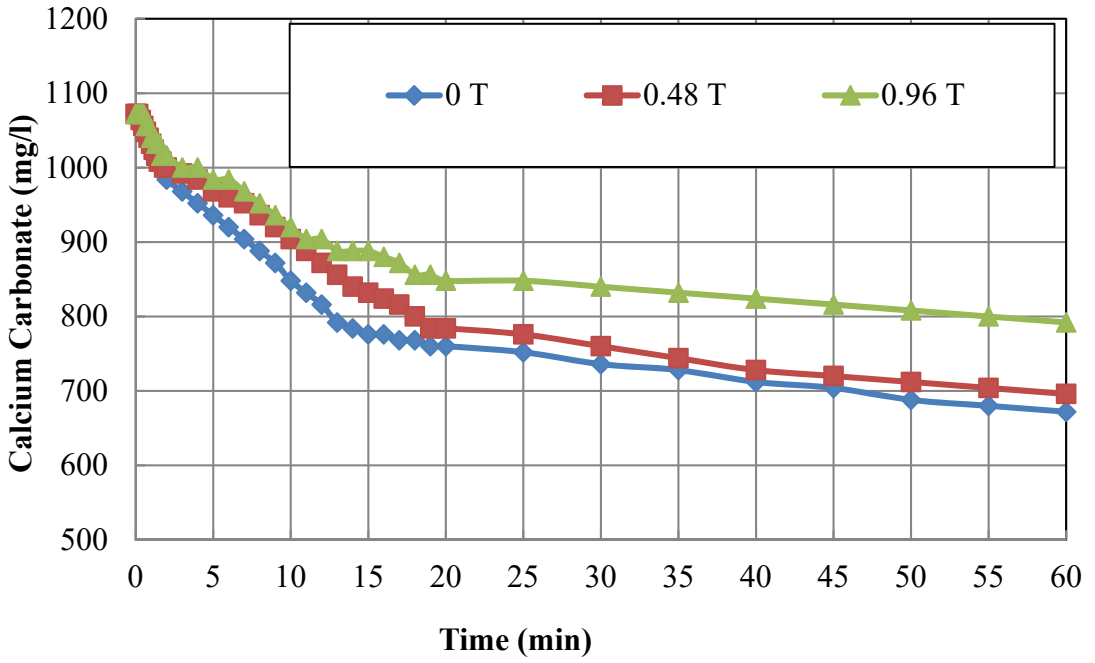

Fig. 3. Calcium carbonate concentration at 0.5 m/s velocity, pH 8.3 and 70°C at different magnetic field.

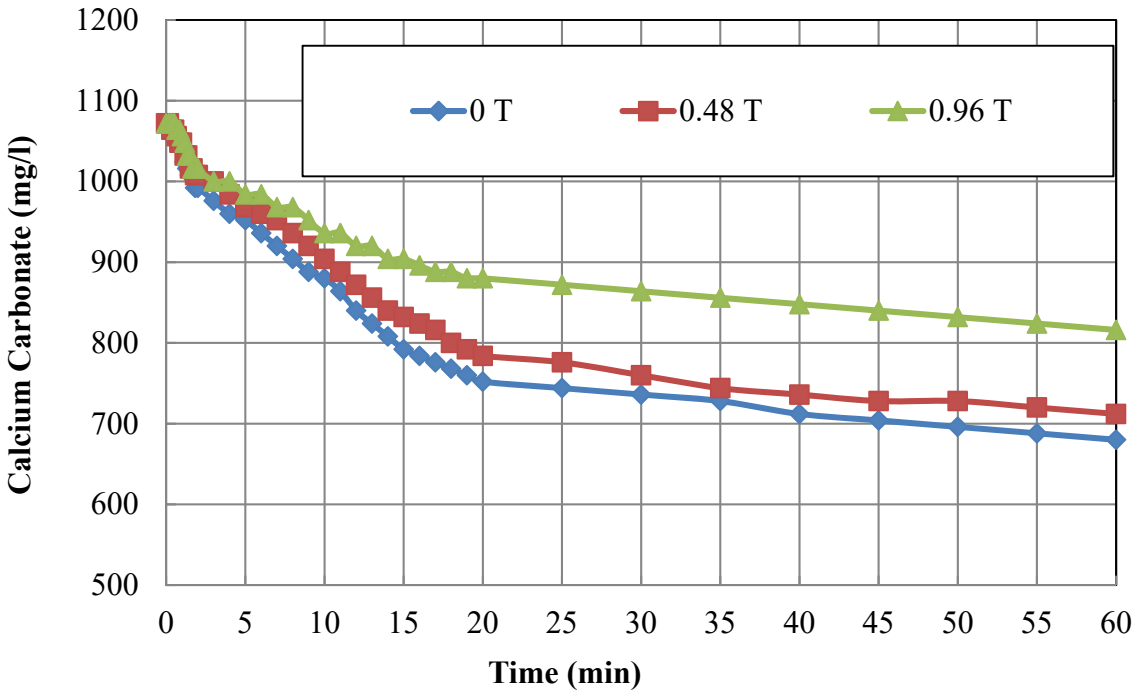

Fig. 4. Calcium carbonate concentration at 0.5 m/s velocity, pH 8.3 and 90°C at different magnetic field.

Performance of Magnetic Treatment Method in Retarding Calcium Carbonate at a Flow Velocity of 0.5 m/s. The AMM was tested at three magnetic field strength which are 0 Tesla, (without magnetic treatment method), 0.48 Tesla and 0.96 Tesla. Although the differences between the three magnetic field is not too much clear in Figures 2 to 4. However, it is clear that the ATM decreased the potential for calcium carbonate scaling, and the power for retarding calcium carbonate by AMM can be increased when the applied magnetic field strength (MFS) is increased.

The AMM increased ß for calcium carbonate scaling at a concentration of 1000 mg/l of HCO_3^- from less than 3 min to 5 min at 0.96 T magnetic fields. Moreover, it can retard the carbonate scaling at a concentration of 800 mg/l of HCO_3^- for about 45 min as shown in Fig. 2, when compared to 12 min without applying AMM with increment equal to 2.75 times. The increment in ß is calculated as follows:

$$\text{Increment in ß} = \frac{\text{The retention time ß under AMM} - \text{retention time ß without AMM}}{\text{Retention time ß without AMM}}$$

Thus, it is clear that AMM is a selective treatment. However, knowing that the bicarbonate concentration in Kuwait seawater does not exceed 200 mg/l (Salman et. al., 2013), this implies that the AMM could be effective in retarding calcium carbonate scaling. Figs. 3 and 4 show the performance of AMM in retarding calcium carbonate concentration under pH 8.3 and flow velocity of 0.5 m/s and a temperature of 70°C and 90°C. Both figures show that the AMM could increase ß for about 50 min instead of 12 min without AMM at a concentration of 800 mg/l of calcium carbonate scaling, which represent an increment of 3.16 fold as shown in Figs 3 and 4 under 0.96 T. ß was increased to 60 min when the operating temperature was increased from 70°C to 90°C as shown in Fig. 4.

Performance of Magnetic Treatment Method in Retarding Calcium Carbonate at a Flow Velocity of 0.3 m/s. Figs. 5, 6, and 7 show the performance of AMM at different operating temperatures and different magnetic fields under 0.3 m/s of flow velocity.

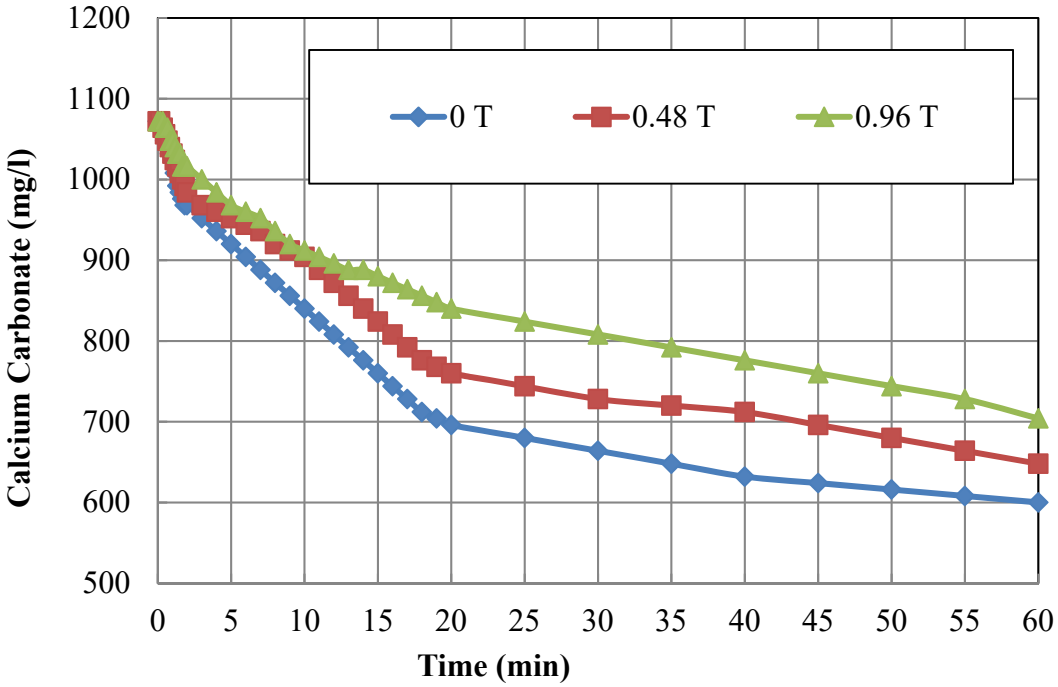

Fig. 5. Calcium carbonate concentration at 0.3 m/s velocity, pH 8.3, and 50°C at different magnetic field.

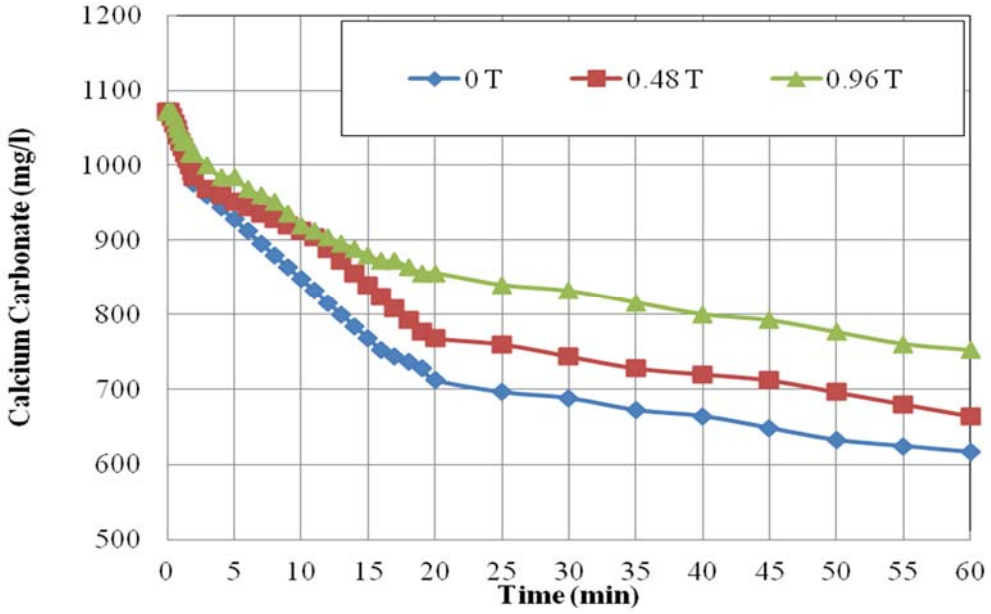

Fig.6. Calcium carbonate concentration at 0.3 m/s velocity, pH 8.3 and 70°C at different magnetic field.

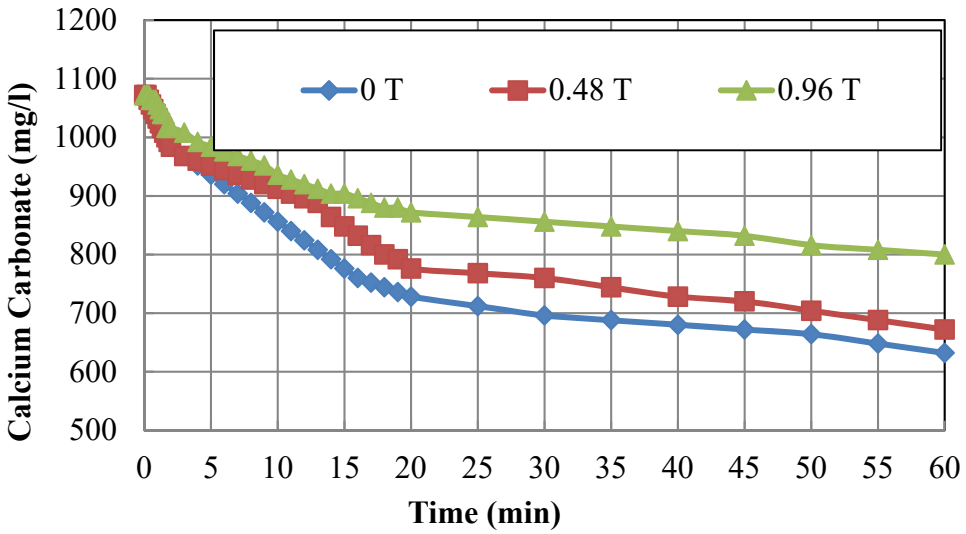

Fig.7. Calcium carbonate concentration at 0.3 m/s velocity, pH 8.3 and 90°C at different magnetic field.

From Figs 5, 6, and 7, it is clear that the AMM succeeded in increasing the retention time from 11 min at 800 mg/l of calcium carbonate concentration to about 35 min at 0.96 T and an operating temperature of 50° C as shown in Fig. 5. Moreover, ß was increased from 12 min without AMM to about 40 min at an operating temperature of 70°C and 0.96 T as shown in Fig. 6. The ß at 800 mg/l of calcium carbonate concentration was increased from 14 min to 55 min as shown in Fig. 7.

Performance of Magnetic Treatment Method in Retarding Calcium Carbonate At a Flow Velocity of 0.1 m/s. Figs. 8, 9, and 10 show the performance of AMM at different operating temperatures and different magnetic fields under 0.1 m/s flow velocity.

From Figs. 8, 9, and 10, it is clear that the effective concentration level was decreased from 800 mg/l to about 700 mg/l, where noticeable rice in retention time can be found. The increment in ß at 800 mg/l was almost small and did not exceed 7 min at 0.96 T and an operating temperature of 90° C. However, at a concentration of 700 mg/l, marked rise in retention time ß was noticed. This implies that the performance of AMM decreased strongly, with a decrease in flow velocity, than that of a reduction in operating temperatures.

The AMM succeeded in increasing the ß from 17 min at 700 mg/l of calcium carbonate concentration to about 35 min at 0.96 T and an operating temperature of 50° C as shown in Fig. 8. Moreover, the retention time ß increased from 19 min. without AMM to about 35 min. at an operating temperature of 70°C and 0.96 T as shown in Fig. 9 at the same level of calcium carbonate concentration. However, at 90°C as shown in Fig. 10, the retention time ß at 700 mg/l of calcium carbonate concentration increased from 19 min to 40 min, which is an increase of 110.5 %.

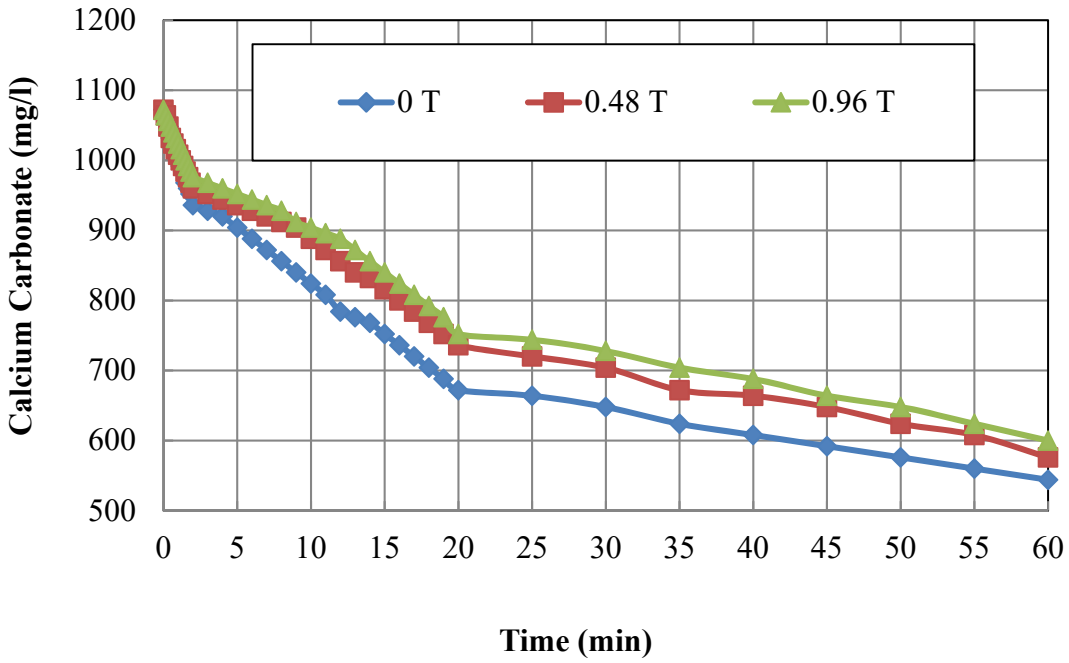

Fig.8 . Calcium carbonate concentration at 0.1 m/s velocity, pH 8.3 and 50°C at different magnetic field.

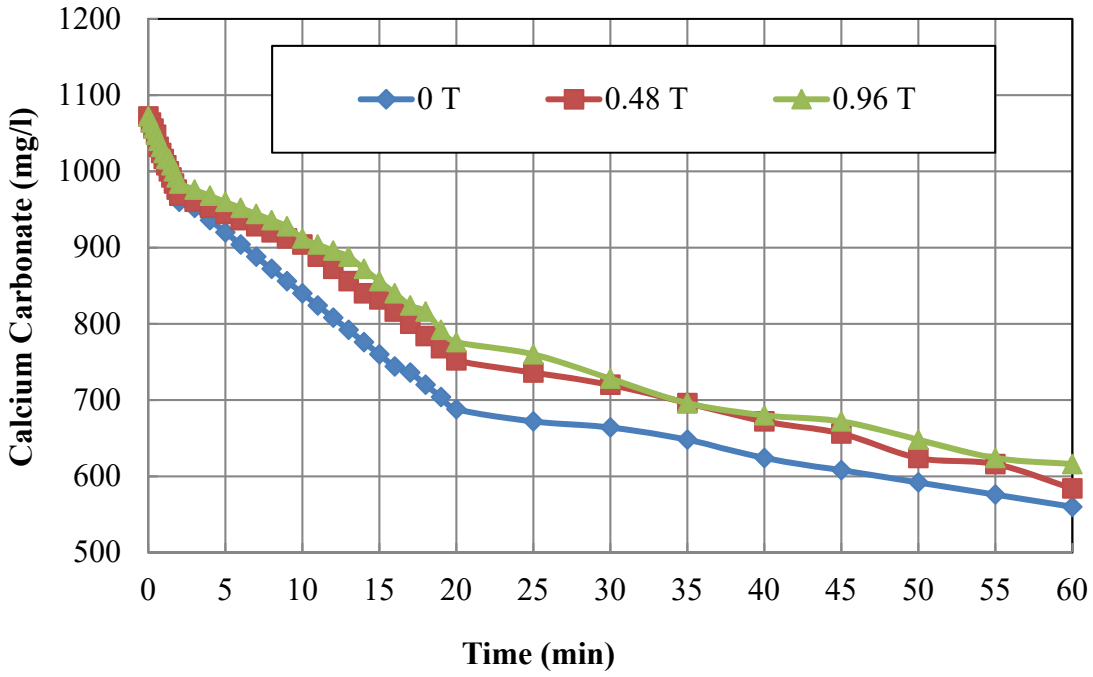

Fig.9. Calcium carbonate concentration at 0.1 m/s velocity, pH 8.3 and 70°C at different magnetic field.

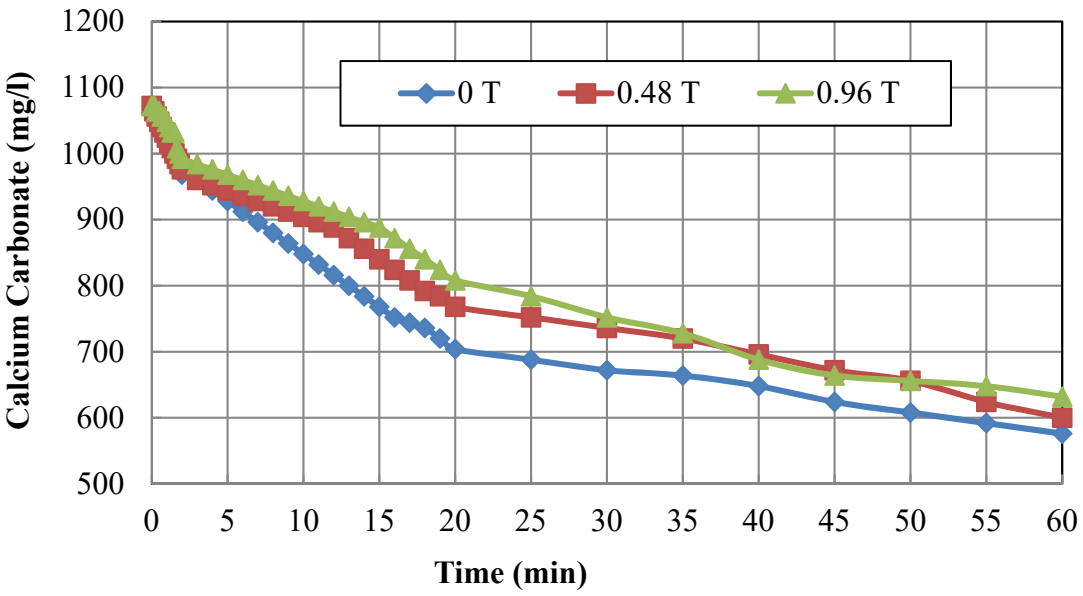

Fig.10 . Calcium carbonate concentration at 0.1 m/s velocity, pH 8.3, and 90°C at different magnetic field.

Performance of Anti-Scale Magnetic Treatment Method in Retarding Calcium Carbonate at a Flow Velocity of 0.03 m/s. Figs. 11, و12 and 13 show the performance of AMM at different operating temperatures and at different magnetic fields under 0.03 m/s flow velocity.

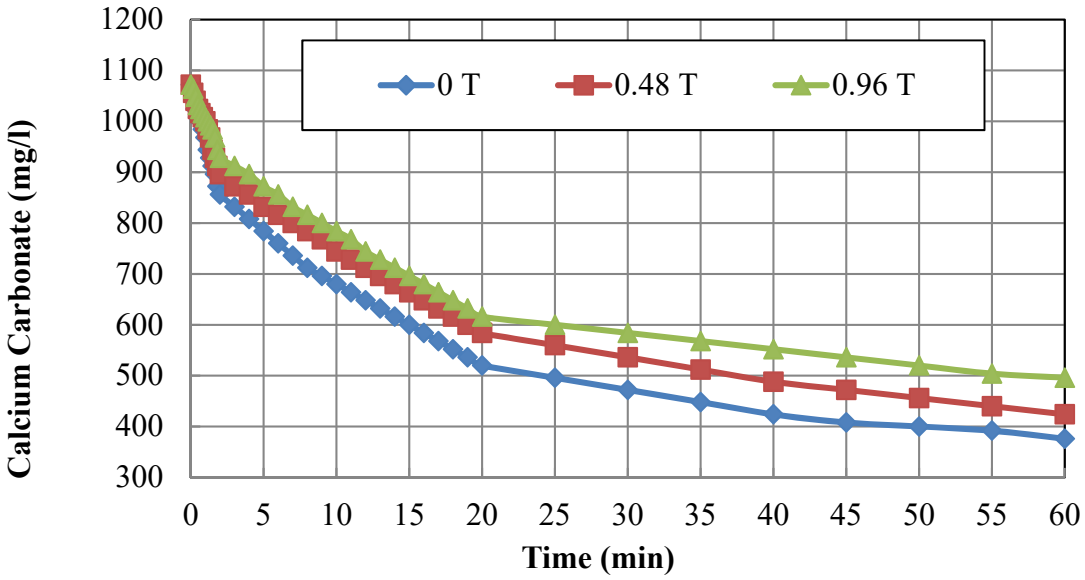

Fig.11. Calcium carbonate concentration at 0.03 m/s velocity, pH 8.3 and 50° C at different magnetic field.

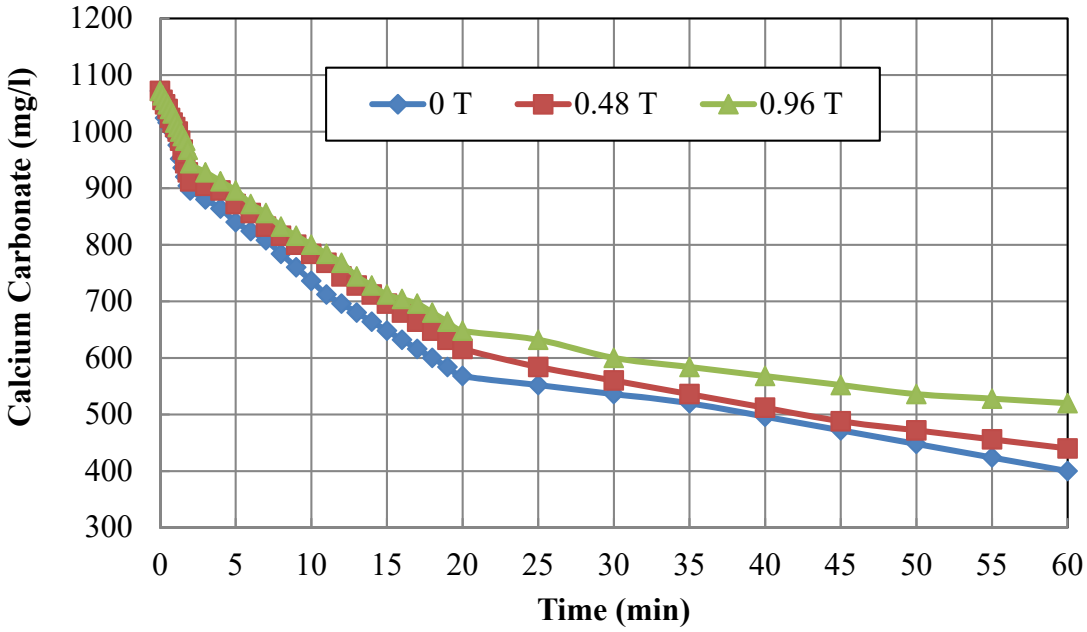

Fig. 12. Calcium carbonate concentration at 0.03 m/s velocity, pH 8.3 and 70° C at different magnetic field.

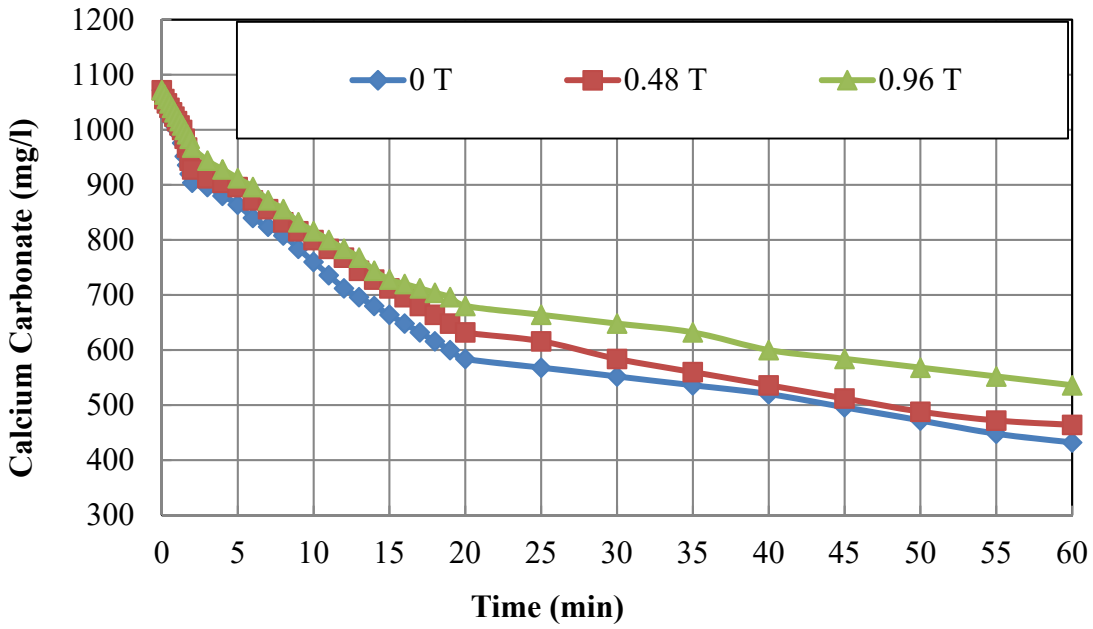

Fig.13 . Calcium carbonate concentration at 0.03 m/s velocity, pH 8.3 and 90° C at different magnetic field.

From Figs. 11, 12, and 13 it is clear that the effective concentration level reduced from 700 mg/l at flow velocity of 0.1 m/s to about 500 mg/l at a flow velocity of 0.03 m/s, where a noticeable increment in the retention time can be found. Thus, the increment in ß at 700 mg/l was almost small and did not exceed 7 min at 0.96 T and operating temperature of 90°C. However, at a concentration of 500 mg/l, a big increment in retention time can be noticed. This confirms the fact concluded before, where the performance of AMM decreased more strongly with a decrease in flow velocity, than that of the decrease in operating temperatures or a decrease in magnetic field strength.

The AMM succeeded in increasing the retention time from 20 min at 500 mg/l of bicarbonate concentration to about 55 min at 0.96 T and an operating temperature of 50°C as shown in Fig. 11. Moreover, the retention time increased from 20 min without AMM to about 55 min. at an operating temperature of 70°C

and 0.96 T as shown in Fig. 12 at a concentration level of 550 mg/l of bicarbonate. However, at 90°C as shown in Fig. 13, the retention time at 700 mg/l of bicarbonate concentration increased from 19 min to 40 min, which represents an increment of 110.5 %.

Performance of Magnetic Treatment Method in Retarding Calcium Carbonate at pH of 9.5. Figures 14 to 16 show the performance of the AMM at a flow velocity of 0.5 m/s at different operating temperatures at different magnetic field strengths and a higher pH of 9.5.

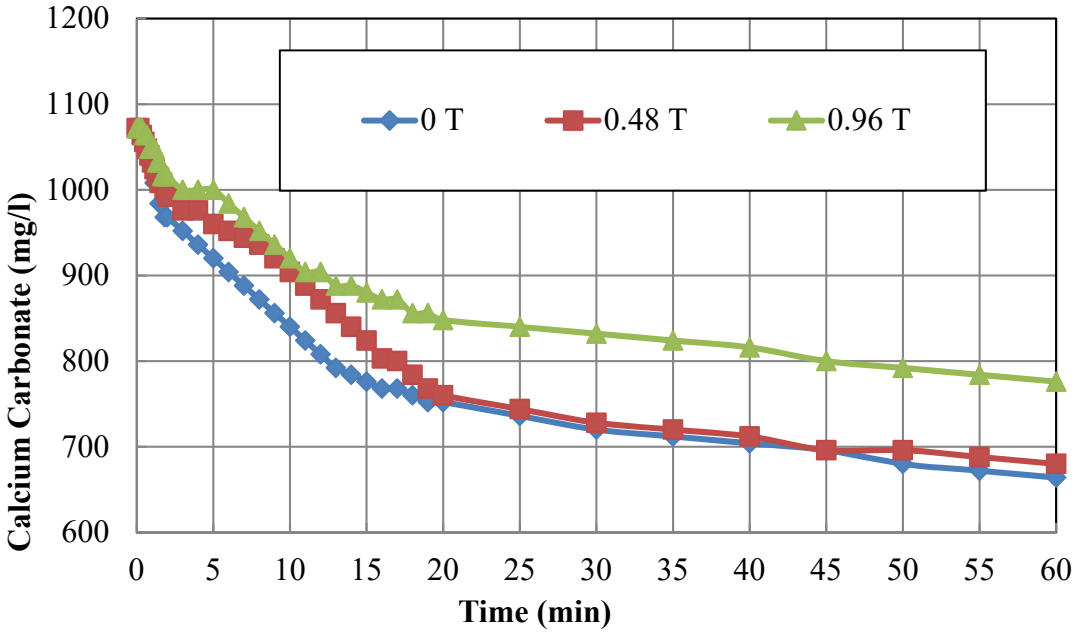

Fig.14. Calcium carbonate concentration at 0.5 m/s velocity, pH 9.5, and 50°C at different magnetic fields.

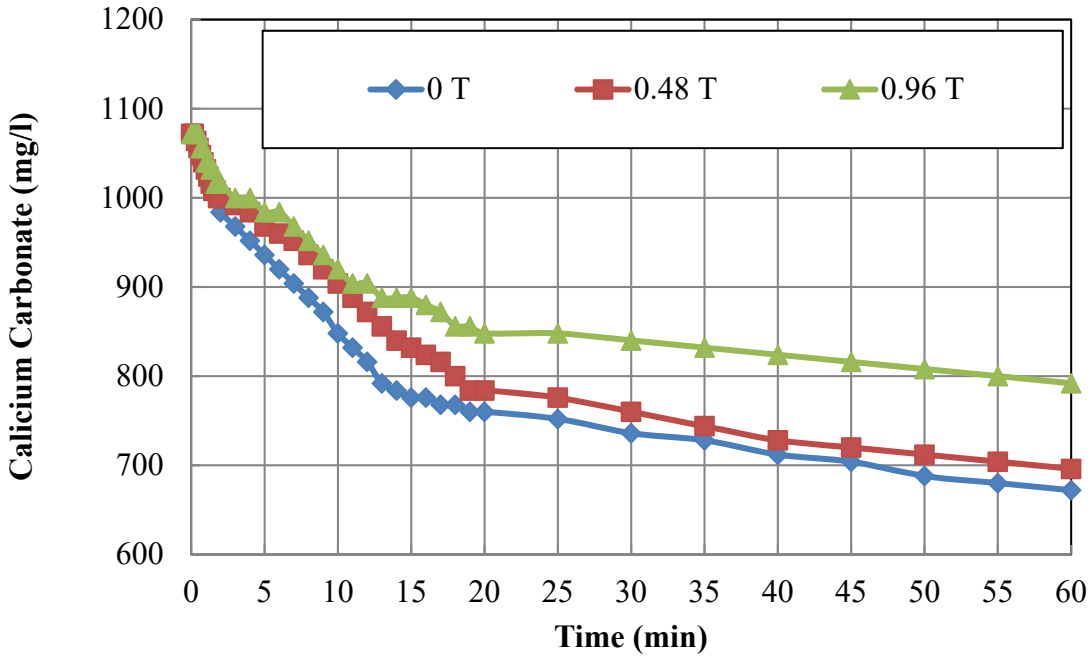

Fig.15. Calcium carbonate concentration at 0.5 m/s velocity, pH 9.5, and 70°C at different magnetic fields.

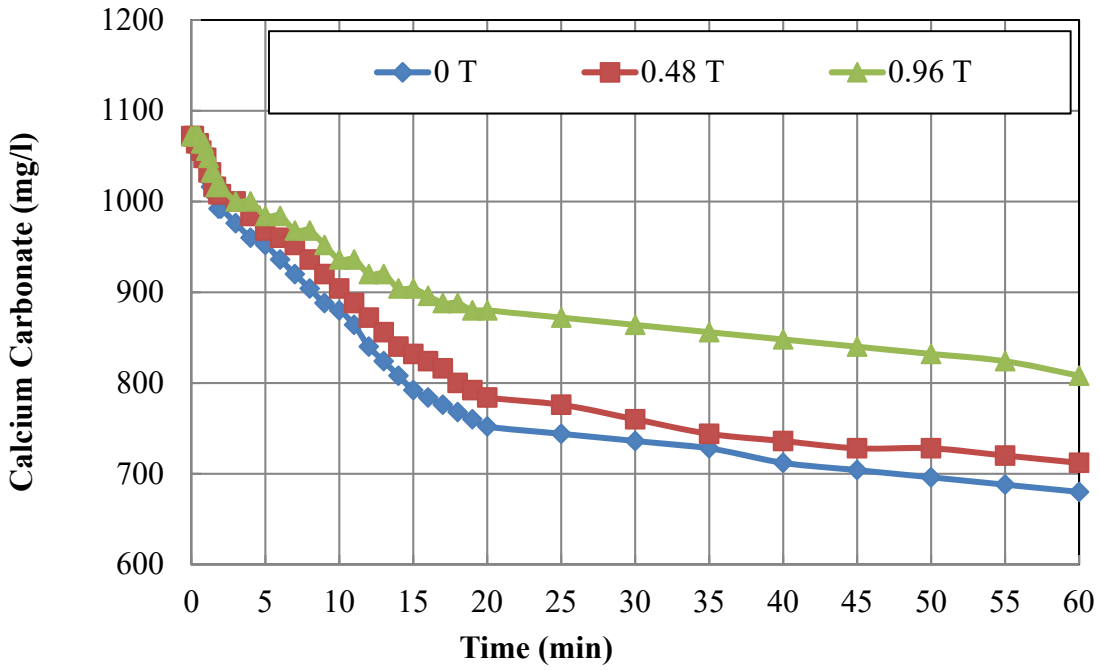

Fig.16. Calcium carbonate concentration at 0.5 m/s velocity, pH 9.5, and 90°C at different magnetic field.

The result showed a similar performance of AMM at 9.5 to that at pH 8.3. At pH of 9.5, the AMM effectiveness was found to be increasing with increasing magnetic field from 0.48 T to 0.96 T as shown in Fig. 14. This trend was observed also at 70 and 90°C (Figs. 15 and 16).

It is clear from Fig. 14that the AMM at a pH of 9.5 and flow velocity of 0.5 m/s increased the retention time at 800 mg/l from 12 min to about 45 min using 0.96 T magnetic fields with an increment of 2.75 equal to exactly the increment at a pH 8.3. On the other hand, the retention time increased from 12 to about 55 min at 800 mg/l concentration as shown in Fig. 15. However, the AMM could increase the retention time at 800 mg/l from 14 min to about more than 60 min, as shown in Fig 16. Hence, we can conclude that the AMM shows the same performance at a pH of 8.3 and 9.5.

Critical Flow Velocity Using Magnetic Treatment Method for Retarding Calcium Carbonate. Table 2 summarizes the performance of AMM at different flow velocities where it is clear that the critical velocity was 0.5 m/s for calcium carbonate scaling, and when the flow velocity exceeded this value, the AMM was not a more effective method in retarding carbonate scale as shown in Table 2.

Table 2. The Effect of Different Flow Velocity on the Performance of Magnetic Treatment Method for Retarding Calcium Carbonate Scaling Solution

Flow Velocity (m/s)	Effectiveness
1.0	No effect
0.5	Effective
0.3	Effective
0.1	Effective
0.03	Effective

The performance of AMM in retarding calcium carbonate at different flow velocities is presented in Figs. 17, 18, and 19 for four flow velocities (0.5, 0.3, 0.1, and 0.03) and the three operating temperatures as 50, 70, and 90°C.

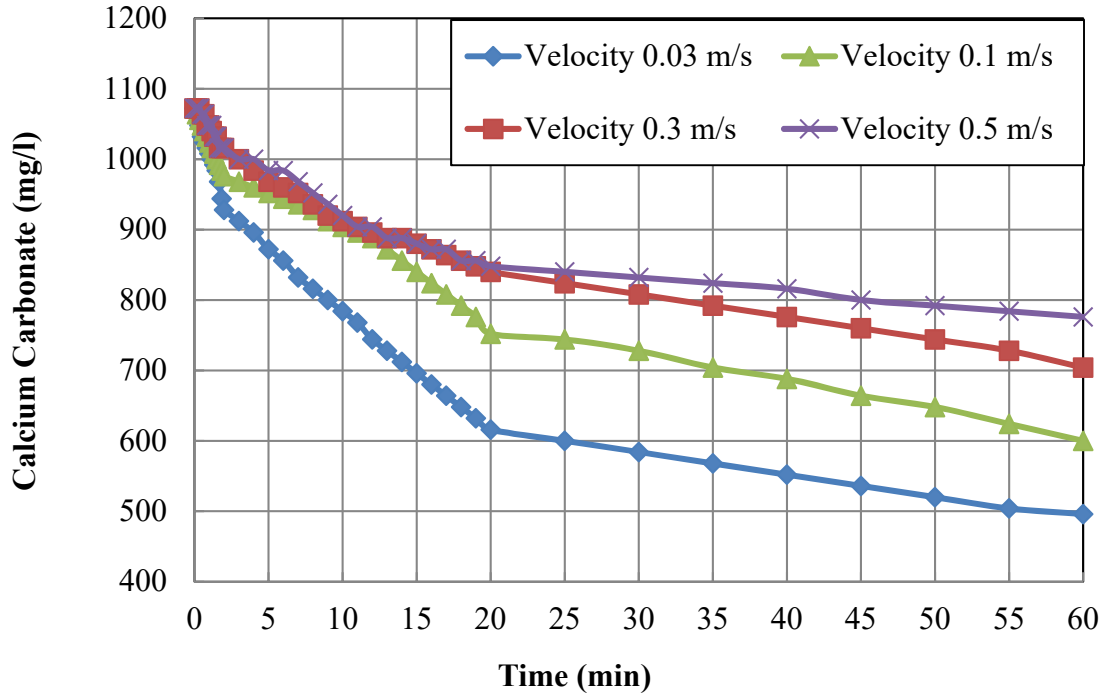

Fig. 17. Calcium carbonate concentration at pH 8.3, 50°C, and 0.96 T magnetic fields at different velocities.

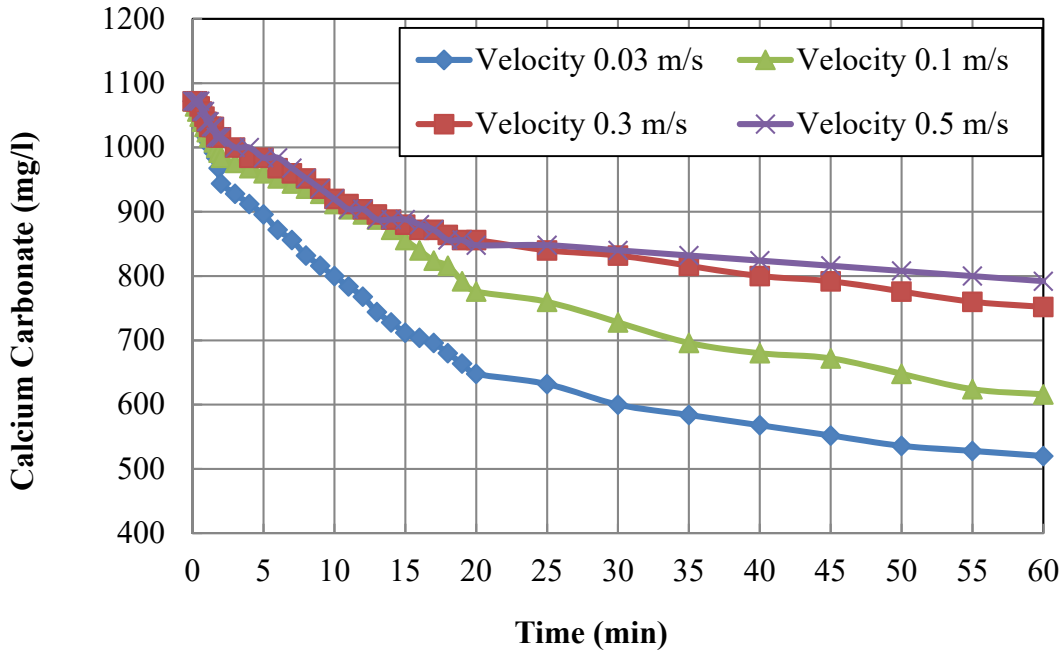

Fig. 18. Calcium carbonate concentration at pH 8.3, 70°C, and 0.96 T magnetic field at different velocities.

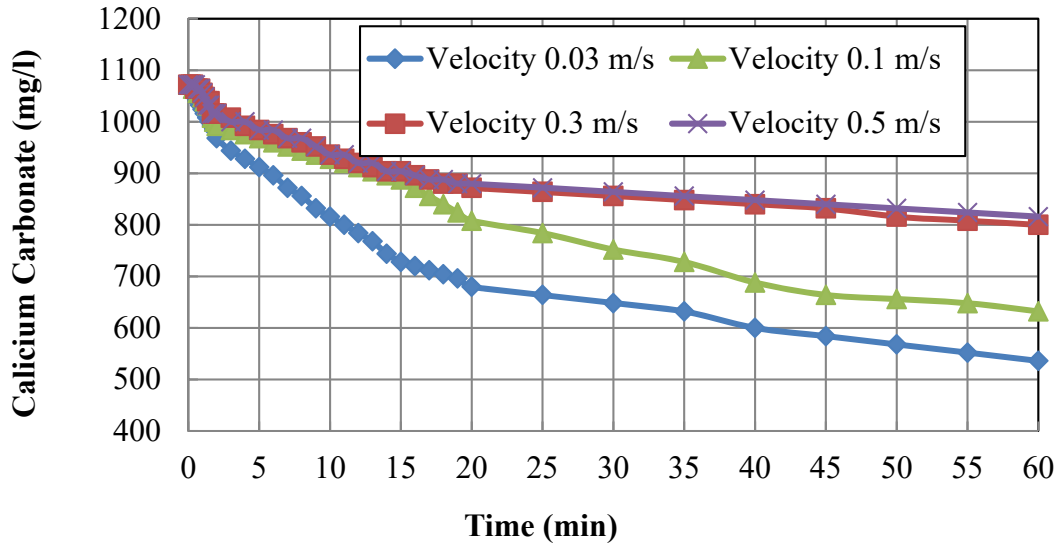

Fig. 19. Calcium carbonate concentration at pH 8.3, 90°C, and 0.96 T magnetic field at different velocities.

Fig. 17 shows the performance of AMM at 50°C; while Figs. 18 and 19 show the performance of AMM in retarding calcium carbonate at 70 and 90°C, respectively.

It is clear from Fig. 17 that the effective concentration decreased as the flow velocity decreased, where at 0.5 m/s, the effective concentration was 800 mg/l which decreased to 500 mg/l at a flow velocity of 0.03 m/s.

It can be concluded from Fig. 17 that the performance of AMM improved when the flow velocity increased from 0.03 m/s to 0.1, then to 0.3, until a critical flow velocity, equal to 0.5 m/s was reached. After the critical flow velocity, the effect of AMM would be demolished.

Figures. 18 and 19 confirm the fact that as the flow velocity increased, the effectiveness of AMM in retarding calcium carbonate increased. Furthermore, Figs. 18 and 19 confirm the effect of temperatures, where, as the operating temperature increases, the performance of AMM improved.

Performance of Magnetic Treatment Method in Retarding Calcium Carbonate at Different Operating Temperatures. Figures. 20, 21, 22, and 23 show the effect of different operating temperatures on the performance of AMM under the highest magnetic field strength at 0.96 T and a pH of 8.3, and different operating temperature.

It can be concluded from Fig. 20 that when the flow velocity was low at 0.03 m/s, the calcium carbonate scaling can be retarded for about 20 min at 50°C and a concentration of 600 mg/l, the retention time increased to 30 min when the operating temperature increased to 70°C. However, the retention time increased to 40 min when the temperature increased to 90°C.

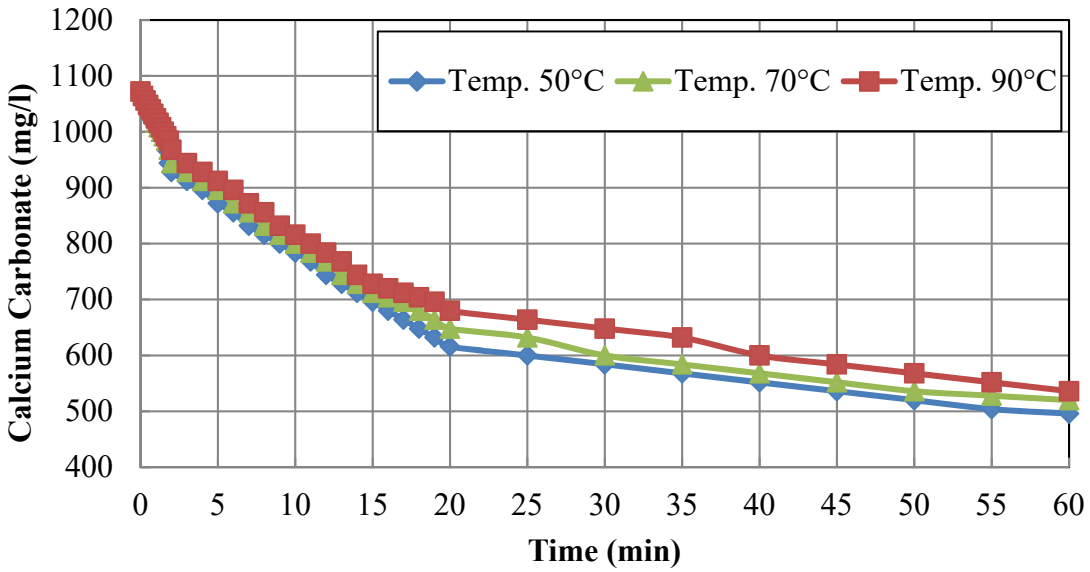

Fig. 20. Calcium carbonate concentration at 0.03 m/s velocity, pH 8.3, and 0.96 T magnetic field at different temperatures.

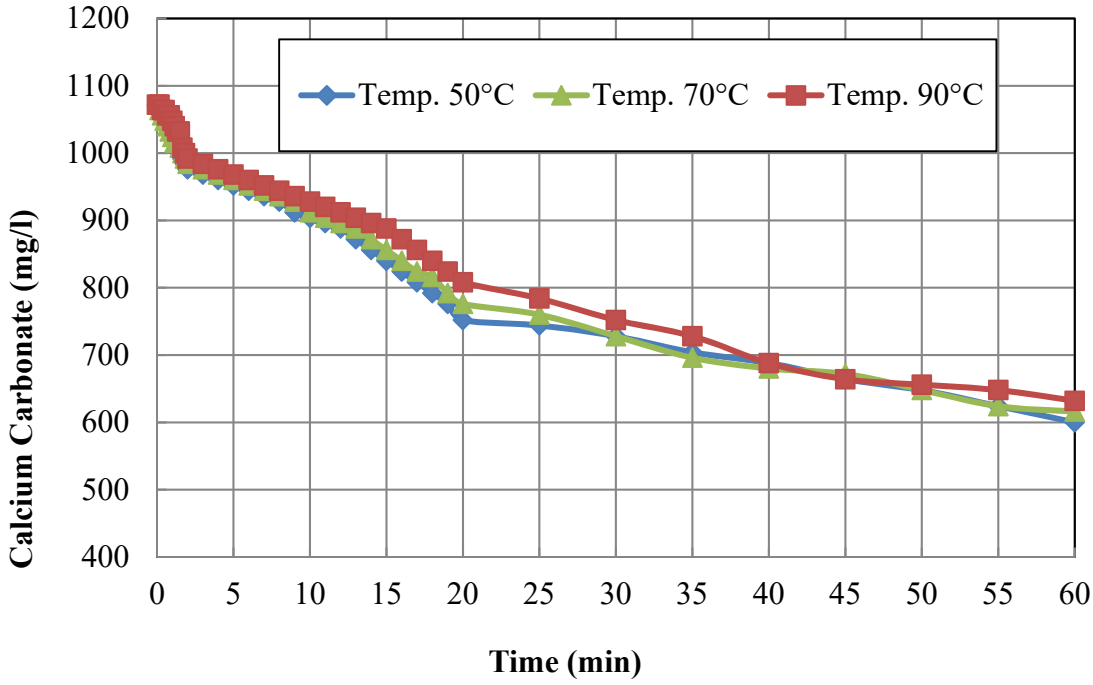

Fig. 21. Calcium carbonate concentration at 0.1 m/s velocity, pH 8.3, and 0.96 T magnetic field at different temperatures.

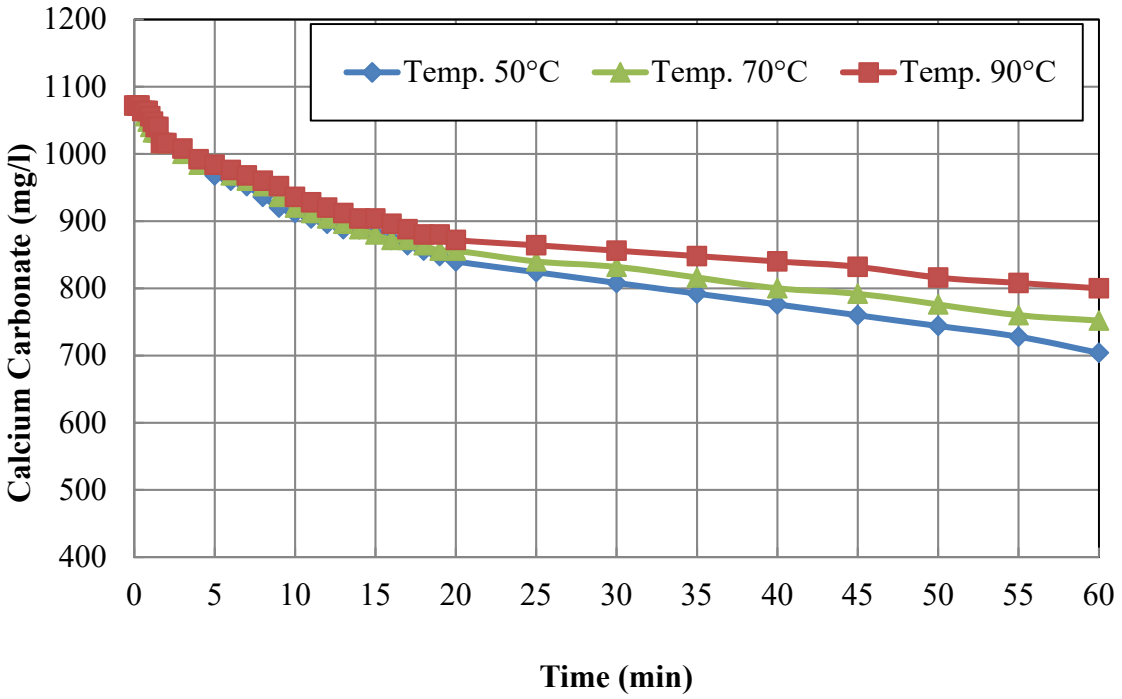

Fig. 22. Calcium carbonate concentration at 0.3 m/s velocity, pH 8.3, and 0.96 T magnetic field at different temperatures.

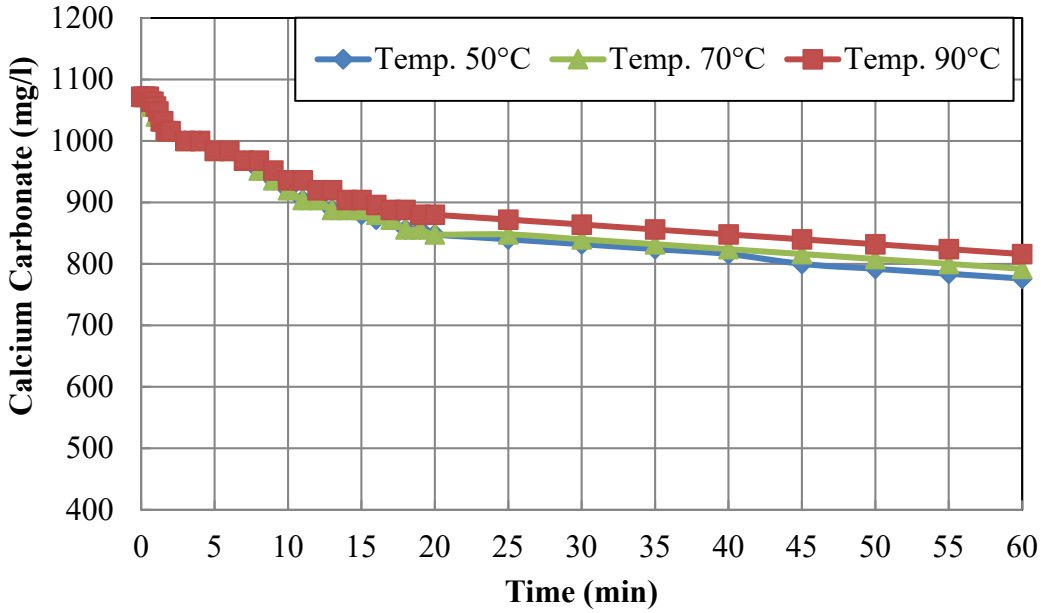

Fig. 23. Calcium carbonate concentration at 0.5 m/s velocity, pH 8.3, and 0.96 T magnetic field at different temperatures.

The same trend in Fig. 20 was observed within Figs. 21, 22, and 23 as the temperature increased and the retention time increased, which implies that as the operating temperature increased, the performance of AMM in retarding the calcium carbonate scale improved.

Effect of pH on the Performance of Magnetic Treatment Method in Retarding Calcium Carbonate. Figures 24 to 26 show the effect of different pH on the performance of AMM under 0.5 m/s flow velocity and a variable operating temperature and magnetic field.

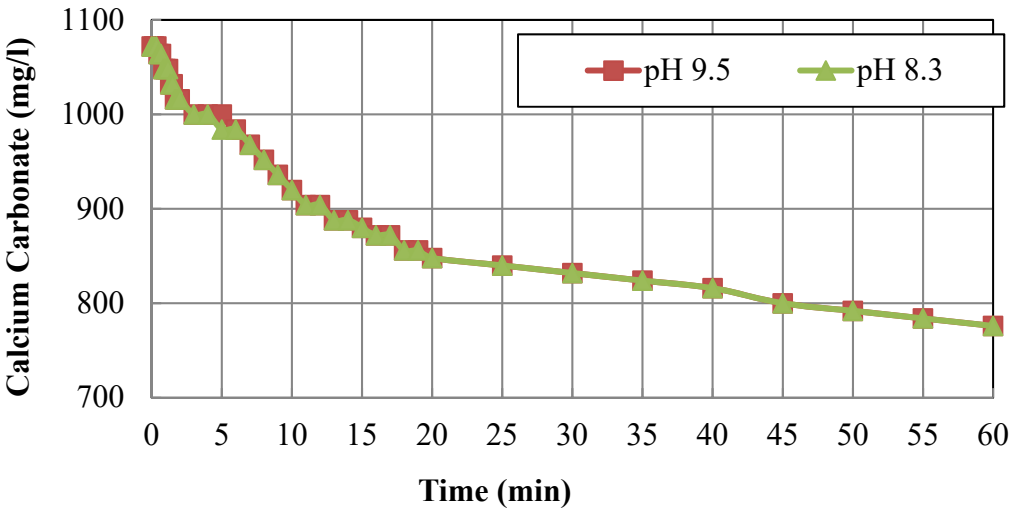

Fig. 24. Calcium carbonate concentration at 0.5 m/s velocity, 50°C, and 0.96 T magnetic field at different pH.

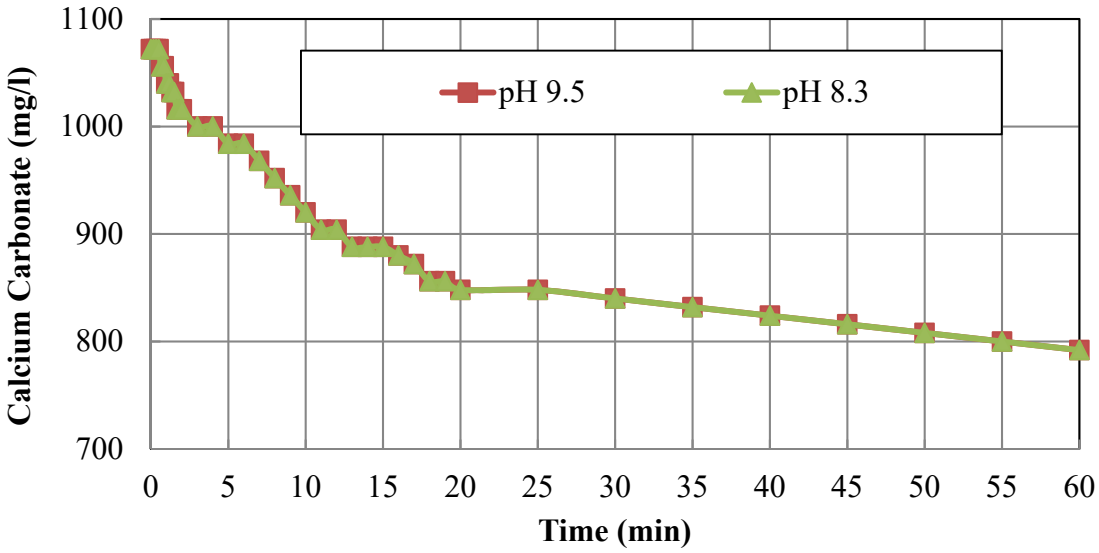

Fig. 25. Calcium carbonate concentration at 0.5 m/s velocity, 70°C, and 0.96 T MFS and different pHs.

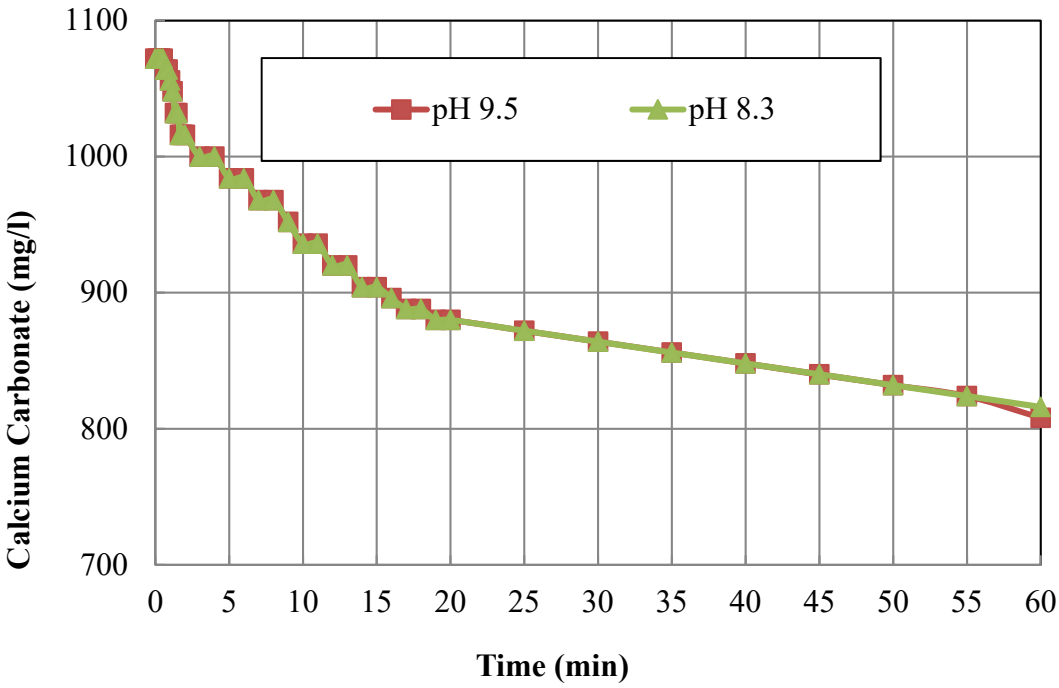

Fig. 26. Calcium carbonate concentration at 0.5 m/s velocity, 90°C, and 0.96 T MFS at different pHs.

It was found that from previous Figs. 23, 24, 25, and 26, the effect of pH on the performance of AMM in retarding calcium carbonate at high flow velocity (0.5 m/s) was negligible, where a similar effect was found in Figs. 24, 25, and 26. Hence, pH cannot be considered an effective parameter on the performance of AMM in retarding calcium carbonate scaling.

Conclusions

Based on the test results and data analysis, the following conclusions have been derived.

- It was confirmed that the effectiveness of AMM increased as the magnetic field strength increased.
- The performance of AMM in retarding calcium carbonate could depend on different parameters as flow velocity, operating temperatures, and magnetic strength.
- AMM decreased the potential of calcium carbonate scaling, at a concentration of 800 mg/s of calcium carbonate and at a flow velocity of 0.5 m/s by a three-fold increase.
- The power to retard calcium carbonate using AMM increased when the applied magnetic field was increased.
- The power to retard calcium carbonate using AMM increased when the operating temperatures were increased.
- AMM was effective in retarding calcium carbonate at a concentration level of 700 mg/l when the flow velocity was 0.1. However, the effective concentration level decreased to 500 mg/l as the flow velocity decreased to 0.03 m/s.
- The flow velocity is the key parameter of the performance of AMM in retarding calcium carbonate, while other effecting parameters had lower effect on the performance of AMM in retarding calcium carbonate.
- The performance of AMM in retarding calcium carbonate scaling at pH 8.3 and 9.5 was found to be similar, and the pH cannot be considered an effective parameter on the performance of AMM in retarding calcium carbonate scaling.

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CHOOSING THE BEST TRAINING AIRCRAFT FOR A FLIGHT TRAINING ORGANIZATION BY MULTI CRITERIA DECISION MAKING METHODS

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Abstract: In today's world, now it is more important to make fair judgements and give right decisions for companies and organizations. The aim of this paper is to choose the best training aircraft for a flight training organization by using Analytic Hierarchy Process (AHP) and Technique Order Preference by Similarity to the Ideal Solution (TOPSIS). Sensitivity analysis is carried out to see possible consequences. Results show that the best aircraft among alternatives is the Daimond DA 42 VI for the flight training organization.

Keywords: Decision making, MCDM, aircraft

Introduction

Airline companies and educational institutes are both organizations that should consider undergoing economic status, climate, potential benefits etc. when it comes to purchasing for the company, especially for purchasing on aircrafts. When purchasing for aircrafts, a flight training organization must consider its limited budget, safety of employee and students, technical parameters and specifications that they need and efficiency of the aircraft in general. For significant and reasonable decisions, flight training organizations should analyze these conflicting criteria such as budget and technological features carefully.

In literature search, Esposito et al. (2013), proposed a hybrid model for regional aircraft evaluation, based on the two main approaches, the Analytic Hierarchy Process (AHP) and the Fuzzy Set Theory (FST). They proposed a model that considers not only traditional characteristics (direct and indirect operative costs and technical performance such as the cruise speed) but also includes a variety of aspects whose importance is increasing, such as comfort. Dožić and Kalić (2014), proposed a solution for aircraft type(s) selection problem for known route network and forecasted air travel demand by using the Analytic Hierarchy Process (AHP). They have seen that sensitivity of *CI* and *CR* is significant to the changes of different judgements in the comparison matrix for the first level, while solution (rank of alternatives) sensitivity is almost insignificant to these changes.

Materials and Methods

In this study the best aircraft among alternatives is chosen based on flight training and organizational needs. In order to include basic and needed criteria, both qualitative and quantitative parameters are used. In this context evaluation of two methods proposed in literature the Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are applied by using Expert Choice, Super Decisions and Microsoft Excel programs.

In AHP method, first, problem should be defined and hierarchical representation of decision system should be formed. This hierarchical form should include overall objective, criterias that will affect the decision and some predetermined alternatives. Second, alternatives and criteria should be pairwise compared. In this step, there are two kinds of pairwise comparisons. One is the pairwise comparison that one should compare the alternatives with respect to the criterias and the other kind of pairwise comparison is the one that one should compare the criterias with respect to the decision objective. After obtaining matrix A from pairwise comparisons between alternatives with respect to the criterias, normalized A matrix is computed. Next, the weight matrix W is computed. This procedure is repeated for criterias too. And than Consistency Ratio (CR) is computed to see if there is any inconsistency. CR≤0,1 is allowed. For further information one can study the papers performed by Thomas L Saaty titled "How to make a decision: The Analytic Hierarchy Process" (Saaty, 1990) and "Decision making with the analytic hierarchy process" (Saaty, 2008).

Saaty and Ozdemir (2003) stated that, when the number of the elements are more than seven, the resulting

incostistency is too small for humans to obtain the element which causes the biggest inconsistency to fix it. So, for AHP method, elements no more than seven are used in this study. Saaty and Sağır Özdemir (2015) also stated that there can be even one judge to evaluate the criteria weights if he/she is experienced and efficient enough for the subject.

TOPSIS method is applied in six steps as follows:
Step 1: Calculate the normalized values r_{ij} and matrix N.

$$r_{ij=x_{ij}}\sqrt{\sum_{i-1}^{m} x_{ij}^2} \quad \text{i=1,…,m} \qquad \text{j=1,…,n}$$

Step 2: Calculate the weighted normalized decision matrix V. Here, w_j is the weight of the j^{th} criteria.

$$V_{ij} = r_{ij} \times w_j \qquad \text{i=1,…,m} \qquad \text{j=1,…,n}$$

Step 3: Determine the ideal and negative ideal solutions, A^* and A^- respectively.

$$A^* = \left\{\left(max_{i\ V_{ij}} \middle| j \in C_b\right), min_{i\ V_{ij}} \middle| j \in C_c\right\} = \{V_j^* | j = 1,2,\dots,m\}$$

$$A^- = \left\{\left(min_{i\ V_{ij}} \middle| j \in C_b\right), max_{i\ V_{ij}} \middle| j \in C_c\right\} = \{V_j^- | j = 1,2,\dots,m\}$$

Step 4: Calculate the separation measures of each alternative from the positive ideal solution and the negative ideal solution.

$$S_i^* = \sqrt{\sum_{j=1}^{m} \left(V_{ij} - V_j^*\right)^2} \ , j = 1,\dots,m$$

$$S_i^- = \sqrt{\sum_{j=1}^{m} \left(V_{ij} - V_j^-\right)^2} \ , j = 1,\dots,m$$

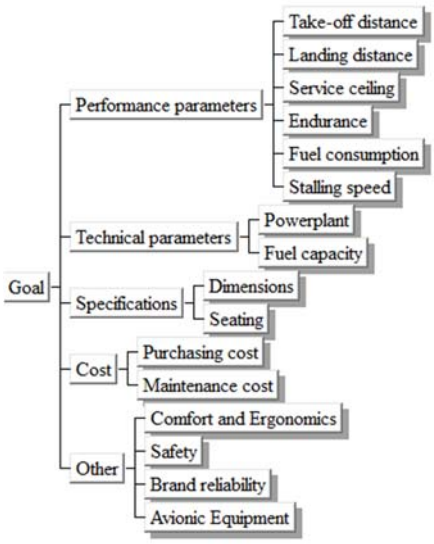
Step 5: Calculate the relative closeness to the ideal solution.

$$C_i^* = \frac{S_i^- + S_i^*}{S_i^-}$$

Implementation

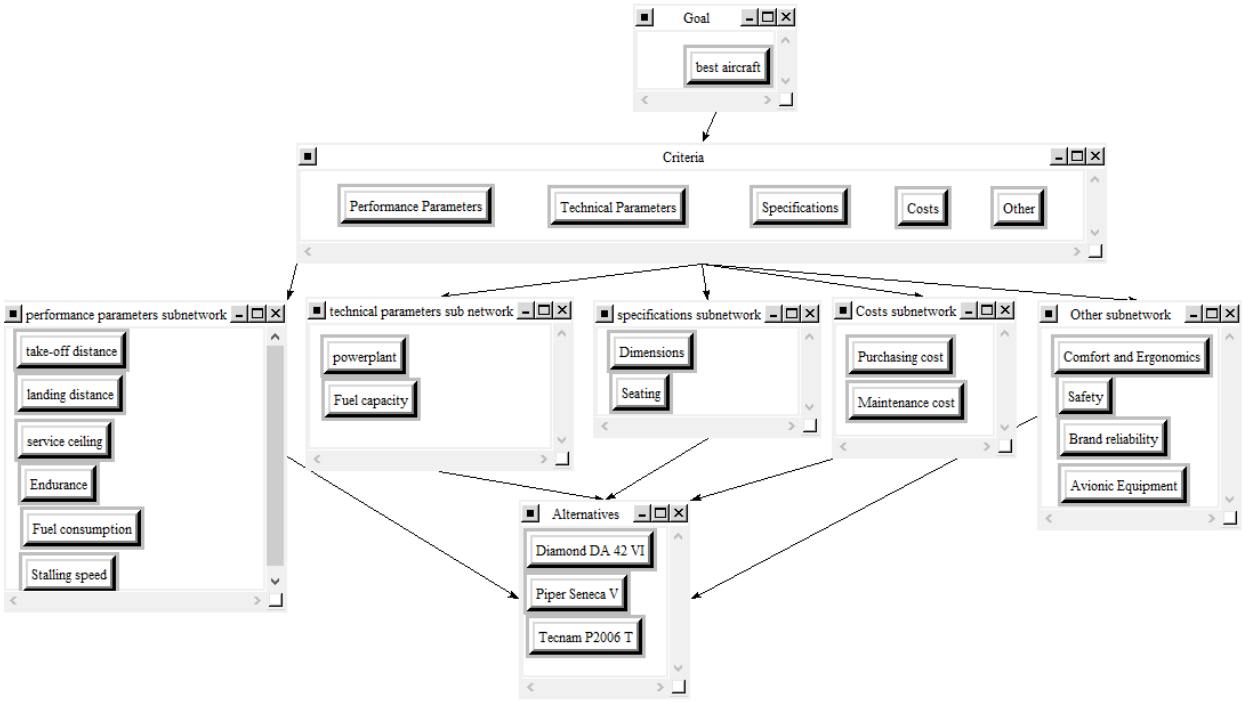
This study deals with giving the right decision to purchase an aircraft for a flight training organization. Within this context, 3 different types of aircraft, 5 main criteria and 16 sub-criteria are defined both by literature search and an expert's knowledge. In this study the expert is a well experienced aviation theoretical lesson teacher who is also the head of the ground education department in a private flight school.
After determining the goal, criteria and alternatives, the analytic hierarchy structure of the proposed system is set up as shown in Figure 1.

Figure 1. The analytic hierarchy structure of the system



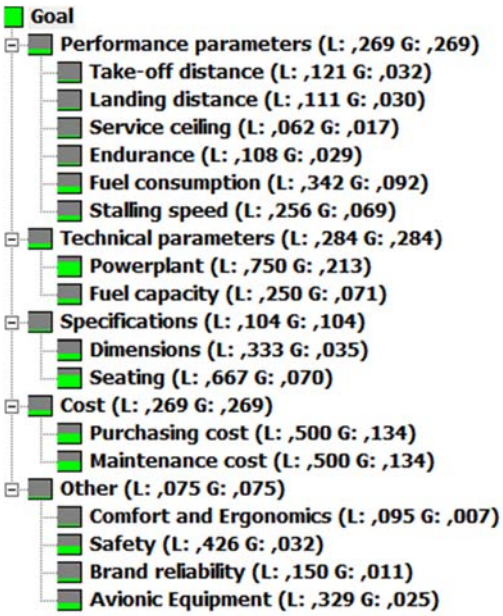
One can also rebuild this hierarchy structure using Super Decisions program for a more relevant image as shown in Figure 2. Here one can see that 3 alternatives are Diamond DA 42 VI, Piper Seneca V and Tecnam P2006T.

Figure 2. Hierarchy structure of the system by Super Decisions program



After setting up the hierarchy structure, pairwise comparisons are made and final weights of the criteria are obtained as seen in Figure 3.

Figure 3. Final local and global weights of the crtieria



After determining the weights of the criteria by AHP, TOPSIS method is applied. For this purpose, the decision maker rated all alternatives with respect to all criteria using Saaty's fundamental scale. Standard decision matrix is formed and normalized as seen in Table 1.

Table 1: Normalized decision matrix (N)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
A1	0,625	0,514	0,647	0,873	0,436	0,226	0,780	0,408	0,577	0,485	0,588	0,588	0,376	0,577	0,436	0,588
A2	0,625	0,514	0,740	0,436	0,218	0,566	0,390	0,816	0,577	0,728	0,784	0,784	0,847	0,577	0,873	0,784
A3	0,468	0,686	0,185	0,218	0,873	0,793	0,488	0,408	0,577	0,485	0,196	0,196	0,376	0,577	0,218	0,196

Normalized decision matrix is multiplied by the weights of the criteria and positive, negative ideal solutions, separation measures are calculated.

Results and Discussion

At the final step, relative closeness to the ideal solution are calculated and alternatives are lined up with respect to their closeness to the ideal solution as seen in Table 2.

Table 2: Relative closeness of alternatives to the ideal solution.

A1	0,576514
A2	0,475493
A3	0,404159

Here, A1 refers to Diamond DA 42 VI, A2 refers to Piper Seneca V and A3 refers to Tecnam P2006 T. As one can see, the best aircraft is Diamond DA 42 VI among others.

Conclusion

In this paper 2 multi-criteria decision making methods – AHP and MCDM – are applied to the problem titled "choosing the best training aircraft for a flight training organization." As a conclusion, both methods helped the decision maker to make a fair judgement and give the best decision. Here, the best alternative among others is the Diamond DA 42 VI aircraft.

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EFFECT OF Al CONTENT ON STRUCTURE AND WEAR BEHAVIOR OF AlCoCrFeMoNi HIGH ENTROPY ALLOYS

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Abstract: High-entropy $Al_xCoCrFeMo_{0.5}Ni$ (x=0-2) alloys are prepared by the vacuum arc melting and casting method. The effects of Al content on the microstructure, hardness and wear resistance of the high-entropy alloys (HEAs) are investigated. The HEAs were characterized for phase content by X-ray diffractometer (XRD) and morphology by scanning electron microscope (SEM). Wear tests were performed under dry friction conditions with WC balls at a 5 N normal load and sliding speed of 5 $cm \cdot s^{-1}$ in a ball-on-disc geometry. The worn surfaces of the samples were also examined by SEM to identify the wear mechanism. The hardness starts from 328 HV, at x=0, reach to the maximum, 710 HV, at x=1.0 and then declines to 684 HV, at x=2.0. On the other hand, the wear resistance of HEAs gradually increases with the increasing aluminum content. The correlation between composition, microstructure, hardness and wear properties of these alloys is detailed discussed with in this study.

Keywords: High Entropy Alloys, Wear, Hardness

Introduction

HEAs are the new field of materials science, which are defined as more than five major elements in equi-atomic or near equi-atomic compositions with each elemental concentration between 5 at% and 35 at% (Yeh et al., 2004). In this way, these alloys are perfectly form disordered solid solutions due to the higher mixing entropy (Yeh, 2006). However, many experimental studies show that the intermetallics and ordered solid solutions besides the simple solid solutions can be found in HEAs. Although, the formation of these phases is a contrast to the origin of HEAs, controlling the formation and the amount of phases is crucially important to the design of HEAs according to the desired application. Since its discovery, HEAs have been extensively investigated for the many applications due to their exceptionally high strength and hardness, good wear and corrosion resistance and high-temperature strength properties (Wu, 2006; Mary, 2015).

The AlCoCrFeMoNi system is one of them that has potential for structural and tool industries. The effects of the elements Co, Fe, Cr, Al, Ni and Mo contents on the microstructure of the AlCoCrFeMoNi HEAs that have been widely studied by Hsu et al. (2010a, 2010b, 2011, 2013a, 2013b) and Zhu et al. (2010). The alloy system exhibits the face-centered cubic (FCC), body-centered cubic (BCC), ordered body-centered cubic (B2) and body-centered tetragonal (σ) phases for the various contents. The BCC and B2 phases are promoted by Al, where Co and Ni promoted FCC, Cr and Mo promoted σ, and Fe inhibited the σ phase in alloy system (Hsu et al., 2013c).

To investigate the mechanical properties of alloys, commonly hot-hardness measurements were performed by the same groups while wear behavior only examined for the $AlCoCrFe_xMo_{0.5}Ni$ HEAs, where x changes between the 0.6-2.0 in molar ratio. Both hardness and wear resistance declines as the Fe content increases that is related to the decreased volume fraction of the σ phase in structure. From the examination of worn surface and worn debris, they found that the wear mechanism of alloys is abrasion (Hsu et al., 2010b).

In HEAs, wear is an important phenomena and gives a good indication for the aforementioned potential applications. Thus, the purpose of this paper is to elucidate the effect of aluminium on wear behavior related with microstructural and compositional phase changes in alloys.

Materials and Methods

$Al_xCoCrFeMo_{0.5}Ni$ high-entropy alloys with different aluminium contents (x = 0-2.0 molar ratio) (these alloys are designated: Al0.0, Al0.5, Al1.0, Al1.5, Al2.0) were prepared by the vacuum arc melting and casting method in high purity argon atmosphere. The purity of each constituent elements were above 99.95%. For the chemical

homogeneity of alloys, the melting procedure was repeated at least four times. As-cast microstructures and phases of the alloys were characterized with SEM (ZEISS SUPRA 50 VP) and XRD (Panalytical EMPYREAN). Microhardness measurements (Future Tech FM-700) were performed with a load of 100 g and duration time of 10 s. Sample surfaces were polished with the standard metallographic procedure. The wear behavior of the alloys under the dry sliding condition was examined using ball-on-disk testing machine (CSM Instrument) according to ASTM G99 standard. The 3mm WC ball was used as the counter body with a normal load of 5N. The rotation diameter, sliding speed and sliding distance were 5 mm, 5 $cm \cdot s^{-1}$, 100 m, respectively. After the wear tests, specific wear rates of the alloys were calculated from track profiles, which measured with a surface profilometer (Mitutoyo SJ-400) and rear tracks were also examined by SEM.

Results and Discussion

XRD patterns of the alloys are presented in Fig. 1. Alloys with different aluminum content show different phases, including FCC, BCC, B2 and σ. XRD examination of alloys indicated that Al0.0 and Al0.5 alloys consist of the FCC and σ phases. The addition of aluminium to the alloys causes formation of the B2 phase, while the FCC phase totally disappeared when aluminium content higher than x=0.5. Also, the BCC phase appeared in Al1.5 alloy. The σ phase, which exists in all alloys except the Al2.0 alloy that contains only the B2 and BCC phases. This trend can be explained by Al acts as a stabilizer of the BCC and B2 phase [Hsu et al., 2013a], and also increasing the aluminum content hinders the formation of σ phase in alloy.

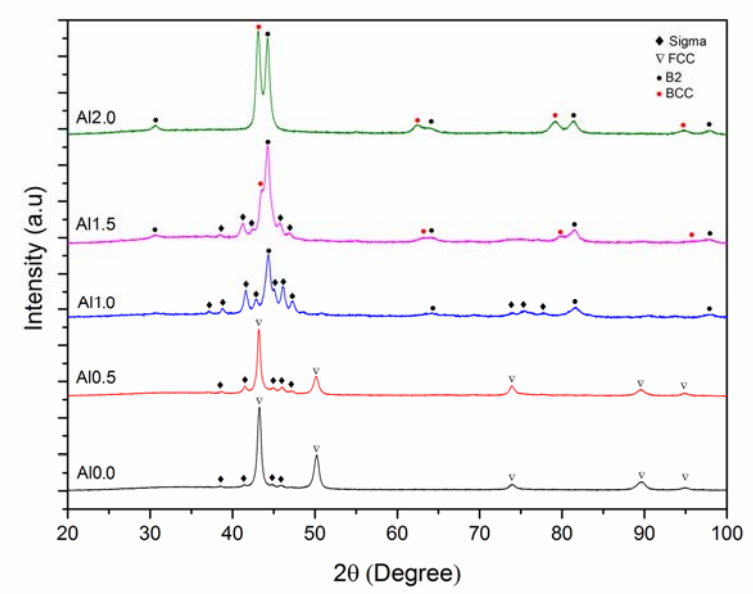

Figure 1. XRD patterns of as-cast $Al_xCoCrFeMo_{0.5}Ni$ alloys.

Fig. 2. presents the microstructures of as-cast $Al_xCoCrFeMo_{0.5}Ni$ alloys. The observed phases in microstructures are labelled on SEM images based on XRD analysis. Also, this is supported from hardness measurements. The Al0.0, Al0.5, Al1.5 and Al2.0 alloys exhibit a dendritic structure, while the Al1.0 alloy has a equiaxial grain structure with visible grain boundaries, where richer σ phase.

Fig. 3. shows the hardness and specific wear rate of alloys as a function of Al content. The hardness of alloys starts from 328 HV, at x=0, reach to the maximum, 710 HV, at x=1.0 and then declines to 684 HV, at x=2.0. Hardness value of alloys is fairly consistent with a presented phases in the structure. Although the Al0 and Al0.5 alloys, which consist of the same phase crystal structures, the hardness of Al0.5 higher than the Al0 alloy due to difference in amount and distribution of the σ phase. The hardness is the maximum in Al1.0 alloy resulting from the formation of a harder the B2 phase. In Al1.5 and Al2.0 alloys hardness slightly decrease compared to the Al1.0 alloy. This is linked with decreasing amount of the σ phase. Also, hardness of phases can be ranked as follows σ>B2>BCC>FCC in alloy system.

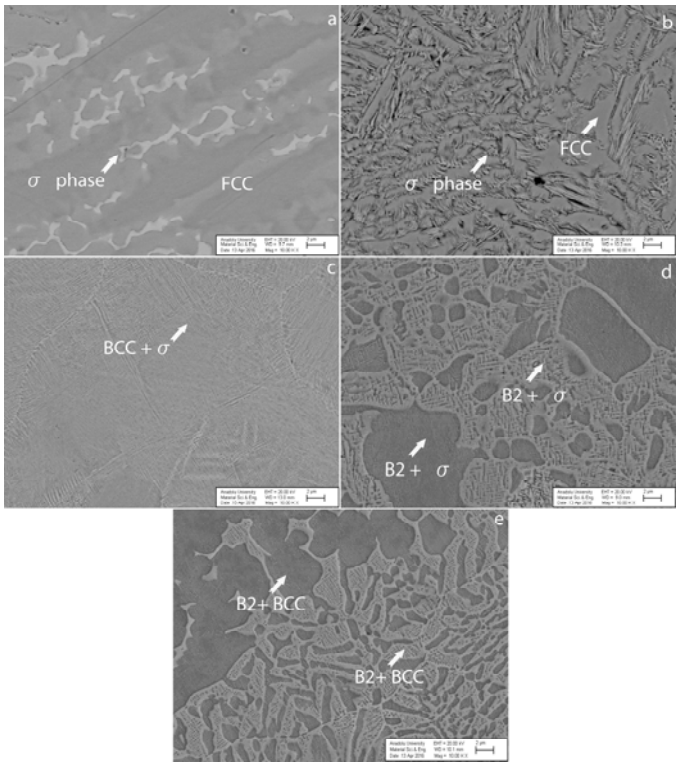

Figure 2. SEM images of as-cast $Al_xCoCrFeMo_{0.5}Ni$ alloys (a) x=0.0, (b) x=0.5, (c) x=1.0, (d) x=1.5, (e) x=2.0.

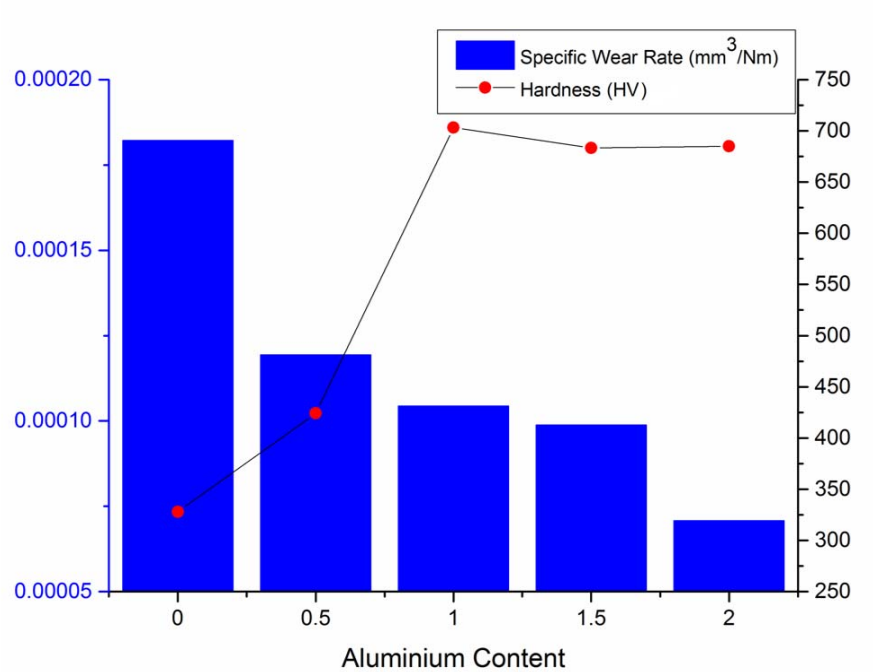

Figure 3. Hardness values of $Al_xCoCrFeMo_{0.5}Ni$ alloys plotted with obtained specific wear rate by wear track profile analysis.

To better understand the wear mechanism for the $Al_xCoCrFeMo_{0.5}Ni$ alloys in dry-sliding conditions, SEM analysis was carried out after wear tests. Fig. 4 presents the worn surfaces and debris of the alloys. Fig. 4 a and b shows the wear surface of the Al0.0 and Al0.5 alloys. The worn surface of these alloys is similar, appearing delamination without oxides. This finding is reasonable since delamination wear is a typical mechanism for ductile metals and Al0.0 and Al0.5 alloys are contained ductile FCC phase [Wu et al., 2006]. In sharp contrast to the wear surfaces of these two alloys, abrasive scratches and significant oxidation features are observed on the worn surfaces of Al1.0, Al1.5 and Al2.0 (Fig. 4 c, d and e) alloys. The dominant wear mechanism was abrasion and oxidation for these alloys.

Fig. 5 displays the wear tracks of alloys. It can be seen from Fig. 5 that the wear tracks of Al0.0 were significantly wide, showing a severe wear occurred in the sliding process. Clearly, the alloys which contain Al exhibited much lower wear rates compared to the Al0.0 alloy.

The highest wear resistance was obtained with the Al2.0 alloy, followed by the Al1.5, Al1.0 and Al0.5, respectively.

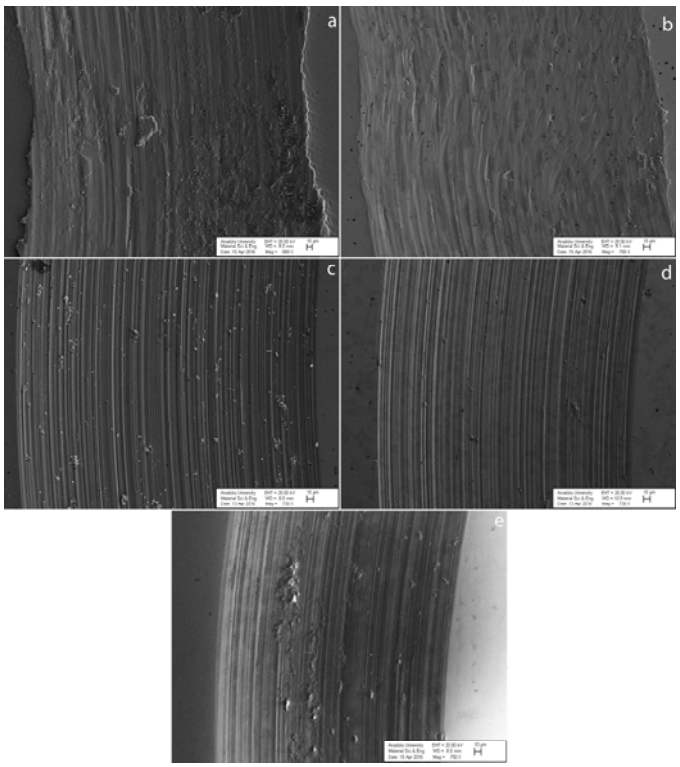

Figure 4. SEM images of worn surface of as-cast $Al_xCoCrFeMo_{0.5}Ni$ alloys (a) x=0.0, (b) x=0.5, (c) x=1.0, (d) x=1.5, (e) x=2.0.

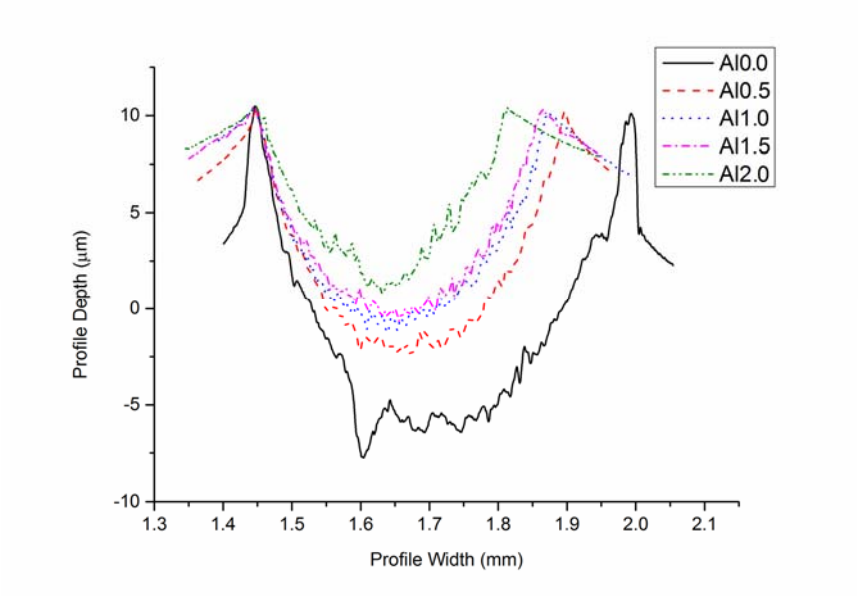

Figure 5. Cross-section profiles of the wear track.

Conclusion

High entropy $Al_xCoCrFeMo_{0.5}Ni$ alloys in different aluminum contents (x=0-2) were successfully produced by vacuum arc melting and casting method. The aluminum content greatly affected the wear performance due to bringing in microstructural and compositional phase changes in alloys. The Al1.0 alloy composed of the B2 and the σ phases has the highest hardness of 710 HV, while the lowest specific wear rate was found 0.00007 mm^3/Nm in the Al2.0 alloy composed of the BCC and B2 phases. Thus, controlling the number and amount of phases was highly important to achieve desired wear performance from HEAs.

Acknowledgements

This research was supported by Eskisehir Osmangazi University Scientific Research Projects Commission under the grant no 201437054-2014-468.

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EFFECTS OF CHEMICAL MODIFICATION ON WOOD PROPERTIES

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Abstract: Chemical modification can be used to improve the properties of wood. Effect of melamine formaldehyde modification on the physical and mechanical properties of Scots pine and Chestnut was investigated in this study. Wood samples were impregnated with melamine formaldehyde (MF) resin under 3 bar pressure for 10 or 30 min and were cured at a temperature of 150 °C for 20 min in an oven. Weight percent gain, water uptake, volumetric swelling, Brinell hardness, modulus of rupture and modulus of elasticity values of the samples were determined according to relevant standards. Modification with MF reduced the water uptake and the volumetric swelling of the woods. Anti-swelling efficiency of the modification were approximately 66 % and 57 % in chestnut and scots pine, respectively. MOE increased in scots pine (3% - 17 %) while unchanged in chestnut but MOR decreased significantly by modification in both chestnut (2.5% - 17.9%) and scots pine (26.2% - 32.7%). Also, MF modification increased the Brinell hardness of the wood, slightly.

Keywords: Wood modification, Melamine formaldehyde, Physical and mechanical properties

Introduction

Wood has many desirable characteristics required for a variety of end uses such as construction, furniture, and tools. However, wood also has properties that, in relation to specific applications, can be regarded as disadvantages. One main disadvantage of wood is its inherent moisture sensitivity, a major cause for fungal decay, mold growth and dimensional instability, resulting in decreased service life as well as costly maintenance (Gindl et al. 2003; Epmeier et al. 2004). Therefore, suitable technologies are needed to improve woods' properties, i.e., the dimensional stability, durability, mechanical strength, and hardness, to meet specific end-use requirements (Cai 2007; Hochmanska et al. 2014). Different methods, involved chemical and thermal modification, have been developed over many years to overcome these disadvantages. Major research approach has been carried out to improve physical properties. Physical properties could be improved, but the mechanical properties of wood decrease during the modification process (Poncsak et al. 2006; Gündüz and Aydemir 2009). Chemical modification of wood can be defined as a process of bonding a reactive chemical to a reactive part of a cell wall polymer to form a covalent bond between them (Rowell 2006).

The treatment of wood, with different types of chemicals or resins, has been widely studied with the end goal of enhancement. Melamine formaldehyde (MF) and phenol formaldehyde (PF) are two common resins for wood-related applications. Melamine formaldehyde (MF) resin, commonly used in thermosetting, has applications in coatings, adhesives, and both paper and textile treatments (Pittman et al. 1994). Various types and grades of MF resin are available for the impregnation of wood. Gindl et al. (2003) examined the factors were selected that influenced the uptake of MF resin into the cell wall of softwood. Impregnation of solid wood with water-soluble MF resin has led to a significant improvement in the surface hardness (Miroy et al. 1995; Gindl et al. 2004) and the modulus of elasticity (MOE) (Deka and Saikia 2000; Deka et al. 2007). Epmeier et al. (2003) and Deka et al. (2007) reported that modification of wood with MF has led to a decrease in swelling (30% - 75%) and equilibrium moisture of content (EMC) (20%) of the wood. Although many studies have been focused on MF modification, it has not been widely applied in an industrial setting because of its higher cost than other polymerizable monomers and pre-polymers (Deka et al. 2007). Epmeier et al. (2004) compared the physical and mechanical properties of 9 different modified woods and reported that the acetylation and furfurylation were the most effective modification methods for achieving a high dimensional and stiffness stability and a low EMC.

The main purpose of this study is improving the properties of wood by using chemical modification to produce value-added material. To achieve this purpose, the effects of melamine-formaldehyde (MF) modification on the physical and mechanical properties of Scots pine and Chestnut wood was investigated.

Materials and Methods

Materials

Scots pine (*Pinus silvestris* L.) (SP) and chestnut (*Castenea sativa* Mill.)(CH) were used as wood material in this experiment. Commercially available melamine formaldehyde resin (Almin-65), provided by the Gentaş Kimya Inc., Tuzla, Turkey, was used for the modification. The properties of the resin are given in Table 1, based on the manufacturer's information.

Table 1: Properties of Melamine Formaldehyde Resin

Appearence	Clear, colorless liquid
Solid content % weight	51±1
Viscosity (sn F.C.4 20 °C)	15 - 20
pH(20 °C)	9.6 - 10.5
Dansity (g/cm3 20 °C)	1.220 - 1.240
Water tolerance (20 °C)	1/1,0 - 1/2,0
Gel time (min. 130 °C)	35.00 - 40.00

Methods

Wood samples cut into dimensions according to relevant standard and were acclimatized before testing at a temperature of 20 ± 3 °C and a relative humidity (RH) of 65%. The weight and the volume of the samples were determined. Then the samples were oven-dried at a temperature of 103 ± 2 °C and the oven-dried densities were calculated before chemical modification.

Melamine formaldehyde resin was used in two grades. One group was modified with melamine formaldehyde resin which was diluted by 50% with distilled water (MFW) while the other group was modified with MF without further modification. Impregnation was performed in a stainless steel vacuum chamber at 3 bar pressure for 10 or 30 minutes and impregnated samples cured in an oven at a temperature of 150 °C for 20 minutes. The impregnation was performed separately for each treatment level and a new resin solution was used for each of the different variations. Before physical and mechanical analysis testing, the samples were cut into various dimensions, according to the specifications of the testing standard. Ten replicates were prepared for each experiment, and the samples were acclimatized at a temperature of 20 ± 3 °C and a RH of 65%. The experimental design was given in Table 2, and the modification process was summarized in Figure 1.

Table 2: Experimental design

Modification groups (Codes)	Wood species	Chemical	Distilled water	Impregnation duration (min)	Pressure	Number of samples
SP-C		Control	-	-	-	10
SP-MF-10			-	10	3 bar	10
SP-MF-30			-	30	3 bar	10
SP-MFW-10			% 50	10	3 bar	10
SP-MFW-30			% 50	30	3 bar	10
CH-C		Control	-	-	-	10
CH-MF-10			-	10	3 bar	10
CH-MF-30			-	30	3 bar	10
CH-MFW-10			% 50	10	3 bar	10
CH-MFW-30			% 50	30	3 bar	10

The oven-dry densities of the samples, before and after the modification treatment, were determined according to the testing standard, TS 2472 (1976). The weight percent gain (WPG) of the samples was calculated according to the following equation:

$$WPG = \frac{m_i - m_0}{m_0} \times 100 \quad (1)$$

where m_o is the oven-dry weight of the samples before the modification in grams and m_j is the oven-dry weight of the samples after the modification in grams.

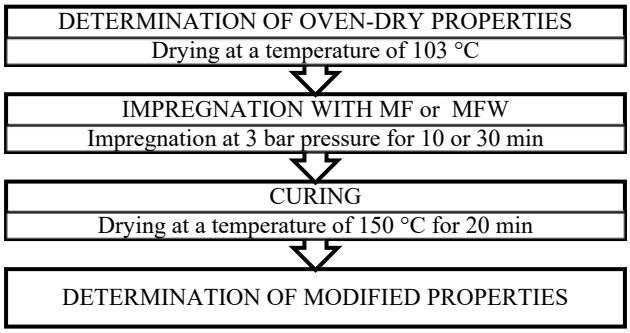

Figure 1: Chemical modification process

To determine the effect of the modification on the dimensional stability, the water uptake (WU), swelling (S), and anti-swelling efficiency (ASE) values of the samples were determined. According to the testing standard, TS 4086 (1983), 20 × 20 × 30 mm (T×R×L) samples were immersed in distilled water for 4 wk. After immersion, the dimension and the weight of the samples were recorded, and the dimensional stability values were calculated according to equations 2 through 4:

$$WU = \frac{m_w - m_i}{m_i} X100 \quad (2)$$

where m_w is the weight of the samples after water immersion in grams and m_i is the oven-dry weight of the samples after the modification in grams;

$$S = \frac{V_W - V_i}{V_i} X100 \quad (3)$$

where V_w is the volume of the samples after water immersion in cm^3 and V_i is the oven-dry volume of the samples in cm^3; and

$$ASE = \frac{S_m - S_u}{S_u} X100 \quad (4)$$

where S_m is the swelling ratio of the modified samples as a percentage and S_u is the swelling ratio of the unmodified samples as a percentage.

The mechanical properties of the MF modified samples, including the modulus of rupture (MOR), modulus of elasticity (MOE), and Brinell hardness (BH) were determined according to the TS 2474 (1976), TS 2478 (1976), and TS 2479 (1976) testing standards, respectively.

The data were analyzed statistically using an SPSS software system (SPSS17, IBM Corp., Armonk, NY). An analysis of variance (ANOVA) model was used to determine the effect of the MF resins on the mechanical and physical properties of wood. Duncan's multiple range tests were used for pairwise comparisons when the overall ANOVA model was significant. Data for Scots pine and chestnut woods were analyzed using separate models.

Results and Discussion

The oven-dry densities of the MF modified wood, and the change as a percentage compared to the unmodified control samples were given in Table 3. Modification with MF or MFW increased the oven-dry density of the both wood species. The highest density increase was determined as 27.2% in Scots pine modified with MFW for 30 min. The density increase in Scots pine were higher than that of chestnut and the change increased with the increasing impregnation duration. Modification with MFW resulted in a higher density increase than modification with MF.

The weight of the samples before and after modification, and WPG values of the modification were shown in Table 4. The WPG values varied from 17.83% to 46.53%. Although the greatest WPG was observed in modification with MFW for 10 min (46.53%), there was no statistically significant difference between the 10-min

and 30-min impregnation durations in Scots pine. It has been found that WPG alters more chestnut than Scots pine. This could be attributed to the relatively low permeability of chestnut. Dieste et al. (2013) noted that the average water vapor permeability of chestnut was lower than that of pine, and this low permeability is attributed to the wood extractives, which reduce the void space and hindered condensation. Chestnut wood has different vapor sorption and vapor permeability than conifers normally used in construction.

Table3: The oven-dry densities of the modified woods

Wood species	Chemical	Distilled water	Impregnation duration (min)	Oven-dry density (g/cm^3)	Change (%)
	Control	-	-	0.451	-
		-	10	0.514	14.0
		-	30	0.541	20.1
		50%	10	0.529	17.4
		50%	30	0.573	27.2
	Control	-	-	0.539	-
		-	10	0.592	9.8
		-	30	0.621	15.3
		50%	10	0.603	12.0
		50%	30	0.614	13.9

Table 4: Weight percent gain values of the modified wood

Modification groups	m_o (g)	m_i (g)	WPG (%)	HG
SP-MF-10	12.49	15.89	26.91	a
SP-MF-30	12.39	16.47	32.75	ab
SP-MFW-10	11.36	16.63	46.53	c
SP-MFW-30	11.72	16.92	44.38	c
CH-MF-10	13.19	15.54	17.83	x
CH-MF-30	12.94	16.42	26.96	y
CH-MFW-10	13.05	16.81	28.91	y
CH-MFW-30	12.97	17.29	33.34	z

HG: Homogenity groups. Means within a column with different subscripts differ ($P < 0.05$)

WPG were higher in MFW than MF in both wood species. These results showed that MF or MFW impregnated both the cell lumens and the cell walls. It was reported that an aqueous melamine formaldehyde solution can penetrate the secondary cell wall of Scots pine or larch wood (Gindl et al. 2002) and the amorphous region of cellulose fibrils (Hua et al. 1987).

Table 5: Water uptake values of modified and unmodified wood

Modification groups	Water Uptake (%)	Change (%)	HG
SP-C	82.1	-	a
SP-MF-10	72.3	11.9	ab
SP-MF-30	65.0	20.8	bc
SP-MFW-10	69.8	15.0	abc
SP-MFW-30	54.3	33.9	c
CH-C	98.0	-	x
CH-MF-10	68.3	30.3	y
CH-MF-30	63.9	34.7	z
CH-MFW-10	62.8	35.8	z
CH-MFW-30	62.1	36.5	z

HG: Homogenity groups. Means within a column with different subscripts differ ($P < 0.05$)

The WU values of the modified with MF and MFW, and unmodified wood were given in Table 5. Reductions in the WU varied from 11.9% to 36.5%. The average decrease in the WU in modified chestnut was about 35%, and there was no statistically difference between them except in modified with MF for 10 min (30.3%). But the difference among the modified pine groups was more evident. It was determined that the impregnation duration was quite effective on the WU in Scots pine; longer impregnation duration caused about twice a decrease.

The volumetric swelling and the ASE values of the modified wood were shown in Table 6. Modification with MF or MFW decreased the volumetric swelling of Scots pine and chestnut. The ASE values of the MFW-modified samples were higher than that of MF-modified samples. Deka et al. (2007) reported a 17.5% increase in ASE for MF-modified Norway spruce. In this study, higher ASE values of 57% and 67.5% for MFW-modified Scots pine and chestnut, respectively, were achieved. Deka et.al. (2007) indicated that this dimensional stability might be due to blocking of water accessible OH groups of wood component with MF resin, which was perceived even after repeated wetting and drying of wood. Since, the MF resin caused volumetric swelling of wood (Militz et al, 1997), it could be inferred that the resin could easily penetrate the wood substrate to reach OH groups of the cell wall components for dimensional stability.

Table 6: Volumetric swelling and ASE values of the modified wood

Modification groups	Volumetric Swelling (%)	HG	Anti-swelling Efficiency (ASE) (%)
SP-C	7,45	a	
SP-MF-10	4,46	c	
SP-MF-30	5,67	b	
SP-MFW-10	3,43	c	
SP-MFW-30	3,2	c	
CH-C	11,54	x	
CH-MF-10	7,92	b	
CH-MF-30	6,71	c	
CH-MFW-10	3,75	d	
CH-MFW-30	3,99	d	

HG: Homogenity groups. Means within a column with different subscripts differ ($P < 0.05$)

Table 7: MOR and MOE of the modified wood

Modification groups	MOE (N/mm^2)	HG	Change in MOE (%)		MOR (N/mm^2)	HG	Change in MOR (%)
SP-C	7566.8	a	-		93.3	a	-
SP-MF-10	8389.5	b	10.9		68.9	b	-26.2
SP-MF-30	8874.8	c	17.3		68.2	b	-26.9
SP-MFW-10	8038.1	ab	6.2		62.8	b	-32.7
SP-MFW-30	7928.1	ab	4.8		64.6	b	-30.8
CH-C	9616.2		-		105.5	x	-
CH-MF-10	9983.4		3.8		102.9	x	-2.5
CH-MF-30	9587.9		-0.3		90.4	y	-14.3
CH-MFW-10	9315.7		-3.1		86.6	y	-17.9
CH-MFW-30	10070.8		4.7		87.7	y	-16.9

MOR: Modulus of rupture; MOE: Modulus of elasticity
HG: Homogenity groups. Means within a column with different subscripts differ ($P < 0.05$)

The mechanical properties of the modified wood were determined and the results were summarized in Table 7. Modification with MF or MFW reduced the modulus of rupture (MOR) more in Scots pine than chestnut. The decrease in MOR was approximately 30% compared to unmodified Scots pine and there was no statistically

significant difference among the modified groups. Decrease in MOR were varied by 2.5% to 17.9% in modified chestnut and there was no statistical difference among the modified groups except samples modified with MF for 10 min. Epmeier et al. (2003) reported an approximately 10% increase in MOR with the methylated melamine formaldehyde resin modification; however, acetylation and furfurylation were not significant. The reduction in the MOR of the MFW-modified samples was higher than that of the MF-modified samples. This reduction in the MOR might be caused by high temperature of the curing step of the modification process. A high treatment temperature causes strength loss in wood (Thermowood 2003;Lekounougou and Kocaefe 2014). Therefore, the process values must be selected carefully when exploiting heat in wood modification. Winandy and Rowell (2013) stated that the bending strength depends on many properties, like specific gravity and Weigl et al. (2012) found that the bending strength reduction is aligned with hemicelluloses degradation.

Modification with MF or MFW increased the MOE of the Scots pine. The highest increase was observed in samples modified with MF for 30 min as 17.3%. The increase was relatively low in the other groups and there was no statistically difference among them. Modification with MF or MFW slightly changed the MOE of the chestnut and there was no statistically difference compared to unmodified samples (p=0.264). Epmeier et al. (2004) indicated that although the MOE was affected by a change of density, an increase in density caused by chemical modification does not affect the MOE in the same manner.

Although chemical modification with MF and MFW slightly increased the HBR (Table 8), it was found that this increase was statistically insignificant. Gindl et al.(2002), Epmeier et al. (2003), Lande et al. (2004), and Deka et al. (2007) reported that the hardness of the wood notably increased by chemical modification at high weight percent gain levels. Deka et al. (2007) inferred that resin's adherence and/or reaction on the surface of treated wood caused increase in surface hardness considerably.

Table 8: Brinell hardness of the modified wood

Modification groups	HB N/mm^2	HG
SP-C	1,49	
SP-MF-10	1,76	
SP-MF-30	1,63	
SP-MFW-10	1,49	
SP-MFW-30	1,57	
CH-C	2,93	
CH-MF-10	3,23	
CH-MF-30	3,13	
CH-MFW-10	3,05	
CH-MFW-30	2,64	

Conclusion

Certain physical and mechanical properties of the wood modified with melamine formaldehyde (MF), and melamine formaldehyde diluted with water (MFW) were investigated. The results show that chemical modification affects the properties of wood in different ways. Based on the findings of this study, conclusions given below can be inferred:

- Chemical modification with MF increased the density of both Scots pine and chestnut,
- WPG values and density increase were higher in samples modified with MF diluted with water,
- Longer impregnation time resulted higher WPG and density increase,
- Modification with MF or MFW decreased the water uptake and swelling of wood significantly,
- ASE of the modification were higher in chestnut than that of Scots pine. ASE of the modification with MFW were higher than that of modification with pure MF. Approximately 55% and 65% ASE were determined in Scots pine and chestnut modified with MFW, respectively.
- Modification with MF or MFW decreased the MOR of Scots pine, significantly. (30%) Decrease in MOR were relatively lower in chestnut (17%).
- Modification did not affect the MOE in chestnut, significantly (p=0.264). But, modification with MF increased the MOE in Scots pine (10%-17%).
- Modification with MF or MFW did not affect the HB of the wood, significantly.

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EVALUATION OF ARASTAS AND BAZAARS OF OTTOMAN CITIES WITHIN THE CONTEXT OF CONSTRUCTION MATERIALS AND ARCHITECTURAL TYPOLOGIES

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Abstract: In Anatolian cities of the Ottoman period, such as the inns, bedestens (covered bazaars), arastas, bazaars, grand bazaars and stores formed the commercial centers. These commercial structures with different functions were the main components forming the fabric of the commercial districts. These commercial centers also contained major public buildings, such as mosques and baths. Depending on the size of a city or town, the number of these structures could vary greatly. All of the buildings located in the center were important facilities, contributing economic, social and distinctive features to an Anatolian city or town. In this study, the "Arasta" and "Bazaar" in historical cities located on the axes of important trade routes in Anatolia were investigated. In addition, the conceptual and architectural differences of arastas and bazaars from inns and bedestens, which are major commercial structures, were investigated. The structures were selected from the cities of İstanbul, Bursa, Edirne, Hatay, and Konya, which were located on the important trade routes of the time. Especially, construction and material techniques, plan and façade typologies of these structures, built in the 15th and 16th centuries, were evaluated, as were the common and distinctive features of the various cities.

Keywords: Historic Commercial Buildings, Arasta, Ottoman Bazaar, Bazaar, Grand Bazaar, Long Bazaar

Introduction

In the Ottoman cities, commercial buildings were not separated from religious buildings. During the process of establishing commercial districts, religious and cultural buildings, such as mosques and madrasas, were constructed within the same urban texture as commercial buildings, such as inns, bedestens, and baths. The commercial organization became prevalent as trade developed over time, and streets consisting of buildings involved in similar businesses were formed in the commercial districts. In these streets, bazaars and small shops that were run by a variety of professional groups were aligned in rows. From the center of the commercial area to the outer castle walls, the buildings for various occupations were arranged in an orderly manner. Workshops such as tanneries, felting shops, dyehouses, smithies, boiler smiths, and tinner shops were located in the outer ring of the commercial district. In the commercial districts, it is seen that the production areas of commercial goods were planned close to the commercial buildings where these goods were sold. This orderly arrangement led to workplaces being located in the streets extending from the center to the castle, and even to the emergence of "long bazaars," which were often seen in the Ottoman cities (Kuban, 1968; Can, 1995; Şahinalp&Günal, 2012;Akar, 2009; Saoud, 2002; Erzen, 1991; Kuban, 1968; Günal&Şahinalp, 2012). The Ottoman-era arastas and bazaars show interesting features in terms of their inner-city locations and architectural properties. These structures, referred to by different names, will be evaluated in the same category because all of them have a similar architectural scheme. In this study, the "arasta" and "bazaar" structures in the cities located on three major trade axes during the Ottoman period will be studied and compared. The following were selected: the ***Selimiye Arasta (Edirne***), the ***Ali Pasha Bazaar (Edirne)***, the ***Spice Bazaar (İstanbul)***, the ***Suleymaniye Tiryaki Bazaar (İstanbul)***, the ***Havsa Sokullu Mehmed Pasha Arasta (Edirne)***, the ***Ilgın Mustafa Pasha Bazaar (Konya)***, the ***Payas Sokullu Mehmed Pasha Arasta (Hatay)***, the ***Hisar Mosque Bazaar (İzmir)***,and the ***Shadirvan Mosque Bazaar (İzmir)*** **(**Figure 1**).**These will be examined and evaluated, especially in terms of their designs and plan schemes. Typological evaluations will be made on the basis of the common and distinctive features of these structures in general (Ataman, 2000; Erdoğan&Kuter, 2010).

Figure 1.The Arasta and Bazaar Structures located on major trade axes during the Ottoman Period (Yıldırım, 2014).

The 16th Century Commercial Buildings: Arastas and Bazaars

The word "arasta" means a bazaar, military bazaar, or mobile bazaar established in the military area where similar types of goods are sold. The structure of an arasta consists of shops arranged on opposite sides; sometimes it has an open top, or is covered with a vault in the center. The structure can be also built as a part of a külliye (a complex of buildings) (Hasol, 1995;Özdeş, 1998:7). In the definition of Sözen and Tanyeli (1986), an "arasta" is "a type of structure with an open or covered top in the Ottoman architecture, where a series of shops is located on an axis, sometimes side by side or sometimes on opposite sides"(Kuban, 2009). The word "bazaar" is derived from the root of the Persian term "Cıhar-Suk," which means "four streets." The bazaar structures are described as areas with open or covered tops, surrounded by shops on both sides, suitable for shopping (Özdeş, 1998:7). However, a bazaar can also be defined as a region which has a bedesten (covered bazaar) in the center and is surrounded by shops of different groups of tradesmen, workshops, an inn, a bath-house, a soup kitchen, a mosque, and a hospital (İnalcık, 1997:120). According to this definition, a bazaar can be described as a region with a commercial focus, in which people living in and around the city meet their social and economic needs and public and business areas are included (Kejanlı, 2010; Dumont &Georgeon, 1999; Faroqhi, 2000).

Figure 2. Shops in the Spice Bazaar, İstanbul (www.misircarsisi.org)

Figure 3. The Suleymaniye Tiryaki Bazaar (http://www.discoverislamicart.org/)

Evaluation of Arastas and Bazaars within the Context of Construction Materials and Architectural Typologies

In many cities of Anatolia, arasta and bazaar buildings attract attention with their substantial masonry masses extending in a longitudinal direction, containing wooden shops in the center of the commercial area. These buildings were built with a stone masonry wall construction system. The tops of these buildings, which were generally built in a single-storey and lengthwise rectangular plan, are closed and the roofs are covered with lead. Some bazaars were located beneath mosques and sometimes designed with an open top, in such a way as to face a street or a passage. By building shops around the shops located on the outer ring, the commercial streets were emphasized. Some bazaars and arastas, on the other hand, were built in the form of a complex and the two main walls of the building were built adjacent to the structures.

According to the location of the building, entrance gates are usually seen on two sides. These gates can be flashy, high, and with gem embellishments. In general, it is seen that the arasta and bazaar gates are sometimes made of iron, and sometimes of wood with ornaments (Cezar, 1985; Yenen, 1987; İntepe, 2005).

Figure 4. The Sokullu Mehmed Pasha Caravanserai, Inn and Arasta; Hatay Payas (http://www.hatay.bel.tr/)

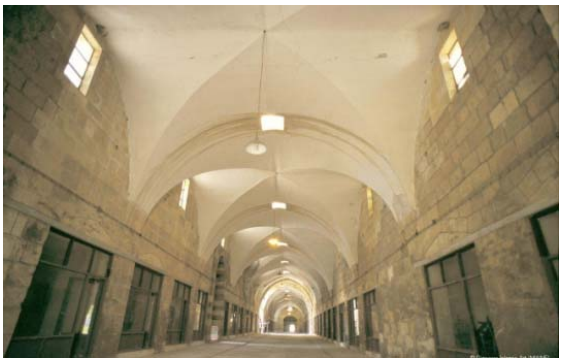


Figure 5. The cross-vaulted interior corridor of the arasta (http://www.discoverislamicart.org/)

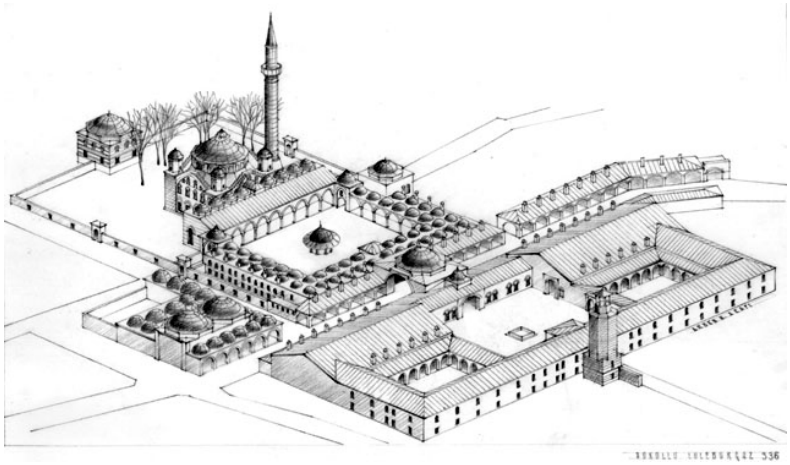


Figure 6.The Lüle Burgaz Sokullu Mehmed Pasha Caravanserai, Inn and Arasta (http://luleburgaz.blogcu.com)

Figure 7.The Ilgın Lala Mustafa Pasha Complex; Ilgın Konya (Genç, 2015)

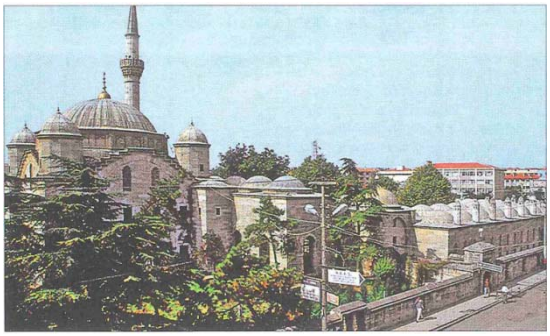


Figure 8. The Sokullu Mehmed Pasha Complex (Islam Encyclopedia, 2009)

Most of the arastas and bazaars that are regarded as dating from the 16th century were built by Sinan, the Architect, and the Sultan's society of architects. Moreover, the distinctive features of these buildings are largely similar due to the facilities of the era and the available construction materials. In the plan schemes of the arastas and bazaars, no development over time is seen. However, it can be said that the cities' needs, depending on their size, had an impact on the size of the plan schemes of these buildings.

As it can be seen in Table 1, in general, the arastas and bazaars of the middle or the end of the 16th century can be separated into two types according to their designs and plans, in order to avoid any conceptual confusion.

- **Type 1. Open-top bazaars and arastas with shops facing the street or passage**

These can be described as bazaars which were built on the ground floor, consisting of a single row of shops facing the street or passage. Sometimes the ground floor of a mosque was planned to be completely filled with bazaar

stores. The Tiryaki bazaar in Suleymaniye İstanbul (Figure 2) and the Shadirvan Bazaar (Figure 9.) Hisar Bazaar in İzmir (Figure 10), , can be given as examples of this type of bazaar (Ersoy, 1991; Atay, 1999; Beyru, 1973).

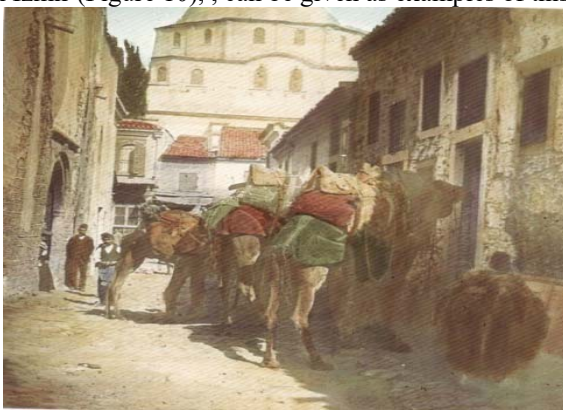


Figure 9. Hisar Mosque and Bazaar in Kemeraltı İzmir

Figure 10. The Shadirvan Mosque, Kemeraltı İzmir (Canbalaban, 2006)

In some parts of The Sokullu Mehmed Pasha Complex (Lüleburgaz, Figure 11), the Sokullu Mehmed Pasha Bazaar (Havsa, Edirne, Figure 8) and the Lala Mustafa Pasha Bazaar (Ilgın, Konya, Figure 7), a plan type is seen where the middle passage was planned with an open top and the shops were designed in opposing longitudinal rows. There is a prayer dome in the center of the sections of these types of structures that are called "arastas" or "bazaars." The prayer dome is a space that is erected with walls, under which one can pass through arches and with a dome in the center. It connects two spaces together (Ramazanoğlu, 2008). The shops in these structures each have an area of approximately 20 m^2 or more. The middle passage corridor is about 8–9 meters wide in these structures.

Fig. 11.The Lüleburgaz Sokullu Mehmed Pasha Complex, the Prayer Dome and the Shops (http://mimariforum.com)

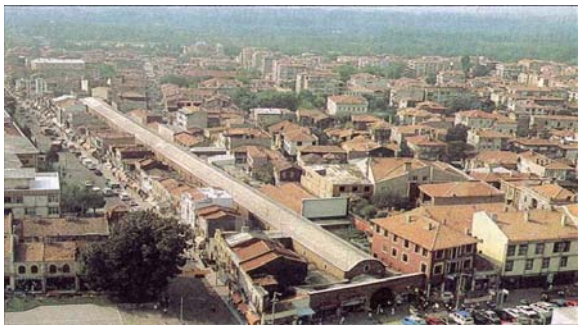


Fig. 12. Ali Paşa Bazaar, Edirne (http://wikimapia.org/)

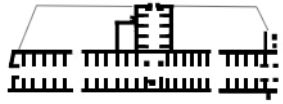
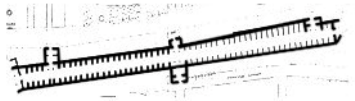
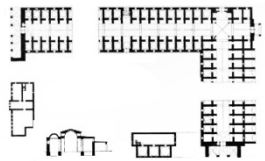
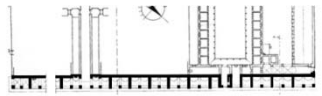
Fig. 13.Selimiye Arastas, Edirne (http://www.kadimdostlar.com/)

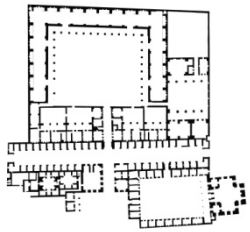
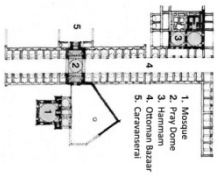
Type 2. Covered bazaars and arastas with shops facing the corridor (longitudinal rectangular, L- or T-planned)

This type consists of rows of shops aligned on both sides of a corridor with a covered top. The Ali Pasha Bazaar (Edirne) (Figure 12), the Selimiye Arasta (Edirne) (Figure 13), the Spice Bazaar (İstanbul), (Figure 2) the Sokullu

Mehmed Pasha Arasta (Payas, Hatay) (Figure 4 and Figure 5), and the Lala Mustafa Pasha Bazaar (Ilgın, Konya) (Figure 7) are examples of this type.

There is a prayer dome in the center of the Sokullu Mehmed Pasha Arasta (Payas, Hatay), but there is also a central passage/corridor covered with cross-vaults in this structure. This type of central corridor with a covered top can be compared to the Sokullu Mehmed Pasha Complex (Lüleburgaz) or the demolished Sokullu Mehmed Pasha Complex (Havsa, Edirne) (Ramazanoğlu, 2008). The size of the shops in these structures is approximately between 10–20 m^2. There are no external shops. While the roofs of the shops are low, the roof of the central corridor is cross-vaulted and high. On the walls that result from the difference in height between the shops and the central corridor, windows were cut and illumination of the central corridor was achieved. The central passage corridor in these structures is approximately 6 meters wide. In some structures, those buildings that were built as simple bedestens (covered bazaars) containing shops may also be called “arastas” or “bazaars.” In this study, these types of structures were considered bedestens, and were not included in the typology of arastas or bazaars (Pakalın,1983).

	Building Name and Location	**Year of Construction / Commissioned by and Built by**	**Plan type and Architectural Distinctive Features**	**Material and Buildings**	**Internal/ External Shops and Corridor width (approx.)**	**Plan scheme** (Özdeş, 1998).
Building 1	The Selimiye Arasta Edirne (Located on the İstanbul-Aleppo-Damascus-Hejaz way)	Commissioned by Murad III and built by Davud Agha the Architect (Özdeş, 1998).	T-plan type, single-row shops.	Stone /Brick Masonry System	Internal shops are 16–20 m^2 No external shops, Corridor is 6m.	
Building 2	The Ali Pasha Bazaar Edirne	1569/ Commissioned by Murad III and built by Sinan the Architect (Özdeş, 1998).	There are longitudinal, single-row shops on either side.	Stone / Brick Masonry System	Internal shops are 10–20 m^2 No external shops, Corridor is 6m.	
Building 3	The Spice Bazaar İstanbul	1660/ Commissioned by Sultan Turhan and built by Kasım Agha (Özdeş, 1998).	There are single-row shops on either side in an L-plan type. There is a dome at the intersection point of the vaults in the center.	Stone / Brick Masonry System	Internal shops are 20 m^2, No external shops, Corridor is6m.	
Building 4	The Suleymaniyah Tiryaki Bazaar İstanbul	Built by Sinan the Architect in the years 1550–1557(Özdeş, 1998).	Single-row shops face the street.(Shops downstairs, madrasa upstairs above the shops)	Stone / Masonry System	No internal shops, External shops are 20 m^2, No Corridor	

Building 5	The Ilgın Mustafa Pasha Bazaar Konya	In 1576, it was commissioned by Lala Mustafa Pasha. It is mentioned among the works built by Sinan the Architect. The Arasta is thought to have been built along with the inn in 1584. The Arasta, which consists of two sections, open and closed, was partially restored to its original state by building on the foundations in 1960 (Genç, 2015).	Entirely covering the north of the Complex, the north side of the Arasta faces the main street, its east and west are adjacent to the road, and its south is adjacent to the inn and the soup kitchen. There is a barrel vault roof above the center of the rectangular shops that face each other.	Stone / Brick Masonry System	Internal shops are 16 m^2 No external shops, Corridor is 6 m. .	
Building 6	The Sokullu Mehmed Pasha Arasta Payas/ Hatay (A Menzil Complex located on the İstanbul-Aleppo-Damascus-Hejaz way. There is an arasta in the center of the Complex in the north-south direction)	In 1574, it was commissioned by Selim II and built by Sinan the Architect. In the Complex, buildings for accommodation, such as the caravanserai, soup kitchen, and guest rooms were located to the east of the Arasta, whereas facilities for worship, education, and cleaning purposes, such as the mosque, primary school, madrasa, and bath were located on the west side.	The “Arasta” was built adjacent to the inn structure. The arasta, with anarea of 115 × 15 meters, consists of 48 shops located on opposite sides of a corridor covered with a cross-vault, also including a prayer dome in the center. The roof cover is a hipped roof.	Stone / Brick Masonry System	Internal shops are 10–12 m^2 Corridor is approx.8 meters.	
Structure 7	The Sokullu Mehmed Pasha Complex Havsa/ Edirne	In the years 1576–77, a Complex consisting of mosque, madrasa, arasta, inn, soup kitchen, double bath, lodge, bridge, fountain, and primary school was commissioned by Sokullu Mehmed Pasha. It was built with the cooperation of the Sultan’s Society of Architects and Sinan the Architect (Islam Encyclopedia,2009) The parts of the Complex, the mosque, the prayer dome of the arasta, the bath, its alcove wall, prayer-room/lodge, and corner fountain have survived to the present day.	There is a prayer dome in the space into which the doors of the arasta, the mosque, and the inn open. The other parts of the Complex, such as the arasta, inn, soup kitchen, guest rooms, madrasa, bridge, founding and primary school have not reached the present day. As understood from the traces, the arasta included rows of shops on either side. The rectangular-planned arasta provided a structural and functional connection between the building masses. The top of the central corridor was open (IslamEncyclopedia,2009)	Stone / Brick Masonry System	Destroyed, Corridor approx. 9 meters.	

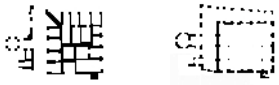
Building 8	The Sokullu Mehmed Pasha Complex and bazaar Lüleburgaz	It is believed that it was commissioned by Sokullu Mehmed Pasha in the years 1559–1570. The design and construction of the complex were carried out by Sinan and the Sultan's Society of Architects, under the sultan's directorship. The historical İstanbul-Edirne-Central Europe road passes through it(Islam Encyclopedia, 2009).	What has survived from the arasta located in the complex are dilapidated shops, whose number has been reduced by half, and the prayer dome. The arasta is adjacent to the north wing of the madrasa, and consists of shops built on both sides of a road extending in an east-west direction. The arasta, consisting of 59 shops built on both sides and a prayer dome, forms the spine of the complex. There are shops lined up in single rows longitudinally. The top of the central corridor is open.	Stone / Brick Masonry System	Shops are mostly destroyed. Internal shops are approx. 10–12 m^2 Corridor is about 8 meters. The corridor is rather wide, as a road passes between the shops.	
Building 9	The Hisar Mosque Bazaar İzmir	It is written in some sources that it was transformed from a Latin Church, and that this was done by Aydınoğlu Özdemiroğlu (Molla) Yakup Beyin 1597–1598. The same sources also state that this transformed mosque was demolished by Timur in 1402. (http://www.izmirkulturturizm.gov.tr/). According to an inscription on the gate of the mosque, it was repaired in H.1298 (1881) (Özdeş, 1998).	There are shops in rows added next to the mosque. The shops of the bazaar are open to the streets and the courtyard surrounding the mosque.	Cut-rubble stone Masonry System	There are shops of various sizes.	
Building 10	The Shadirvan Mosque Bazaar İzmir	This mosque, which is located on the Old Inner Harbor shore inside the Historical İzmir Kemeraltı Bazaar, took its name from the eight-columned shadirvan beside and under it. Therefore, it is referred to as the Shadirvan Mosque and Bazaar. It was built in 1636 and restored in 1815 (Özdeş, 1998).	There are shops under the mosque. The shops located on the ground floor face the streets and the passage around the mosque.	Cut-rubble stone Masonry System	There are shops of various sizes.	

Table 1. Systematic evaluation of building materials and typologies of Arastas and Bazaars

Discussions and Results

Arastas and the bazaars, located in the Ottoman trade routes, have been built in the 17th and 16th centuries. 10 important structure of them, located in this trade route and examine the scope of the this research, contribution of the architecture of Arastas and bazaars.

When examining the plan schemes of arastas and covered bazaars in, it is seen that single-row shops face each other on either side. There is a high vault above the central corridor, which usually extends longitudinally. There may be a dome in the midpoint of the longitudinally extending corridor, or at the intersection of the corridors. These domes functioned as prayer dome in some arastas.

For example, it is seen that some buildings, such as the Spice Bazaar (İstanbul), the Selimiye Bazaar (Edirne),and the Tokat Bazaar, were planned with a central dome over the central aisle. There is, again, a prayer dome at the center of the Sokullu Mehmed Pasha arastas (Lüleburgaz, Edirne, Hatay).

The sizes of the shops that are located on opposite sides, as required by plan schemes in arastas, bazaars, and covered bazaars, vary between 10 and 20 m^2.For example, while the widths of the shops in the Niğde Covered Bazaar range between 2 and 2.5 m, the widths of the shops are 3.75 m in the Ali Pasha Bazaar (Edirne) by Sinan, and 3 m in the Payas Covered Bazaar. When we look at the Edirne arasta, it is seen that the façades of the shops vary between 3 and 4m in width. The internal shops face the corridor. External shops are not included in most arastas. The width of the corridors is usually 6 meters wide. The shops are closed, with arched doorways. In some arastas and bazaars, there may be divisions for sales stands without any doors. The cross-vault or the dome can be seen from each shop individually.

The construction technique in the arastas, bazaars, and covered bazaars, and the commercial structures investigated, is, in general, masonry; the construction material is usually stone and brick, and sometimes only stone. Security concerns dictated the use of this construction technique. Sometimes, since these structures operated as banks and stock bazaars, as in bedestens, and valuable goods were sold, stored and exhibited in these places, the walls of these structures were made relatively thick, and the windows were located quite high and secured with iron grates. When we look at the architectural characteristics and construction techniques of arastas, bazaars, and covered bazaars, it is seen that these structures were built with a one- or two-storey, stone/brick masonry system.

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EVALUATION OF THE ENVIRONMENTAL IMPACTS OF RENEWABLE ENERGY SOURCED ELECTRIC PRODUCTION FOR THE PROVINCE OF SINOP/ TURKEY

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Abstract: This paper is a report on the findings of a study conducted on a graduate level virtual conference summer school course. Discourse analysis techniques were used to examine the resulting transcript of texts for evidence of a democratic discourse within a community of learners. Findings indicate that gender is not masked in the text driven discussions on the Internet. Distinctive discursive styles are often sex class linked. Like face to face or classroom contexts, status is accorded unequally within discourse communities. Participants are not equal and are not equally attended or responded to. Educators need to take a serious and wary approach to accepting claims of ensured democratic participation in computer mediated communication formatted classes.

Keywords: Sinop province, Electric energy production, Renewable energy sourced, Environmental impacts

1. Introduction

Demand for energy is increasing day by day in our country and worldwide due to many factors, such as population growth, industrialization, technological progress, more people live in the city (Mann and Teilmann, 2013). From the perspective of our country, our energy production from domestic sources cannot meet the energy that we consume (Yüksel, 2010). In order to get to the level of the industrialized countries in the development process of our country, the need to increase energy production and energy consumption compared to the current situation (Acaroğlu, 2013). In developed countries, there have been made investments at a great rate in renewable energy sources, to meet the energy demand of electricity production and to minimize the damage to the environment (Kenisarina et al. 2006). Adding essence and affordable, environment- friendly alternative energy sources to our energy production policy, it is an inevitable necessity to reduce our dependence foreign countries (Yüksel and Kaygusuz, 2011). In addition, national and international legal and statutory contracts are also supportive of this orientation (Anonim1, 2016). It makes attractive alternative energy sources that they are unlimited, renewable and not cause environmental pollution. As a result of these developments in the energy sector in our country, a large number of theoretical and practical studies have been made on environmentally friendly energy sources (Akdağ and Güler 2010). Wind energy is the energy source that in the focus of this studies (İlkiliç, 2012). Wind energy stands out in terms of more economical, easy installation and operation of power plants when compared with other forms of energy (Güler, 2009). Researchers have done a lot of work for the regions where they thought it was the wind potential in sub-issues such as, cost, environmental impacts and site selection (Özgener, 2010). In our country, with increase of the support in the wind energy field of, increasing numbers of new wind power plants have been established every day without huge installed power capacities. In Turkey, annual production capacity of wind energy is 11 552 GWh at the end of 2015. The installed capacity of wind power plants in operation by the end of the year 2015 4.503 MW (Anonim2, 2016).

In this study it was analyzed and evaluated of the possible environmental impact of a wind energy power generation system with taking into account recent data that may be established in Sinop.

2. Evaluating The Environmental Impact Of The Wind Energy Plant For Sinop City

2.1 Electric Energy Production and Consumption in Sinop

Altınkaya, First Energy, Boyabat, Erfelek and Ayancık HPP plants provide the electricity for Sinop. Installed capacity of these HPPs except for Altınkaya HPP is 543 MW. Annual electricity production of these plants is 872 GW (Anonim3, 2016). Electricity distribution in the region is executed by a privileged company called Yesilirmak Electricity Distribution Co. (YEDAS). As seen in Table 1, electricity energy consumption in Turkey is increasing every year.

Table 1. Electric Energy Consumption in Turkey (2010-2014) (Anonim4, 2016).

Year	Government	Industrial	Commercial	Household	Illumination	Other	Total (GWh)
2010	4,1	46,1	16,1	24,1	2,2	7,4	172.051
2011	3,9	47,3	16,4	23,8	2,1	6,5	186.100
2012	4,5	47,4	16,3	23,3	2,0	6,5	194.923
2013	4,1	47,1	18,9	22,7	1,9	5,3	198.045
2014	3,9	47,2	19,2	22,3	1,9	5,5	207.375

When Table 2 is examined, the consumption of electric energy in Sinop has been increasing every year as much as in Turkey general.

Table 2. Electric Energy Consumption in Sinop (2010-2014) (Anonim4, 2016).

Year	2010	2011	2012	2013	2014
Net Consumption (MWh)					
Household	106.853	119.894	127.491	128.209	136.943
Commercial and Public Services	65.414	71.266	73.438	78.980	94.977
Industrial	84.461	105.494	83.722	77.167	71.727
Agricultural Irrigation	605	1.293	1.269	1.732	1.894
Other	11.058	21.404	21.164	19.925	22.482
Total (MWh)	268.391	319.351	307.083	306.013	328.022
Number of Subscribers					
	133.231	135.808	140.564	144.845	149.699
Loss-Theft Rate (%)					
	14,9	11,1	9,7	8,4	7,5

The total number of subscribers was 154 225 in Sinop in 2015. The total power consumption was 339.499.562 kWh. Sold energy was 312.784.282 kWh (Anonim5, 2016). According to these data, theft-loss rate was 7.87% in Sinop.

2.2. Wind Energy in Sinop

Sinop is a city established in Mid- Black Sea region in north Anatolia at the narrowest part of Boztepe peninsula. Its location serves as a transition zone of between the West and the East of Black Sea region. The city is situated between 41.2 to 43.5 34.5 to 35.5 meridians and parallels. The city has a total border of 475 kilometers with 300 kilometers inland border and 175 kilometers marine border (Anonim6, 2016). Sinop is a city in the Central Black Sea Region with an average height of approximately 200 m. The height of the Küre Mountains, located behind the coast, is above 1500 meters. Seasonal temperature difference is not high in Sinop. The long term average temperature in the coastal towns of Sinop is 13-15◦C and 12◦-14◦C in the inland towns. Main wind direction is northwest (mistral) and the long term average wind speed is 3,5 m / sec. In inner parts, the dominant wind direction is west and the wind blows softer than the coastal winds with an average of 1.0m / s to 2.0 m / s . The population of Sinop is 204 133 (Anonim6, 2016). In Table 3, Sinop wind intensity and speed at a height of 50 meters have been shown. In addition, the total power capacity of the wind power plant that may be installed has been given. For an economic wind power plant (WPP) investment, a wind speed of 7 m / s or more is required. As seen in Table 3, dominant wind speed is between 6.8 and 7.5 m / s in Sinop; thus, it can be argued that it would be an economic investment

Table 3. Wind Power Plant Power Capacity that may be installed in Sinop (Anonim8, 2013).

50 m Wind Power (W/m^2)	50 m Wind Speed (m/s)	Total Area (km^2)	Total Power Capasity (MW)
300-400	6,8- 7,5	289,63	1.448.16
400-500	7,5- 8,1	8,59	42,96
500-600	8,1- 8,6	0,00	0,00
600-800	8,6-9,5	0,00	0,00
> 800	> 9,5	0,00	0,00
		298,22	1.491.12

2.3. Environmental Impact Assessment (EIA)

It is important to have an understanding of environmental issues in order to suggest solutions for these problems. Environmental impact assessment reports may suggest ideas on how to suggest solutions for environmental issues. These reports determine the possible positive and negative effects of environment-related plans and projects. EIA reports benefit from the studies on evaluation and supervision methods and measures to be taken so that environmental damage will be minimized (Anonim9, 2016). The power plants are used to produce electricity energy through energy conversion. In this conversion process, these power plants can have both positive and negative effects on environment. Wind power plants have positive aspects such as not polluting the air. Attention should be paid to location selection, field conditions, noise sequence, visual pollution and impacts on bird mortality in the wind power plants planning process.

2.3.1. Air Pollution Concerns

Industrialization, increasing number of motor vehicles, urban life and many other factors lead to increased air pollution. Moreover, in Turkey, coal-based thermal power plants operate on high sulphur brown coal. They are constructed via old-fashioned techniques. The absence of filter system or efficiency causes problematic sulphur dioxide (SO_2) emissions. These facilities are considered high level pollutants in power generation facilities category. Therefore, there are specific emission limit values decreed by environmental legislations (Yüksel and Sandalcı, 2011). In Table 4, the limit values by the International Air Quality Index have been given. This table is categorized according to airborne pollution levels in different colours. For example purple colour illustrates that there is a health emergency status and that this status is more likely to affect the entire population.

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*..air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Table 4. EPA (Environmental Protection Agency), International Air Quality Index (Anonim10, 2016).

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.

Table 4. EPA (Environmental Protection Agency), International Air Quality Index (Anonim10, 2016).

Air pollution reduces the quality of life by affecting human health directly or indirectly. There is an air quality monitoring station in the central town of Sinop. At the station, PM_{10}, $S0_2$, relative humidity, relative temperature, wind direction and speed, air pressure values are measured regularly. In Figure 1, airborne pollutants PM_{10} and SO_2 values from the previous year in Sinop are provided. Natural gas is not available in Sinop yet. Coal is used for heating. Therefore, air pollution in winter has usually been observed to increase due to coal use for heating.

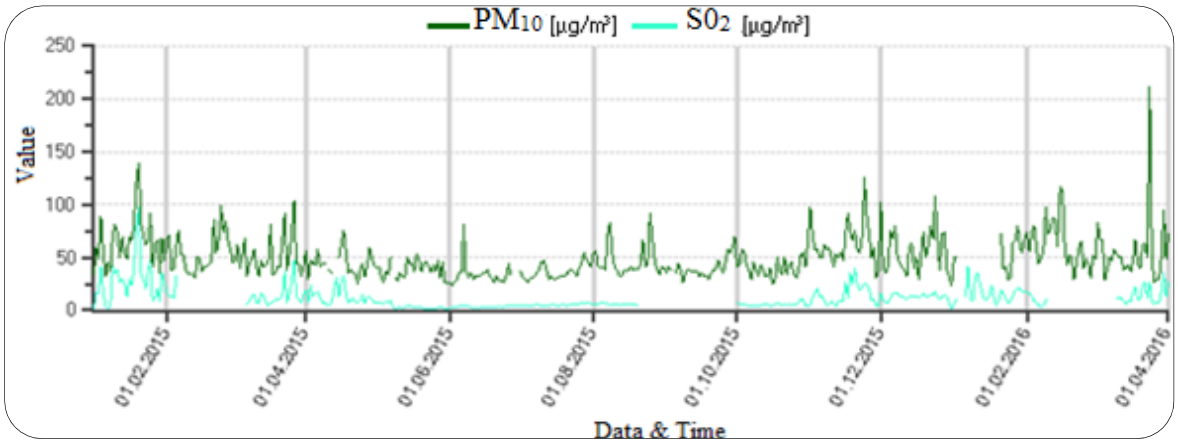

Figure 1. 2015 Air Quality Measurement Station Locations and Measured Parameters in Sinop (Anonim11, 2016).

Wind energy is one of the renewable energy sources and has a positive impact on the environment. Wind turbines are extremely important for reducing CO2 emissions. In table 5, it is shown that the harmful gas emissions into the atmosphere from wind energy production can be prevented by using 1 kW of energy.

Table 5. Prevention of emissions by 1kW wind power generation (Anonim11, 2016).

Emission Type	Quantity(gr)
Carbon dioxide (CO2)	0,7
Sulfur dioxide (SO2)	7,1
Nitrogen dioxide (NOx)	2,8
Carbon monoxide (CO2)	0,9

For example, wind power plant's contribution to the reduction of 1 MW carbon dioxide emissions has been calculated considering the wind data from Sinop province. As a result, it is seen that 1 MW Suzlon S64 / 1000 brand wind turbine produces 2,844,492.38614521 kWh of energy per year. Fossil fuels lead to an emission of 0.7 kg CO2 to produce 1 kWh energy. Therefore, using the above mentioned turbine, approximately 2.8 GWh energy may annually be produced and emission of 2000 tons of CO2 may be prevented. On the other hand, one acre (0.404 acres) forest (plant) clears 5 tons of CO2 from the atmosphere per year. Thus, generating energy with a 1 MW turbine, 400 acre forest (wooded with 152 000 trees) is equivalent with CO2 (2000 tons / 5 (tons / acre) = 400 acre = 162 acres) cleaning job (Özkaya et al.,2008, Özgener, 2002).

2.3.2 Noise Concerns

Noise is a major problem that results from unwanted sounds in their environment. Noise pollution is one of the environmental problems that are caused by factors such as development of technology, rapid population growth, unplanned urbanization and industrialization. There are different opinions about the noise from the wind power plants. Some argue that the quality of life in the city is affected adversely by wind turbines and it is disruptive for human health. Some others state that two types of wind turbine noise occur- mechanical noise and aerodynamic noise- and noise pollution is at a high level (Anicica et al., 2006). Many experimental and theoretical studies have been made in order to minimize the noise (Leea and Leeb 2016). According to the data, the noise level is 45 dB, 250 metres away from of a wind turbine. Insomnia is caused when the noise is beyond this level. Therefore, the distance between wind turbines and residential units should be arranged to be less than 500 m. In addition noise problems can be reduced significantly using insulation materials. Two locations in Sinop are suitable to install a wind power plant. These locations are outside the residential area. Thus, it can be argued that the wind turbine in the province of Sinop do not create a negative environmental impact in terms of noise level (Özkaya et al.,2008).

2.3.3. Bird mortality and Habitat Effects of Wind Turbines

In many countries around the world, projects and policies have been developed to rapidly increase the share of renewable energy sources in energy production in recent years. Wind power plants stand out among the renewable energy sources in the world with its increased production volumes with low costs, easy installation and operation (Dai et al., 2015, Dennis and Leung, 2012). However, the adverse environmental impact has been also increased together with the increase of electricity generation from wind energy. The disadvantages of wind turbines include impact on bird mortality and habitat (McDonald et al. 2009). In many countries around the world and in Turkey, various studies have been carried out in order to eliminate these problems (Larsen et al. 2007). In addition, some studies have been carried out to compare the impact on nature and bird mortality caused by wind energy production and fossil fuel energy production technologies (Sovacool, 2009).

In these studies have shown that the adverse impact on nature caused by wind energy production is significantly less than the adverse impact on nature caused by fossil fuel power plants. Sinop covers an area of 586 200 hectares. 37% of the 217 276 hectares of land is arable except meadows and pastures. Agriculture can be done on a total of 91 865 hectares of this area. The remaining 56% of non-agricultural areas are forested. 6% is settlement area and 1% is pastures and meadows. Available land for agriculture is rugged, very fragmented and 86 % of land is susceptible to water erosion (Anonim7, 2016). Sarıkum zone is located within the area of nature protection in Sinop. It is an area of 785 hectares, 20 kilometres from the city centre. Sarıkum Lake hosts various ecosystems and habitats. It is a convenient place for feeding and wintering for birds. RES map in Figure 2, there is also Sarıkum in areas cannot be established seen by grey colour. Short-term migration of various species of birds are seen every month.

7 m / s wind speed or over is required for an economic WPP investment. As can be seen in Table 3, dominant wind speed is between 6.8 to 7.5 in Sinop, WPP can be said to be an economic investment (Anonim8, 2013). When the wind speed at 50 m height and at the distribution of power are considered, the effect can be seen in the total number km^2 In the framework of this effect is shown in the total number of MW wind power plant can be built. As a result, the idea of wind power plant construction in Sinop is not been considered as a drawback in terms of bird mortality and agricultural areas.

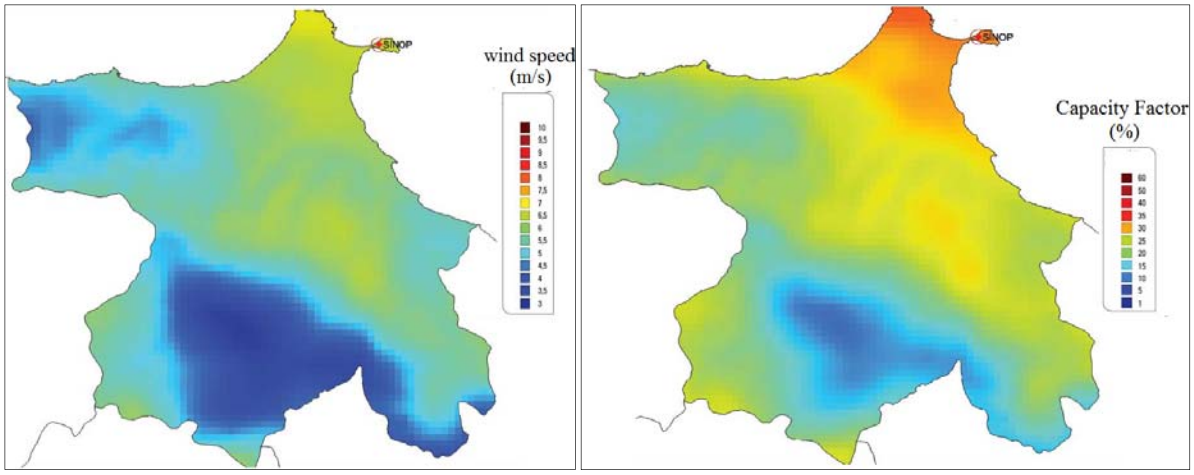

Figure 2. Sinop wind resource information.

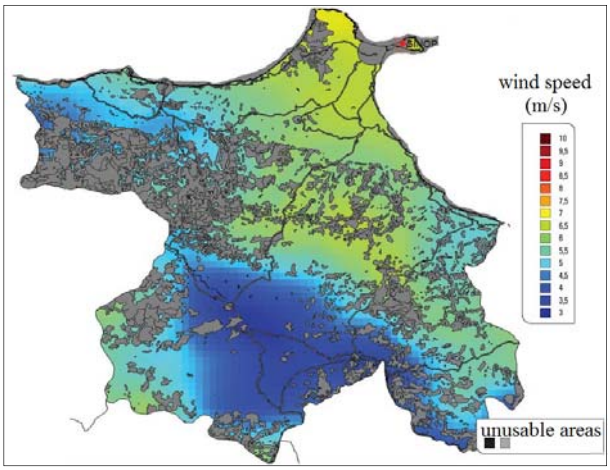

Figure 2. Sinop wind resource information.

Conclusions

Wind energy is a renewable alternative energy source that can meet growing energy needs in the world and in Turkey. Wind energy is indispensable, because it is an environmentally friendly and infinite source of energy that does not release emissions into the atmosphere.

Among the factors that are taken into account for a possible project of a wind power plant in Sinop environmental impact assessment; location selection, space requirements, air pollution, noise effect, impact of turbine presence or absence on habitat, bird migration routes and impact on the natural conservation areas can be listed. This study also provides an environmental impact evaluation for Sinop Province.

A wind speed of 7 m / s or over is required for an economic WPP investment. When the wind atlas prepared for the province of Sinop is examined, it can be assumed that the wind speed in Sinop is at a suitable level that can support an economic WPP investment. Today, any such investment has not been made yet. The region should benefit from this environmentally friendly and renewable energy sources as soon as possible.

Based on wind data from the province of Sinop, the construction of a possible 1 MW wind power plant will contribute 2.8 GWh per year to electricity production. Moreover, the wind power plant will help prevent approximately 2,000 tons of carbon dioxide emission per year.

In Sinop, air pollution is seen especially in winter due to absence of natural gas heating infrastructure and coal use for heating. In this regard, WPPs are promising because they don't cause air pollution.

The effect of the construction of a possible WPP on migratory birds should not be ignored. Therefore, taking into account WPP numbers of operations and migration time of birds at Sarıkum Lake, which is an important bird migration area in Sinop peninsula, will be helpful in preventing potential losses. It is expected that, if these studies done, harmful effects of WPPs on the environment will be eliminated.

Priority should be given to methods of electricity generation with renewable energy technologies as an alternative to nuclear and thermal power plants being considered to be established in Sinop.

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HEAVY METAL REMOVAL BY POLYMER – ZEOLITE BASED ADSORBENT

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Abstract: Water resources are threatened by a lot of pollutants such as heavy metals. Copper, a heavy metal, is quite toxic at high concentrations similar to the other heavy metals. These metals can also accumulate fatty tissues of livings. Due to these reasons heavy metals should be removed from wastewaters before being discharged. There are many methods to remove heavy metals such as chemical precipitation, ion exchange, membrane technologies, etc. Adsorption is an alternative method which is cheap, easy to apply and effective. Various adsorbents including biopolymers are used efficiently for heavy metal removal. Alginate is one of them composed of mannuronic and guluronic acid monomers. Alginate can form beads by adding mostly calcium which were used for heavy metal removal. Recent studies were particularly focused on improvement of these beads by adding some materials capable of capturing heavy metals such as clay, bentonite, activated carbon, etc. In this study, a natural zeolite, clinoptilolite was used to increase copper removal capacity of alginate beads. For copper removal, series of adsorption experiments were performed under constant temperature and mixing rate. Alginate-clinoptilolite beads were found to be more effective (almost 20 % of higher copper removal) compared to alginate beads alone. Adsorption of copper was equilibrated after about 8 hours of incubation and the highest copper reduction was observed as 87 mg Cu^{2+}/g alginate-clinoptilolite beads at initial Cu^{2+} concentration of 100 mg/L.

Keywords: Alginate, Clinoptilolite, Copper, Toxicity

Introduction

Environmental pollution is particularly get worse by industrial evolution. A lot pollutants become wide spread in the biosphere, such as heavy metals. Heavy metals are generally toxic even at considerably low concentrations. Also, they can accumulate in fatty tissues which resulted increase in heavy metal levels in the food web. Therefore, heavy metals are required to be treated before discharge into the environment (Papageorgiou et al, 2008). There are many methods used for the treatment of heavy metals such as chemical precipitation, filtration, ion exchange, membrane technologies and adsorption. One of the alternatives is adsorption by natural polymers. For instance, alginates are found to be effective in heavy metal uptake (Vieira and Volesky, 2000).

Alginates are polysaccharides composed of mannuronic (M) and guluronic (G) acid monomers. These monomers can be arranged as MM-, MG- and GG-blocks (Hay et al, 2010). Carboxylic acid groups linked to these monomers are claimed to be the main functional groups in heavy metal removal. Also, complexation reactions together with divalent cations might have a role in heavy metal uptake. Alginates with high GG-blocks content can form strong gels with divalent ions particularly calcium ions (Davis et al, 2003). Generally alginate beads formed by gelation investigated in related studies. However, in recent years, studies especially focused on improving heavy metal removal capacity of alginate beads by forming composite structures. For example, heavy metals like Pb^{2+}, Mn^{2+}, Cd^{2+}, Cu^{2+}, Zn^{2+}, Fe^{2+}, Al^{3+} and Hg^{2+} were removed by magnetic alginate beads (Bee et al, 2011; Idris et al, 2010; Idris et al, 2012; Ngomsik et al, 2009; Park et al, 2007), alginate montmorillonite beads (Shawky, 2011), pectin alginate beads (Harel et al, 1998) and ceramic membrane alginate beads (Athanasekou et al, 2009). Similarly, this study aimed to improve heavy metal uptake capacity of alginate beads by combining alginate and clinoptilolite.

Clinoptilolite is a natural zeolite having ability to remove metals from wastewaters by ion exchange. Cd^{2+}, Cu^{2+}, Ni^{2+}, Cr^{3+}, Pb^{2+}, Fe^{3+} could be removed by using clinoptilolite effectively (Kocaoba et al, 2007; Inglezakis et al, 2002; Inglezakis et al, 2003; Iznaga et al, 2007; Petrus et al, 2005; Sprynskyy et al, 2006). Also, it is a cheaper source and very abundant in Turkey (DPT, 1996). As a result, the main purpose of this study is determination of optimal conditions for composite alginate-clinoptilolite beads formation and then testing these beads for their ability to take copper from a synthetic wastewater. It is thought that this study might be useful in order to have a new designed and effective adsorbent for heavy metal removal by using cheaper and natural materials, one of which has major sources in our country.

Materials and Methods

Alginate was purchased and used directly. Clinoptilolite was first ground and then sieved into different sizes. The lowest size clinoptilolite (<100 µm) was selected due its possible higher surface area. It was washed with 2M NaCl solution for 1 day at 150 rpm in order to increase heavy metal uptake capacity. After that, it was washed with distilled water, then dried at 100 ºC for 1 day and stored in a desiccator.

Essentially, alginate beads are produced by pouring alginate solution drop by drop into $CaCl_2$ solution. However, there is no standard procedure for the production these beads. For this reason, 1, 2 and 4% alginate solutions were prepared and added dropwise into 50, 100, 250 mM $CaCl_2$ solutions by using a peristaltic pump under constant stirring at 50 rpm. After that these beads were incubated overnight for hardening and separated by filtration through 0.45 µm filter under vacuum by washing with distilled water. At the end, optimal concentrations for alginate and calcium ion were selected for bead preparations. This procedure was used for both alginate and alginate-clinoptilolite (1g / 1g) beads formation.

For the removal of copper, first, the efficiencies of alginate and alginate-clinoptilolite beads were compared by using 100 mg (i) alginate beads and (ii) alginate-clinoptilolite beads. These beads were added into 100 mg/L Cu^{2+} solution (100 mL in 250 mL erlenmeyer flasks) at pH 4, 25 °C and 200 rpm for 72 hours. Two samples, collected at time zero and 72 hours, were filtered through 0.45 µm filter and acidified by HNO_3. Finally, copper analyses were performed by Inductive Coupled Plasma-Mass Spectroscopy (ICP-MS).

In the second experimental set, the kinetics of copper adsorption by alginate-clinoptilolite beads were followed by using 100 mg alginate-clinoptilolite beads. These beads were added into 100 mg/L Cu^{2+} solution (100 mL in 250 mL erlenmeyer flasks) at pH 4, 25 °C and 200 rpm for 72 hours. Samples, collected at 1, 4, 8, 12, 24 and 72 hours, were filtered through 0.45 µm filter and acidified by HNO_3. Finally, copper analyses were performed by ICP-MS.

Results and Discussion

Optimization of the Procedure Used for Alginate Beads Production

Essentially, alginate beads are formed by combining two solutions under constant and gentle stirring: alginate and calcium salts. However, there is no standard procedure for the bead production. For this reason, first different concentrations of alginate and $CaCl_2$ solutions were prepared and alginate beads were formed. Second, the results were evaluated in terms of homogeneity of the beads' size, shape and hardness of the beads. For this purpose, three different alginate solutions, 1, 2 and 4 %, dropped into 50, 100 and 250 mM calcium ion containing solutions.

Alginate solution at 4 % concentration showed considerably high viscosity, probably because of its polymeric nature. In general, solution of a polymer has high viscosity particularly when the polymer has high polymerization degree. If this kind of a polymer is used at high concentration, the solution would have high viscosity. Thus, the beads formed by alginate solution at 4 % concentration had irregular shapes independent of calcium concentration. When the beads produced by 1 and 2 % of alginate solutions were compared, the ones formed by 2 % of alginate solutions were found hard enough to use in the experiments although beads formed by 1 % of alginate solutions were a bit softer.

On the other hand, there were no obvious variations between the beads formed at different calcium ion concentrations. Only the beads formed at 50 mM of $CaCl_2$ solutions seemed to have smaller and more homogenous size distribution when they were observed visually. This could also reduce the chemical usage compared to other calcium doses tested (100 and 250 mM) in the study. As a result, alginate beads were determined to produce by dropping 2 % of alginate solution into 50 mM of $CaCl_2$ solutions (Figure 1). This procedure was also utilized for the production of alginate-clinoptilolite beads.

Copper Removal by Alginate-Clinoptilolite Beads

The main goal of this study is to form a new composite alginate bead by cheaper and possibly local sources which is more effective in heavy metal uptake. Clinoptilolite is selected for this purpose since it is a low cost material with abundant sources in Turkey. Then, in order to determine the effectiveness of zeolite addition into alginate beads, first, copper removal capacities of alginate beads and alginate-clinoptilolite beads were investigated for 72 hours at constant temperature and mixing rate. Results showed that both alginate and alginate-clinoptilolite beads could remove copper efficiently from the synthetic wastewater having about 100 mg/L of Cu^{2+}. Alginate-clinoptilolite beads had higher heavy metal uptake capacity. About 20 % more copper removal could be achieved by new composite beads after 72 hours (Table 1). Therefore, there should be no diffusional limitations for copper migration due to clinoptilolite addition and functional groups of clinoptilolite appeared to be used for the exchange of copper.

Figure 1. Alginate beads produced by 2% alginate and 50 mM Ca^{2+}

Table 1. Copper removal by alginate and alginate-clinoptilolite beads

Bead type	Initial copper concentration (mg/L)	Final copper concentration (mg/L)	Removal (%)
Alginate	103.3	37.5	64
Alginate-clinoptilolite	107.5	18.4	83

Since alginate-clinoptilolite beads were found to be more efficient compared to alginate beads alone, this combination was subjected to further experiments. For these experiments, first, kinetics of copper removal by alginate-clinoptilolite beads were investigated during 72 hours. The main purpose was to determine the equilibrium time for adsorption process at which there should be no drastic change of copper concentration in the solution.

Samples were collected at previously determined time intervals and variation of copper concentration in solution is presented in Figure 2. When the results were evaluated, adsorption of copper seemed to be considerably fast onto alginate-clinoptilolite beads. For example, only after 1 hour, copper removal efficiency was reached up to 60 %. In addition, copper concentration decreased from 100 to 30 mg/L after 4 hours of incubation period while it was measured around 18 mg/L after 8 hours. Then, until 72 hours, there were no significant changes in copper concentrations. As a result, the maximum copper removal was observed around 83 % and the equilibrium time for the adsorption phenomena was about 8 hours.

Amount of adsorbed copper per mass adsorbent is an important indication for adsorption capacity. In literature, it is generally noted as q_e (mg/g), which is defined as the amount of metal adsorbed per unit mass of adsorbent. The changes of q_e are also illustrated in Figure 2. As it is shown in the figure, at the beginning, the trend is opposite to copper concentration in the solution as expected. Thus, q_e values were first increased and then it was somehow fixed through the end of the experiment. The maximum q_e value was reached around 8 hours that is corresponded to 87 mg Cu^{2+}/g alginate-clinoptilolite beads.

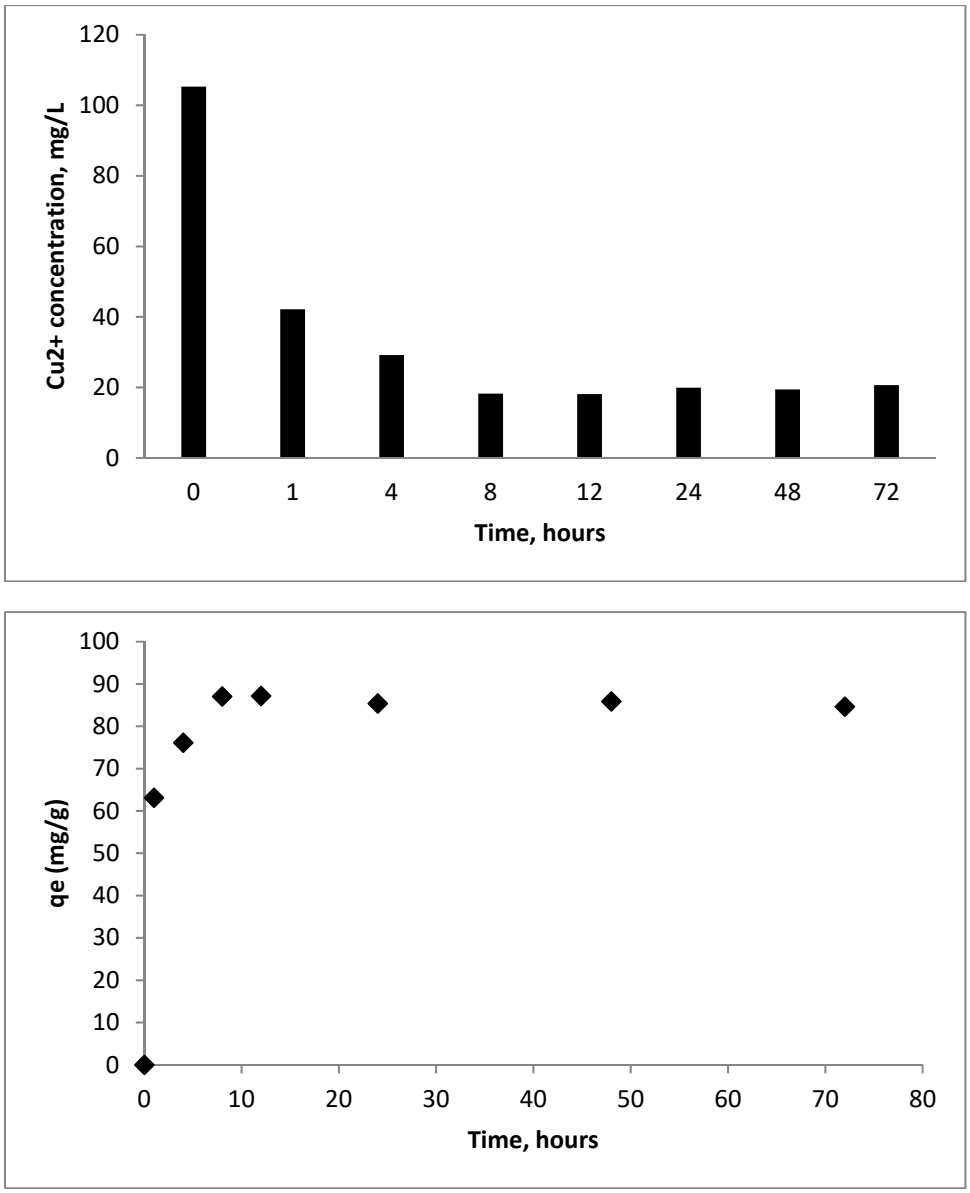

Figure 2. Changes in copper concentration and adsorption with time by alginate-clinoptilolite beads

Conclusion

Heavy metals are one of the major pollutants in industrial wastewater streams. They are required to be treated so that these metals are not harmful for the livings. Alginate – clinoptilolite beads are found to be effective combinations for heavy metal removal according to the results of the current study. These composite alginate beads can be suggested to use as alternative adsorbents since clinoptilolite is one of the local and cheaper sources in Turkey. Also, the results of the study might be helpful for further investigations particularly for column adsorption systems operated in continuous mode.

Acknowledgements

This study is funded by Scientific and Technological Research Council of Turkey – 2209/A University Students National Research Projects Funding Program.

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INFLUENCE OF MICA CONTENT ON DYNAMIC SHEAR MODULUS OF SANDY SOILS

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Abstract: The Gediz River Delta soils contain abundant flatty (platy) mica grains. Mica grains can alter static and dynamic engineering characteristics of sandy soils due to their flatty shapes. In this study, influence of mica grains on dynamic shear modulus of sandy soils in Gediz River Delta was investigated. Maximum shear modulus (G_{max}), which is a major parameter in dynamic soil response analyses, can be obtained at small deformation amplitudes. Therefore, it is determined through measurement of shear wave velocity. Shear wave velocity provide valuable information about dynamic characteristics of soils. So it is very important to determine the shear wave velocity with high accuracy for dynamic soil response analysis. In this respect, firstly engineering boreholes were drilled and sandy soil samples were recovered along the borehole depth. The mica content of the samples was determined by means of X-RD analysis method. Then test sample contain 1.5%, 10% 20% mica grains were prepared to represent the Gediz River soils. Shear wave velocity of the sand samples were determined with bender element tests under 100 kPa cell pressures in triaxial test device. Followed by the bender element tests maximum shear modules were determined. End of the test program, shear wave velocity of the dense (Dr:55%) samples were determined as 249 m/sn, 214 m/sn and 187 m/sn for 1.5%, 10% and 20% mica content respectively. Mica was reduced the shear wave velocity in considerable percentage about 25% rate. Smiler effect was observed on the maximum shear modules and it is determined as 111.6 MPa, 82.4 MPa, and 62.9 MPa for 1.5%, 10%, 20% mica contents respectively for dense samples (Dr:55%). 20% mica content was reduced the shear wave velocity about 44% rate.

Keywords: Sand, mica content, shear wave velocity, maximum shear modulus

Introduction

Soil properties especially dynamic properties are determined by the empirical relations, although there are special tests for this purpose in the geotechnical engineering. The tests have high cost and perform of the tests requires long time. For this reasons, dynamic properties of the soil are determined by means of Standard Penetration Tests (SPT), Coni Penetration Tests (CPT), and Dynamic Penetration Tests (DPT) etc. Use of the empirical relations based on SPT, CPT, and DPT may lead to error in dynamic soil response analyses for the soils which contain abundant platy grains. In this respect, an experimental study was conducted on sandy soils which are deposited by Gediz River and contain abundant platy mica grains.

The shape of the soil grains are mainly depended on their geological origin and environmental conditions. Alluvial deposits formed by the Gediz River in the west Anatolia are good examples for the soils which contains abundant platy grains. The foundation of Gediz Basin contains rocks which consist of mica minerals (Tabban, 1980) so alluvial deposits in the Gediz Basin may contain about %20 platy mica grains (Başarı, 2012).

In the literature, there are many studies about influence of grain shape on soil behaviors (Santamarina & Cho, 2004). The studies mainly focused on angularity or roundness of grains (Thevanayagam, 2007). Grain shape effects on shear wave velocity were explored by some researchers. Cho et al. (2006) conducted a series bender element tests on rounded and crushed sands. The test results of the Cho et al. (2006) are given in Figure 1. According to Cho et al (2006), shear wave velocity increase with roundness as seen in Figure 1. Shear wave velocity of rounded sand samples is higher than shear wave velocity of angular sand samples. Angularity of the sand grains cause an increase voids between the grains this effect leads to decrease in density of media which shear waves propagate in its. Also, angularity of the grains causes a decrease contact surface area between sand grains. Decreases both of contact surface area and density of media leads to decrease shear wave velocity in soil. Stresses on contact surfaces between grains have a significant role on energy transmission between grains. High stress on the contact surface creates more stable structure in soil, so energy can transferred more easily between grains. In Figure 1 mean effective stress indicates stress on contact surfaces. High mean effective stress means high stress on contact

surfaces. Therefore, increasing the mean effective stress cause an increase shear wave velocity as seen in Figure 1.

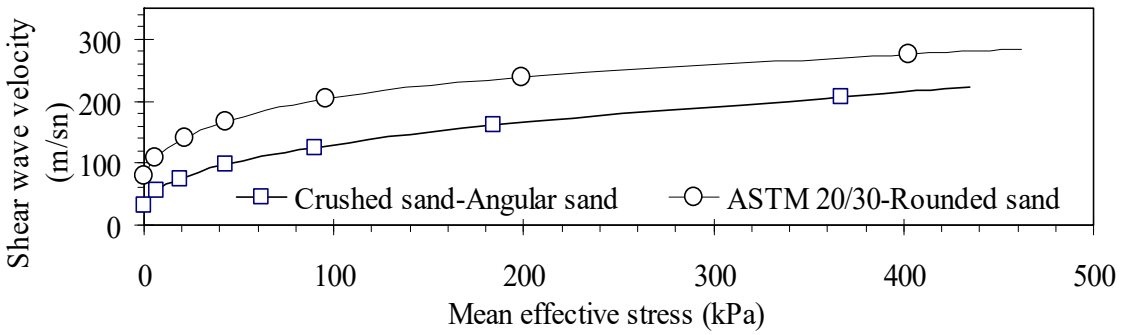

Figure 1. Roundness effect on the shear wave velocity (Cho et al. 2006).

Lee et al. (2007) explored effects of mica grain size ratio on shear wave velocity of sand. In the study, mica grains in different sizes were used. Bender element tests were conducted on samples, which were prepared in conventional oedometer cell as they were vertically loaded. Unfortunately, void ratios or densities of the samples cannot be inferred from the study. Nevertheless, mica effect on the sand samples is obvious in the study (Figure 2). As seen in Figure 2, shear wave velocity decreases with mica content for all mica grain sizes ratio.

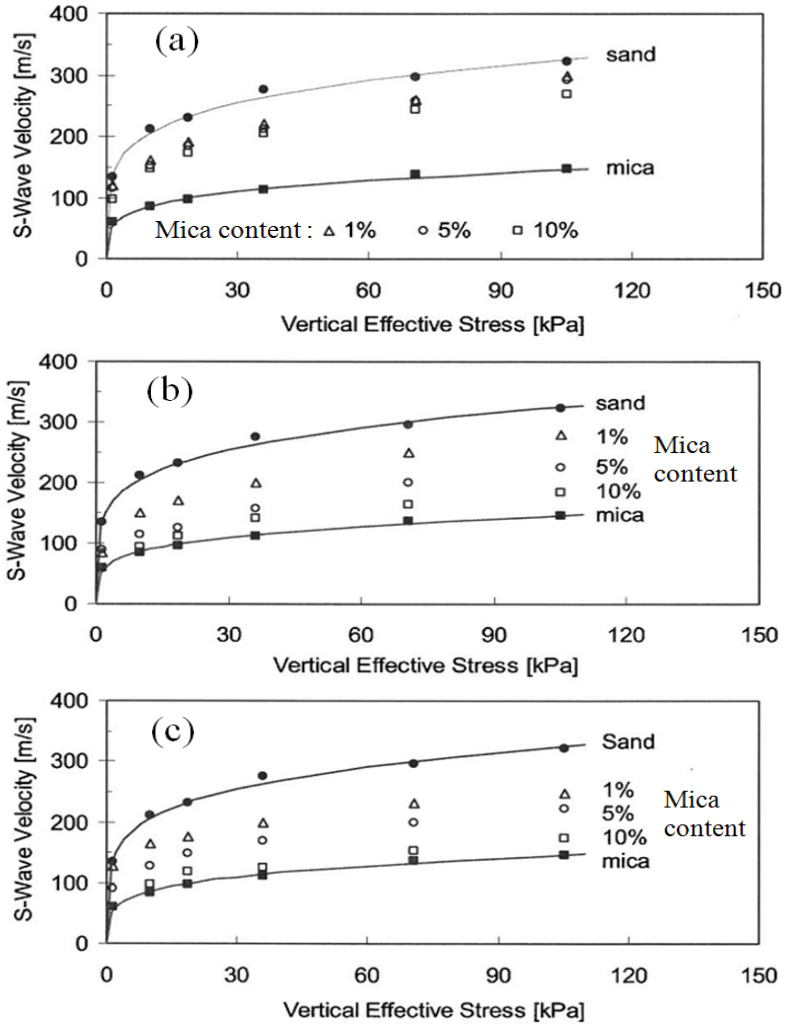

Figure 2. Mica grain size effect on shear wave velocity. (a), (b) and (c) are D_{mica}/D_{sand}=0.33, D_{mica}/D_{sand}=1.0 and D_{mica}/D_{sand}=3.0, respectively (Lee et al., 2007).

Lee et al. (2007) and Santamarina & Cho (2004) explain mica effect on the sand behavior with ordering and bridging concept (Figure 3 and Figure 4). In this concept, when size of the mica grains are equal to or larger than size of the sand grains (D_{50}-mica/D_{50}-sand 1.0), mica grains create bridges among sand grains, and increase the global void ratio. When the global void ratio increases, the strength of sand decreases while compressibility of the sand increases.

Figure 3. Possible mica-sand ordering patterns depending on orientation angle (Lee, et al. 2007).

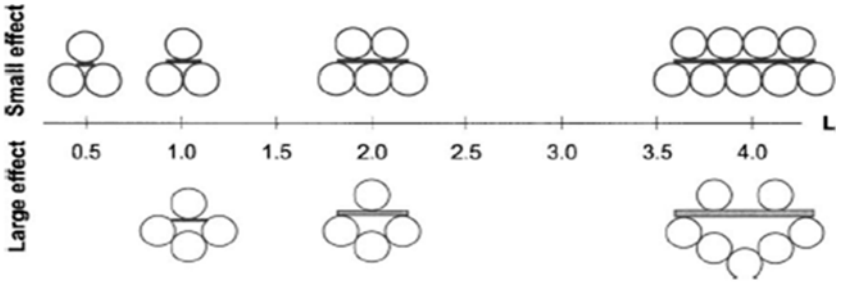

Figure 4. Bridging and ordering effects of mica plates (Lee, et al. 2007)

Materials and Methods

The test samples were taken from field (Figure 5). For this purpose boreholes were drilled in alluvial sandy soils of Gediz River Delta. Alluvial sandy materials which contain platy mica grains in test program were generally obtained from the Standard Penetration Test (SPT) spoon as seen in Figure 5. Amount of sample obtained from the SPT spoon is not enough to prepare the test sample for triaxial device. Because of this reason, the sandy samples of SPT spoons were combined then test program were conducted. The grain size distributions of the field (test samples) can be seen in Figure 5. The upper and lower bounds for the grain size of the alluvial sandy materials in Gediz River Delta are also shown in Figure 5. Diameter ratio of separated sand and platy mica grains (D_{mica}/D_{sand}) is 1.07. Coefficients of uniformity (c_u) for sand and mica grains are 1.67 and 1.64 respectively.

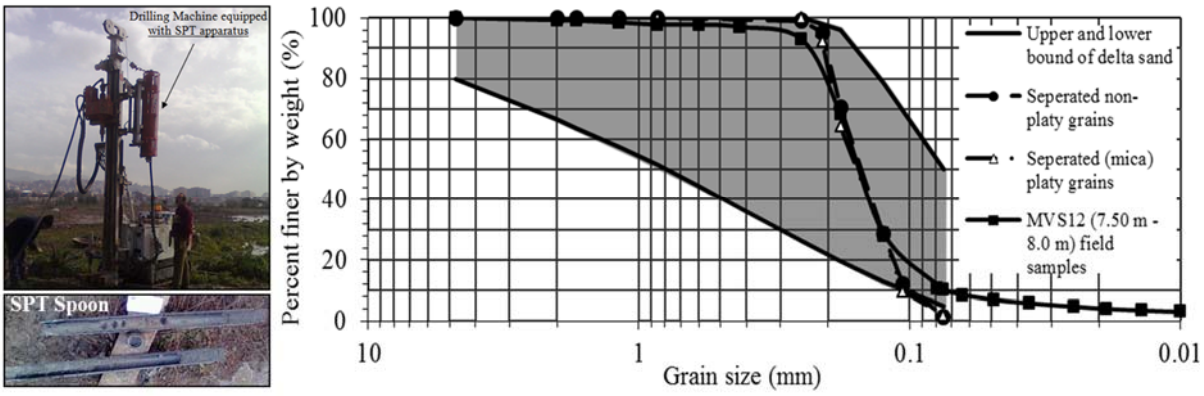

Figure 5. Field study and grain size distribution of field and test samples.

The percentage by weigh of mica minerals (platy grains) for field samples was determined by analyzing the X-Ray Diffraction (X-RD) test results (Başarı, 2012). Mica contents of field samples were determined as %5 - %20. Then mica flakes and rounded sand grains were separated from each other by flotation technique (Geredeli & Özbayoğlu 1995). Separated rounded sand grains and mica flakes were mixed in certain percentage for prepare

test samples. Test samples were prepared at three different mica contents (1.5%, 10%, 20%) by weigh and three different relative densities (30%, 55%, 80%).

Maximum shear modules (G_{max}) of the test samples were determined helping with Equation 1. Shear wave velocity (V_s) of the samples were determined with bender element test. Bender element tests were conducted on triaxial test samples under 100 kPa confining pressure (cell pressure).Triaxial test samples were prepared with moist tamping method (Ishihara, 2003). Diameter and length of prepared samples are 70 mm and 140 mm respectively. Before the bender element test, test samples were saturated and isotopically consolidated under 100 kPa confining pressure. Saturation degree of the tests samples was determined with B value. B values of the all samples are equal or higher than 0.95.

$$G_{max}=\rho V_s^2 \quad (1)$$

Bender element test device consists two piezoelectric tips, signal generator and oscilloscope. One of piezoelectric tips is called transmitter and other tips is called receiver. Transmitter converts electric signals to waves, receiver converts waves motion to electric signals. Travelling time of shear waves in soil sample is determined as illustrated in Figure 6. Wave velocity within the soil is found by dividing the distance between bender element tips to the travelling time. In the bender element test program, amplitude of the used signal was 20 mV.

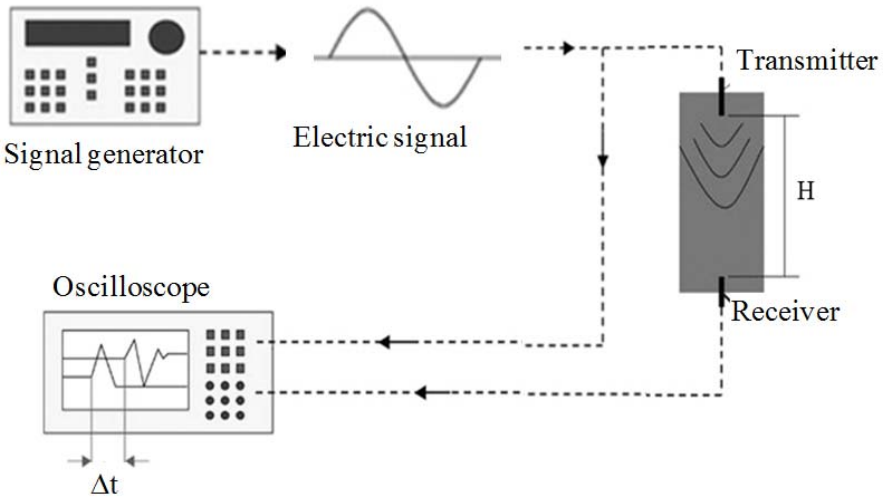

Figure 6. Illustration of bender element test.

Tests Results

Shear wave velocities of soil samples at different mica contents, prepared at relative density values between loose, dense and very dense states, were measured via bender element tests as described above. Samples were set up at 1.5, 10 and 20% mica content. Size ratio of mica and sand (D_{mica}/D_{sand}) grain is 1.07. One of the recorded signals from bender element tests and measured shear wave velocity (V_s) are presented in Figure 7.

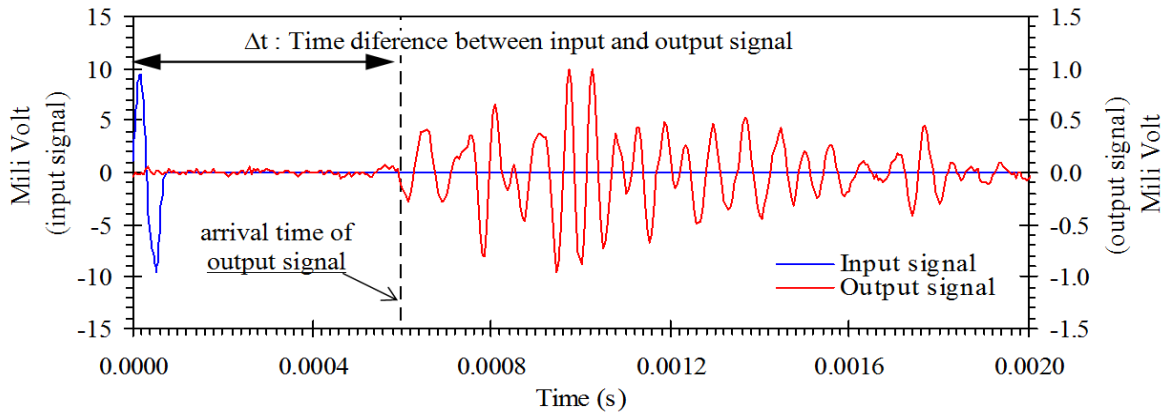

Figure 7. Recorded signals during bender element test.

Test results for shear waves (V_s) presented in Figure 8. Changes of shear wave velocity corresponds to the mica content given in Figure 8.a. Effects of the relative density on shear wave velocity is shown in Figure 8.b. Maximum shear modules (G_{max}) can be seen in Figure 9. Maximum shear modules calculated helping with Equation 1 as seen in Figure 9.a and Figure 9.b. As expected mica and relative density have similar effect on shear waves velocity and maximum shear modules. Both of shear wave velocity (V_s) and maximum shear modules (G_{max}) decrease with increasing of mica content. When the Figures 8 and Figure 9 are carefully examined, it can be seen that relative density can change influence of mica content on shear wave velocity and maximum shear modules.

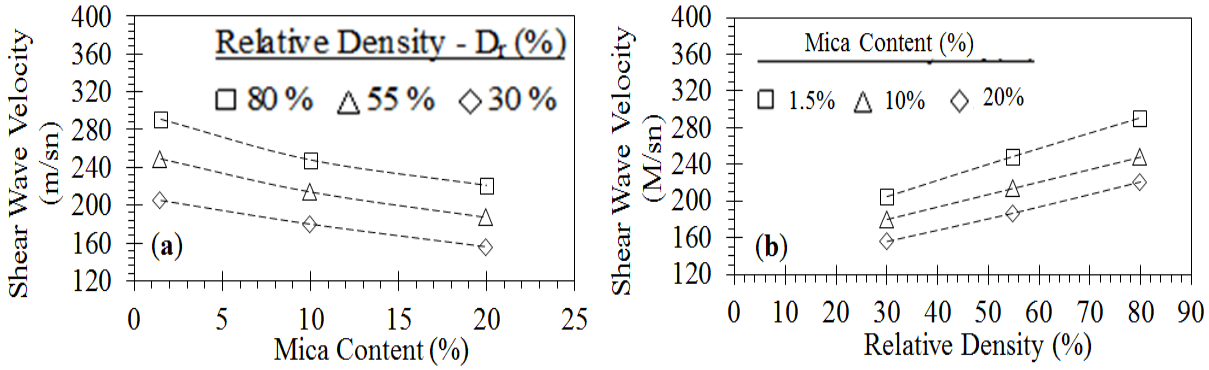

Figure 8. Effects of Platy mica grain and relative density on shear wave velocity.

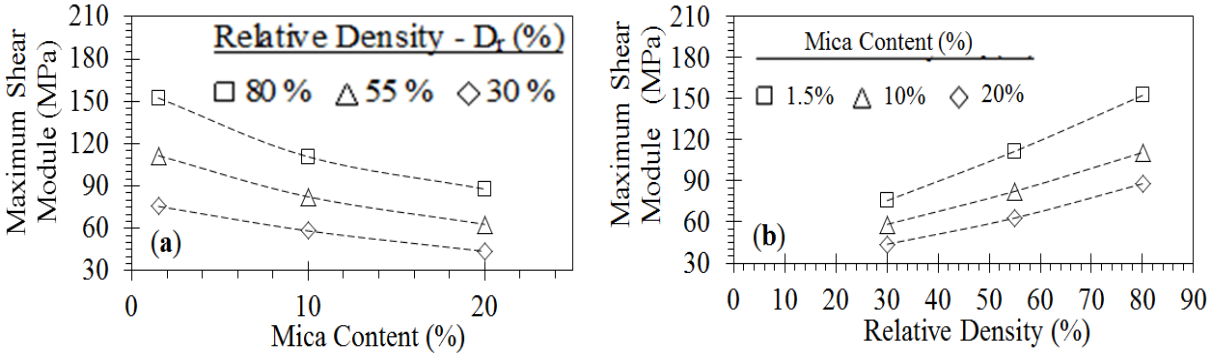

Figure 9. Changing of the maximum shear modules with mica content and relative density.

Conclusion

In this experimental study, the effects of the platy mica grains, on shear waves and maximum shear modules of the sandy soils within the liquefaction depth (20 m) of the study area have been researched.

Soil samples that were recovered from the study area were used in the testing program. Apart from the present study, dynamic experimental studies regarding the Old Gediz River Delta are scarce. Therefore, the findings of this study have significant importance since they will be informative and advisory for future researches to be conducted on the sandy soils of the area.

Platy mica content of the soils within the study area was determined down to 20 m from the surface. Soils of the survey area contain platy mica mineral ranging between 5% and 20%. Such mica content for sandy soils may be sufficient to change major engineering properties especially dynamic properties of the sandy soils. In order to estimate soil behavior correctly, mica content of the sandy soils were studied in detail.

Influence of platy mica grains on shear wave velocity and maximum shear modules were observed during bender element tests. For all mica contents, shear wave velocity and maximum shear modules decrease as relative density and effective confining pressure decreases. It was noticed that shear wave velocity and maximum shear modules were inversely proportional with mica content

Test results shows that, small amount of mica can change shear wave velocity and maximum shear modules of sandy soils. As seen in Figure 8 and Figure 9, when the mica content increases 1.5% to 20%, maximum shear modules decreases 111.6 MPa to 62.9Mpa for dense sand (Dr:55%). Maximum shear modules were decreased about 43.6% rate. Similar effects were observed loose (Dr:55%) and very dense (Dr:80%) sands. When the mica content increases 1.5% to 10%, maximum shear module decreases about 42.1% and 42.3% for loose and very dense sand respectively. An increasing about 10% in mica content caused to decrease in maximum shear modules about 22.9%, 26.1% and 27.4% rates for loose, dense and very dense sand respectively. Shear wave velocity is effected similarly by the platy mica grains. Increasing of platy mica grain contents caused a diminish in shear wave velocity as seen in Figure 8. 10% and 20% mica content caused diminishes about 12~15% and 23~25% in shear wave velocity respectively.

Platy grains have considerable effects on dynamic properties of the sandy soils. Ignoring the effects of platy grain on the sandy soils leads to significant errors in dynamic soil response analyses and other dynamic analyses. Empirical relations should not be used for estimation of soil parameters which contain platy grains.

Acknowledgements
The authors are grateful to the support of The Scientific and Technological Research Council of Turkiye (TUBITAK) provided in the scope of research project 106G159. Also the authors are grateful to the support of TUBITAK-BIDEB and ULAKBIM. We would like to thank TUBITAK for all their supports.

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INFLUENCE OF TEACHER'S PERSONAL FACTORS AND ORGANIZATIONAL CHANGE STRATEGY ON TEACHER EVALUATION FOR PROFESSIONAL DEVELOPMENT IN ELEMENTARY SCHOOLS

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Abstract: The main purpose of this study was to research the influence of teacher's personal factors and organizational change strategy on Teacher Evaluation for Professional Development (TEPD) in elementary schools. According to the literature reviews in influence of teacher's personal factors and organizational change strategy on TEPD, using TEPD Influence Factor Scale as the research tool, targeting elementary school teachers. There are 299 effective samples. With AMOS processing CFA to choose the best model, and further its reliability and validity were tested. Results showed that the model fits, and its goodness-of-fitness conformed to standard. It can prove that teacher's personal factors have influences on the TEPD with causal relationship and organizational change strategies intervening variables effect are significant. We suggest that education institution can notice this issue in order to enhance the efficiency of the TEPD paper is a report on the findings of a study conducted on a graduate level virtual conference summer school course. Discourse analysis techniques were used to examine the resulting transcript of texts for evidence of a democratic discourse within a community of learners. Findings indicate that gender is not masked in the text driven discussions on the Internet. Distinctive discursive styles are often sex class linked. Like face to face or classroom contexts, status is accorded unequally within discourse communities. Participants are not equal and are not equally attended or responded to. Educators need to take a serious and wary approach to accepting claims of ensured democratic participation in computer mediated communication formatted classes.

Keywords: teacher's personal factor, organizational change strategy, Teacher Evaluation for Professional Development, confirmatory factor analysis

Introduction

1. Research Background and Motives

A teacher plays an important role in ensuring the teaching quality and students' learning effectiveness in school (Tucker & Stronge, 2005). Nowadays, each country is committed to improving teachers' quality and promoting teachers' professional knowledge and teaching skills, and their main practice is to apply teacher evaluation which can enhance teachers' professional literacy and promote teachers' professional career development to improve education achievements (Avalos & Assael, 2006; Danielson, 2001). Therefore, the establishment of appropriate teacher evaluation system can improve teachers' quality and working performance and highlight teachers' professionalization, and it is also the only effective method to ensure teachers' dignity and social status (Yen, 2003).

Many researches suggest that teacher evaluation is an important method to increase teachers' professional development, and it is also an important mechanism to guarantee students' achievement (Sun, 2008). In order to respond to the highly expectation from all works of life to education quality, Ministry of Education ever listed "establishment of teacher evaluation mechanism and improvement of teachers' teaching performance" and "improvement of the current performance appraisal system of elementary and secondary school teachers and the enhancement of teachers' professional performance" into the discussion outline "in the meeting on education reform review and advancement in 2001" (Ministry of Education, 2001). In September 2003, in the meeting on national education development, Ministry of Education draws a conclusion to especially formulate "the implementation essentials on the handling of teacher evaluation for professional development with the subsidy of

Ministry of Education", so as to assist in teachers' professional growth, increase teachers' professional literacy, improve teaching quality and increase students' learning achievements. With the premise of teachers' voluntary participation, a three-year "pilot subsidy scheme on teacher evaluation for professional development" has been promoted since 2006 to courage school to participate in pilot scheme (Ministry of Education, 2006). Pilot scheme has been changed into normal scheme since 2007, and "the implementation essentials on the handling of teacher evaluation for professional development with the subsidy" are published, with the purpose of promoting the professional development of elementary and secondary school teachers and enhancing students' learning achievements through normal handling of teacher evaluation for professional development (Ministry of Education, 2014).

The scheme on teacher evaluation for professional development has been promoted for nearly 10 years in Taiwan. In 2016, there are 1,441 elementary schools participating in pilot scheme, accounting for 54.5% of all elementary schools in Taiwan, with 29,493 participating teachers, accounting for 29.91% (website for teacher evaluation for professional development, 2015); the continuous growth in the number of participating schools and teachers shows that teachers can gradually accept and participate in teacher evaluation for professional development, but there is still room for improvement. Executive Yuan has passed "Amendments on some Articles in Teacher's Law" to bring the teacher evaluation in senior high school and below into law, which has entered into the second reading program of Legislative Yuan (Chiu and Lin, 2012). In order to avoid falling into the same old trap of poor effectiveness in education reform in Taiwan, it is necessary to discuss the factors influencing teacher evaluation for professional development, which can be used as reference for future implementation schools and help to promote teacher evaluation policy and achieve the goal of evaluation.

Teacher evaluation for professional development is one of the important education policies at present and is critical to the significant organizational change of schools. During the implementation of this significant policy, the proper organizational strategies are required to be put forward, and meanwhile teacher's personal factors should also be considered, so that organizational stability and development can be achieved. Wu (1999) indicates that teacher evaluation process is a part of teacher's personal development and administrative reform of school. With teacher's personal factors and organizational change strategy as pointcut, this research first collects data and then applies confirmatory factor analysis to analyze the influence of above-mentioned two factors on implementation effectiveness of teacher evaluation for professional development in elementary schools. Thus, it will help to implement teacher evaluation for professional development in elementary schools and put forward feasible improvement strategies.

2. Research Purposes

According to the above research background and motives, the main purpose for this research is to know about the influence of teacher's personal factors and organizational change strategy on implementation effectiveness of teacher evaluation for professional development; with the technology of Structural Equation Modeling as theoretical verification tool, the goodness of fit for the model "influence of teacher's personal factors and organizational change strategy on implementation effectiveness of teacher evaluation for professional development" is tested to further understand its direct and mediating effect.

Literature Review

Teacher evaluation for professional development is the policy scheme promoted strongly by Ministry of Education in recent ten years, and will also bring significant organizational change in schools. This research will verify the influence of teacher's personal factors and organizational change strategy on implementation effectiveness of teacher evaluation for professional development, and the relevant literature review is as follows:

1. Teacher's personal factors

(1) Teacher's demand and attitude. The demand for teacher's professional development comes from the perceived role gap between "reality" and "ideality" (Sun, 1997); Chang and Lin (2006) points out that in order to respond to the implementation of new curriculum and policies of teaching and evaluation, teachers need professional development to increase confidence and self-efficacy and to understand the weakness in their profession and demand and connotation for professional growth through teacher evaluation for professional development, so as to improve teacher's professional status. Castle and Aichele (1994) think that intrinsic motivation is the important kinetic energy to promote teacher's continuous professional growth, and the teacher's consciously professional development demands his personal education idea and professional awareness to generate internal driving force for the pursuit of professional growth; Beerens (2001) also indicates that the best method for teacher's professional development is the initiative pursuit based on intrinsic motivation and demand. In addition, for instance, a teacher can sort out teaching files and data systematically due to being the national education

guidance group members, so as to understand his own profession degree or strengths and weaknesses in teaching through sharing and counseling the teacher's teaching process (Chang and Lin, 2006).

This research discusses the teacher's demand for professional development as well as his attitude towards teaching and evaluation to understand the influence of this factor on the implementation effectiveness of teacher evaluation for professional development.

(2) Teacher's concerns. Discussion on teacher's concerns originates from the "concerns theory" of Fuller (1969). "Concerns" mean that one person tries to do something under the expected situation or has the tendency of trying to do something under other special situations. Concerns can be said to be the motive power of action, while action is the result of concerns (Sun and Chen, 2007). Fuller divides teacher's concerns into three phases: 1) Self-concerns phase: teacher concerns whether his own performance in teaching ability and role play is competent and affirmed. 2) Task-concerns phase: teacher concerns the environmental factors of teaching and how to achieve teaching task, such as routine of school-room, teaching material resources, working atmosphere, etc. 3) Impact-concerns phase: teacher concerns students' learning process, emotional demand, social development, etc. In her opinion, teacher's concern for teaching is a kind of demand and also the learning motive. Following the research into teacher's concerns for teaching, Hall and Hord (1987, 2001) propose "Concerns-Based Adoption Model" (CBAM) to divide teacher's concerns into 7 development phases: awareness, information, personal, management, consequence, collaboration and refocusing, and their integrated viewpoints are shown in Table 1.

Table 1: Characteristics of teacher's concerns in each phase

Phase	Name	Characteristics
	Awareness	Rare concerns for or participation in innovation.
	Information	Having a preliminary understanding of innovation and wishing to understand more contents about innovation.
	Personal	Aimed at the conflict between innovation and existing school structure, innovate in contradictions between the responsibilities needing to be shouldered now as well as in the connotation of their own and colleagues' treatment and status, and consider it deeply.
Task-concerns	Management	Concerns focus on implementation process and work of innovation as well as the best method for information and resource usage, especially the concerns for the requirements for working efficiency, organization, management, plan and time limit.
	Consequence	Concerns for the influence of innovation on students, focusing on the applicableness of innovation on students, evaluation for students' learning achievements and change demands for students' performance gains.
	Collaboration	Concerns for how to coordinate and cooperate with others during the implementation of innovation.
	Refocusing	Concerns for searching more wide benefits from innovation, including discussion on significant change or feasibility of being replaced by another innovation; individuals have other schemes or more specific ideas for selection or innovation.

Source: revision by Hall & Hord, 1987, NY: State University of New York Press, p.60.

Hall and Hord (2001) think that in spite of respective characteristics in each development phase, they are not mutually exclusive with each other and have the relationship of dynamic change. That is to say, a teacher may have concerns for different development phases simultaneously in the certain time, where the greatest concerns will change due to the implementation of change. With the time going, the change participants' concerns for change will change for being affected by personal experience, knowledge, impressions and the attitudes towards participation degree in change. The opinions of teacher's concerns imply the problems facing them, the assistance required and psychological resistance to innovation (Hall & Hord, 1987; Hall & Shieh, 1998); it also shows that the input and commitment of organizational members and requires the change agent to provide effective support and intervention. Thus, this research discusses the above-mentioned 7 kinds of teacher's concerns.

2. Organizational change strategy

From the perspective of organizational change theory of Kurt Lewin, teacher evaluation for professional development implemented in elementary schools can be divided into 3 phases of strategy dimensions of unfreezing, action and freezing, and the discussions are as follows:

(1) Strategy in unfreezing phase

1. Inspiration of change demand: Jackson (2000) and Kotter (2007) think that if organizational members have high degree of self-satisfaction, they will have lower interest in participating in change; in the case of lacking incentive factors, the change work will become more difficult. Successful changes mainly originate from that individual or team begins to seriously think about organizational competition situation and pays attention to potential crisis. Therefore, Kotter (2007) puts forward that the top priority is to establish crisis awareness among the 8 steps of change leadership. The promotion of organizational change requires the highly cooperation of organizational members, and the inspiration of change demand through crisis awareness is related to the cooperation degree of change action, so how to develop members' demands for organizational change and cultivate crisis awareness are the indispensable methods. By means of crisis awareness, the potential crisis and opportunity appearing in organizations are found out, or with the understanding of market competition situation and organizational status, organizational members are promoted to reflect on their own situation to increase their commitment to organizational change.

2. Analysis of change environment: Chen (2003) and Hsieh (2004) indicate that the resistance of school organizational members to the promotion of teacher evaluation change for professional development should be eliminated in unfreezing phase, so as to shape the organizational culture in favor of change. During the promotion of change scheme, the positive driving force in favor of change and negative driving force going against change are bound to appear. Fidler (1996) thinks that school organization has 3 important jobs in this phase: they are respectively presenting the evidence of organizational problems, linking organizational problems and school goals to trigger teachers and administrative staff's anxiety and motivation and presenting the possible solving strategies. In other words, in order to eliminate the adverse factors for the promotion of teacher evaluation for professional development in unfreezing phase, schools should analyze the adverse environment factors and make students know about them, so as to formulate solving strategies in combination with school goal.

(2) Strategy in action phase

1. Organizational change team: Keyton (2005) indicates that the premise for school's promotion of change is that school must formulate change scheme according to organizational characteristics, and the expectation of students, teachers and administrative staffs, community and parents, and really carry out the action strategy of change. Yukl (2002) further indicates that organizational working scheme and promotion process need powerful force, and it is certain that the work will not be completed with only one-man force. The establishment of a powerful change team is the indispensable factor of organizational change and transformation for change team, and its team members must have mutual trust and common goal; only if the team members have the aspiration to pursue common excellent goal, the true collaboration will occur.

2. Construction of shared vision: organizational shared vision is one of the key factors for the success of organizational change (Hall & Hord, 2001), as organizational vision has three roles: clarifying the direction of organizational change, inspiring organizational members to adopt proper action towards the correct direction and rapidly and effectively organizing members to coordinate each other's action. Vision is just like an image presenting the future and provides an open or implicit explanation for the future that partners are try best to create. Keyton (2005) further points out that the formation of vision relies on the effective communication and coordination between change leaders to reach a consensus; the team's change cognition is increased and teacher's personal goal and organizational goal are integrated through the process of whole staff's participation, so as to improve school organizational change efficiency.

3. Inspiration of change and innovation: for individuals, team or organizations, change often goes along with pains and difficulties (Torres & Preskill, 2001), which may cause individual's sense of anxiety for the uncertainty of future or the resistance to organizational structure inertia or team inertia to threaten the existing power relation (Robbins & Judge, 2007). Therefore, the method of inspiring change and innovation or reducing the resistance to change can be adopted, such as, increasing staff's participation and communication to enhance identity and support, intensifying staff's educational training, adopting material and spiritual reward and counseling and step by step method (Wu, 1999). In addition, relevant researchers indicate that the external incentives and motivations are also extremely important factors; in particular, the factors of peer influence and invitation of directors hold a majority (Li, 2007; Hung, 2007; Chen and Lo, 2011).

4. Enhancement of teacher's empowerment: with teacher's professional development as the main guidance, teacher evaluation for professional development aims to assist teacher in professional growth and increase teacher's professional literacy and improve teaching quality. If school operator can construct a platform where teachers can give full play to their expertise and potential and are willing to share, so as to apply the concepts of teaching leadership, teacher leadership and other distributed leadership for fully empowerment and hierarchical

responsibility, the members can be inspired to implement change and innovation to effectively achieve organizational goal (Li, 2003; Lin, 2011; Chang, Chou, and Li, 2011) and realize the functions of teacher empowerment.

(3) Strategy in freezing phase

According to Kurt Lewin, organizational change theory means that establishment of a certain program can make the new action and operation continue and original state will no longer recover, so that the effectiveness obtained in promotion phase is steadied and retained (Hall & Hord, 2001). Only when change is transformed into organizational culture and integrated into the blood of organizations, change can last for long. (Kotter, 2007).

1. Timely review and improvement: after the evaluation for the effectiveness of change, the evaluation results must be fed back to organizational members for the revision of change strategies; with the methods of reward system, resource support, positive reinforcement, etc, the change scheme will become the formal organizational planning to retain the change effectiveness for a long term. After the change (no matter whether it is change in organization, individual or team and technology) lasts for some time and can achieve the change goal of school organizations, it must be institutionalized and formalized to retain the change effectiveness for long, so that organizations will return to the stable and balanced state, i.e. the organizational institutionalization and the permanence of new action of organizational members (Hall & Hord, 2001).

2. Shape of organizational culture: organizational culture is the code of conduct and shared value of organizational members; during the shape of change culture, it is necessary to let members know about the new practice and action to improve performance and guarantee the consistence of supervisor's words with his action (Yen, 2003; Kotter, 2007); if members can clearly see and affirm the effectiveness of change, they will further vigorously advocate the effectiveness of change. In case of the combination between organizational change and organizational culture, organizational members can not only observe the system of organizational change, but also can accept the idea of organizational change heartily (Kotter, 2007).

Therefore, the effectiveness of teacher evaluation for professional development lies in whether organizational members can timely make the review and improvement, so that change scheme will become the common rules of organizational members and be shaped into organizational change culture to retain the effectiveness of organizational change for long.

3. Relationship between teacher's personal factor, organizational change strategy and teacher evaluation for professional development

Tseng (2006) thinks that teacher evaluation for professional development refers to the "formative evaluation" for teacher's profession; during the process of change, teachers are helped to understand their own strengths and weaknesses in teaching or where it can be better and proper help are provided for teacher's growth, so as to promote teacher's professional development and improve teaching quality. Hung and Hsieh (2007) hold that teacher evaluation for professional development refers to the teaching evaluation with the aim of enhancing teacher's professional development. With the teacher's profession as principal axis, this evaluation emphasizes the teacher's initiative participation; a set of systematic evaluation indictors is used to carry out teacher's self-evaluation and intramural evaluation, and evaluation results can assist teachers to understand the strengths and weaknesses in teaching and its reasons and can be used as the basis for the arrangement of teacher's training or enhancement of professional knowledge and skills. Based on the Taiwanese research, it is found that teacher's initiative, personal motives and attitude are all the influence factors promoting teacher's professional development (Chen and Jiao, 2009; Li, 2002). Goodson (2001) emphasizes that the educational change should not only consider the organizational internal affairs and external relationship, it should also consider the balance between personal factors. In the analysis of change, personal transformation should be put to the top; only when teacher's personal input is considered as the motives for change and its necessary goal, educational change can achieve the greatest effectiveness. Lin (2007) thinks that the implementation process of teacher evaluation for professional development is affected by social opinions, teacher culture, economic factors, structure, politics and other environment factors. According to Chang, Chou, and Li (2011), the influence factors for teacher evaluation scheme for professional development focus on 3 items of teaching leadership, teacher culture and external environment.

School organizations are characterized by bureaucracy system and loosely coupled dual system and belong to domesticated organization (Qin, 2000), so it is more difficult to promote organizational change in schools compared with general business establishments. Since 2006, Ministry of Education has promoted and encouraged

teachers below high schools and higher vocational schools to voluntarily participate in evaluation scheme for professional development; it is hoped to assist in teacher's professional growth, increase teacher's professional literacy, enhance teaching quality and increase students' learning achievements through the promotion of this scheme. According to Owens (1995), in face of the change of internal and external environmental factors, in order to achieve the sustainable development in school affair and improve education quality, the school authority will certainly master school organizational characteristics and change focus and adopt good coping strategies for organizational change.

RESEARCH DESIGN AND IMPLEMENTATION

1. Research Subjects

According to the data provided by website for teacher evaluation for professional development (2015), aimed at the schools selected by each county and city to implement teacher evaluation for professional development in elementary schools, stratified random sampling was used for test according to the proportion of teachers in elementary schools participating in teacher evaluation for professional development in northern, middle and southern district; after deducting the samples with incomplete answers and the samples answered by teachers without the experience of participating in evaluation, 299 valid samples were obtained.

2. Research Tools

This research adopted "scale on influence factors of teacher evaluation for professional development implemented in elementary schools" (Su, 2014) as the tool, and the measurement items in this scale has been treated as follows in trial test: 1. With the adoption of extreme value test method, trial test samples are divided into two groups by 27% before and after trial test samples; with the significant difference of the two as discrimination degree, items without discrimination degree are deleted; 2. With the use of correlation analysis method of items and total scores, items where the correlation coefficient between item and total scores is smaller than 0.3 and the Cronbach's α coefficient will increase after the deletion are deleted; 3. According to the suggestions of Hair, Anderson, Tatham and Black (2009), items where commonality is smaller than 0.5 are deleted. The scale on "teacher's personal factors" covers teacher's personal demand and attitude (attitude towards teaching and demand for professional development) and teacher's concerns (awareness concerns, information concerns, personal concerns, consequence concerns, collaboration concerns, refocusing concerns), with a total of 8 factor dimensions and 25 items. Bartlett's sphericity test of dimensions is significant, KMO value is 0.939, dimension explanation quantity is 82.30% and Cronbach's α coefficient is 0.931. The scale on "organizational change strategy" is divided into 6 potential factors: inspiration of change demand, analysis of change environment, organizational change team, construction of shared vision, inspiration of change and innovation, enhancement of teacher's empowerment, with a total of 27 items. Bartlett's sphericity test of dimensions is significant, KMO value is 0.942, dimension explanation quantity is 84.230% and Cronbach's α coefficient is 0.944, indicating the good reliability and validity in this questionnaire, so it can be used to discuss the influence of organizational change strategy on implementation effectiveness of teacher evaluation for professional development.

3. Research Method

Through literature review and integration, this research constructs the research structure of teacher's personal factors and organizational change strategy (Figure 1), and applies the structural equation modeling software Amos for confirmatory factor analysis (CFA) to confirm the goodness of fit of this structural modeling.

By referring to Bagozzi and Yi (1988), Jöreskog and Sörbom (1996) and Hairet al. (2009), this research uses the indicator of overall goodness of fit, including (a) the chi-square value of absolute index ($\chi 2$), ratio of chi-square and degree of freedom ($\chi 2/df$), fit index (GFI), root mean square residual (RMR) and root mean square error approximation (RMSEA); b. incremental fit index of incremental index (IFI) and comparative fit index (CFI); c. Parsimony Goodness Of Fit Index (PGFI) after the parsimony and adjust for parsimony index and Parsimony Normed Fit Index (PNFI) to gain compact model.

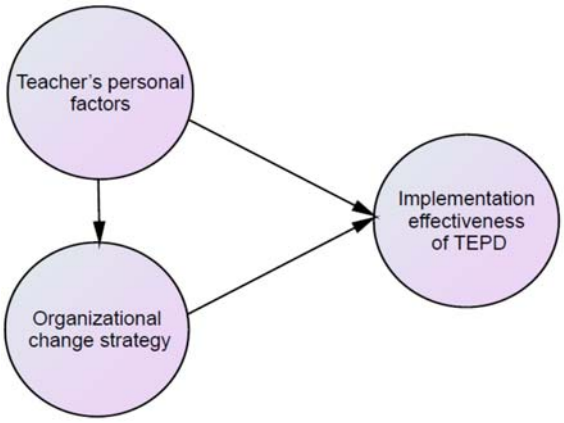

Figure 1. Structural Equation Modeling

RESEARCH RESULTS AND ANALYSIS

1. Goodness of fit test for the modeling of teacher's personal factors

This research uses 299 valid samples to carry out the SEM analysis, and there are totally 8 observation variables in teacher's personal factors (see Figure 2), degree of freedom 8* 9/2=36, with a total of 8 residual errors; with the addition of 1 variance and 7 factor loadings, the degree of freedom is greater than estimated parameter, so the modeling belongs to over identification, conforming to the requirements of positive definite model in theory. The factor loading of the 8 observation variables after CFA is greater than 0.5, but the residual errors of 3 observation variables of collaboration concerns, personal concerns and information concerns are not independent. Due to the compact modeling and the violation of the principle of residual error independence, 5 observation variables are retained after these 3 observation variables are deleted. Each factor loading is as follows: attitude towards teaching is 0.65, demand for professional development is 0.87, awareness concern is 0.6, consequence concern is 0.69, and refocusing concern is 0.76 (see Figure 3).

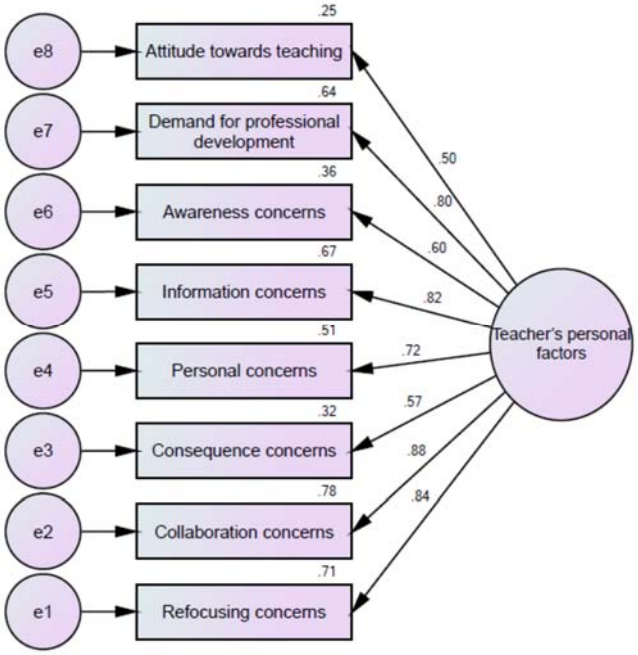

Figure 2. Dimension of teacher's personal factors

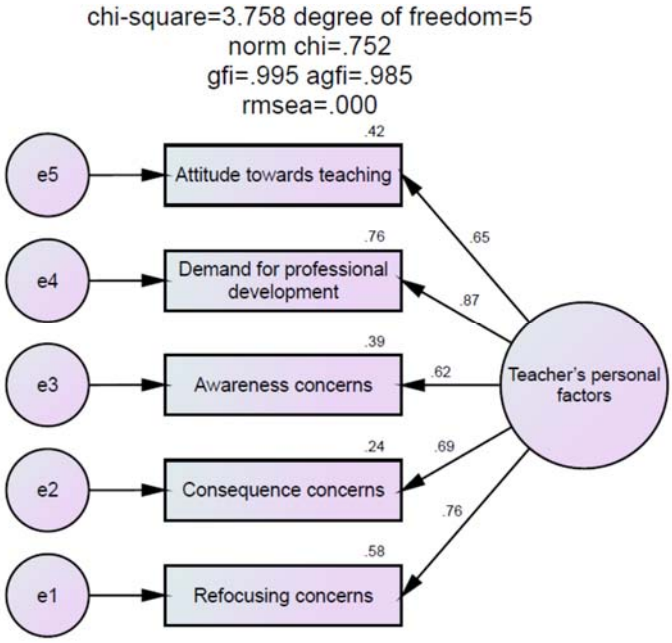

Figure 3. Dimension of teacher's personal factors after cfa

After deleting observation variables, PGFI=0.332 is smaller than suggestive value 0.5, and the reason may be that the item similarity is too high, causing the lower statistics of this index; other absolute fit index, incremental fit index and PGFI all get the ideal value, and the index within the evaluation index is greater than suggestive value, indicating that this modeling has good goodness of fit (See Table 1); the composite reliability of this dimension is (CR value) is 0.884, average variance extracted (AVE) is 0.524, and both of them are greater than suggestive value.

Table 2: Each goodness of fit index and statistics for the dimension of teacher's personal factors

Goodness of fit		Statistics	Suggestive value
	χ^2	3.758	The smaller, the better
	df	5	
	χ^2/df	.752	<3
	GFI	.995	
	AGFI	.985	
	RMR	.009	
	SRMR	.0181	
	RMSEA	.000	
	NFI	.991	
	NNFI	1.006	
	CFI	1.0	
	RFI	.983	
	IFI	1.00	
	PGFI	.332	
	PNFI	0.50	
	CN	878	>200

2. Goodness of fit test for the modeling of organizational change strategy

There are totally 6 observation variables in organizational change strategy (see Figure 4), degree of freedom 6* 7/2=21, with a total of 6 residual errors; with the addition of 1 variance and 5 factor loadings, the degree of freedom is greater than estimated parameter, so the modeling belongs to over identification, conforming to the requirements of positive definite modeling in theory. The factor loading of the 6 observation variables after CFA is greater than 0.5, but the residual errors of observation variable of "inspiration of change demand" are not independent. Due to the compact modeling and the violation of the principle of residual error independence, 5 observations are retained after this observation variable is deleted. Each factor loading is as follows: inspiration of change and innovation is

0.70, analysis of change environment is 0.83, organizational change team is 0.72, construction of shared vision is 0.83 and enhancement of teacher empowerment is 0.77(see Figure 5).

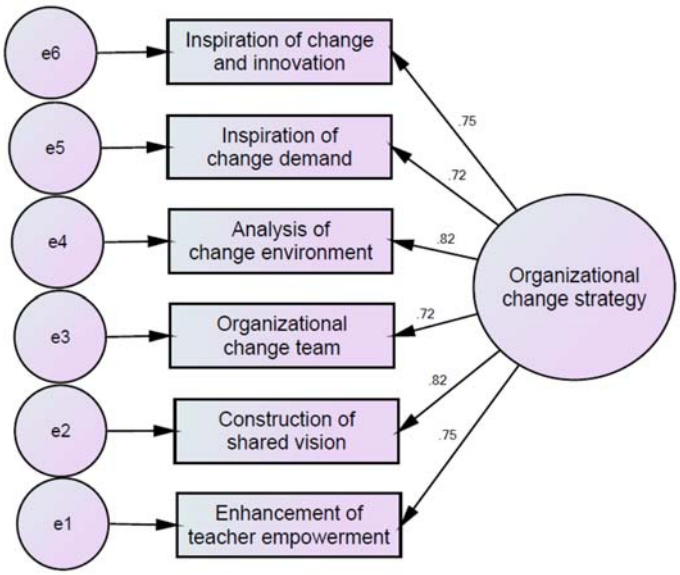

Figure **4.** Modeling of dimension of organizational change strategy

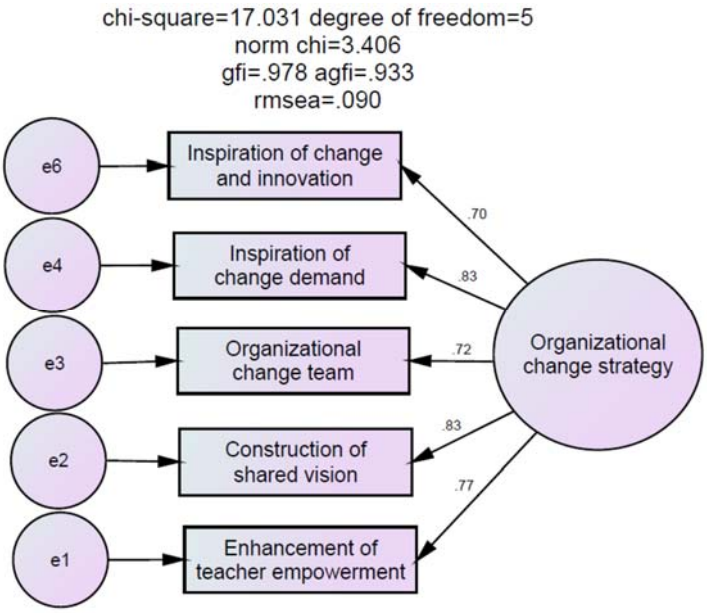

Figure 5. Modeling of dimension of organizational change strategy after cfa

Table 3: Each goodness of fit index and statistics for the dimension of organizational change strategy

Goodness of fit		Statistics	Suggestive value
	χ^2	17.03	The smaller, the better
	df	5	
	χ^2/df	3.406	<3
	GFI	0.978	
	AGFI	0.933	
	RMR	0.008	
	SRMR	.0266	
	RMSEA	0.009	
	NFI	0.977	
	NNFI	0.967	
	CFI	0.984	
	RFI	0.955	
	IFI	0.984	
	PGFI	.326	
	PNFI	0.499	
	CN	264	>200

3. Effect analysis between potential variables for structural modeling

According to the results of path model (see Figure 6), it can be known that the influence coefficient of teacher's personal factors on teacher evaluation for professional development has achieve significant level (0.79). Thus, teacher's personal factor has the significant direct effect on implementation effectiveness of teacher evaluation for professional development.

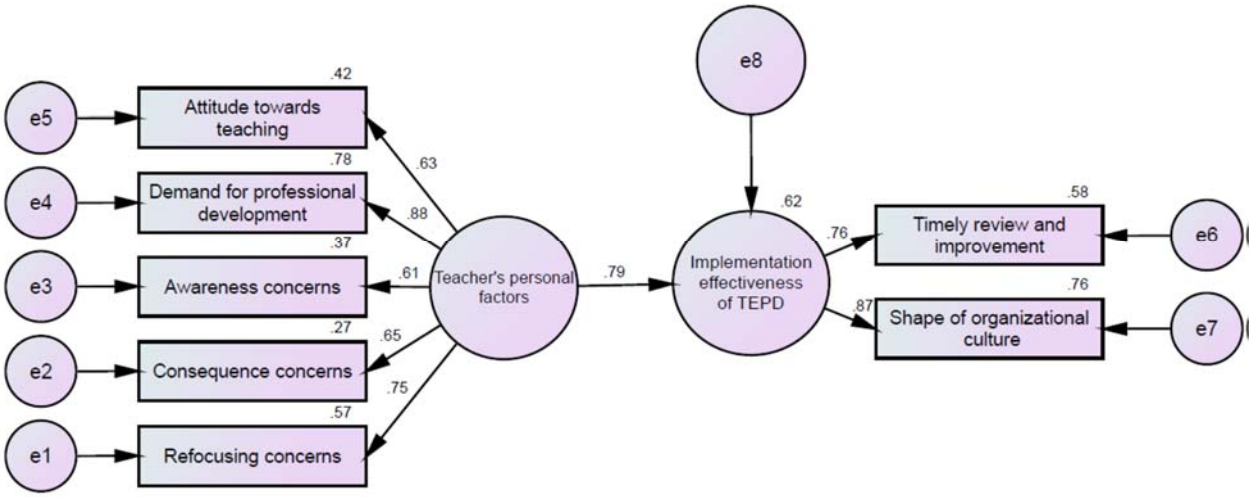

Figure **6.** Coefficient of path structural modeling

As for the effect between all the variables of structural equation modeling in this research, (see Figure 7), Amos is used to test mediating effect and it is found that teacher's personal factors and organizational change strategy have the significant total effect on implementation effectiveness of teacher evaluation for professional development. Moreover, teacher's personal factors also have significant indirect effect on implementation effectiveness of teacher evaluation for professional development through organizational change strategy, indicating that organizational change strategy has the significant mediating effect. The effect of each variable is summarized in Table 4.

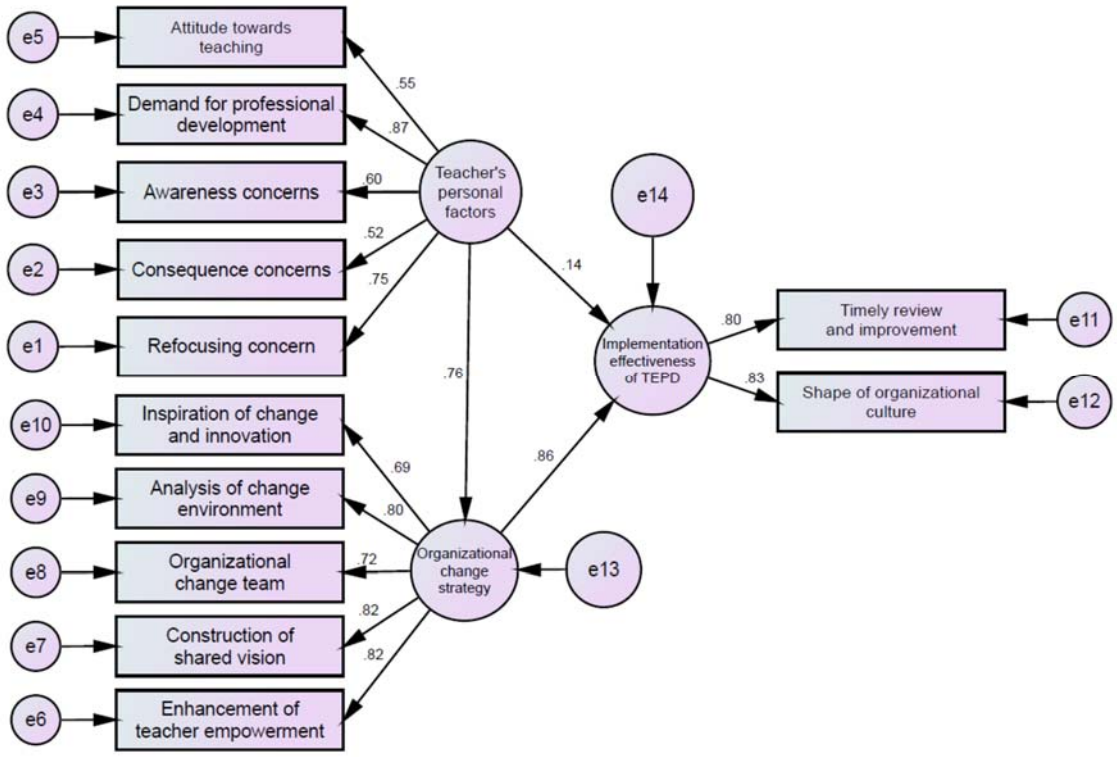

Figure 7. Structural equation modeling for teacher's personal factors and organizational change strategy

Table 4: Effect between variables of structural equation modeling

Potential independent variable	Potential dependent variable	
	Organizational change strategy	**Implementation effectiveness of teacher evaluation for professional development**
Teacher's personal factors		
Direct effect	.76	.14
Indirect effect		.65
Total effect		.79
Organizational change strategy		
Direct effect		.86
Total effect		.86

Conclusion and Suggestions

With the teacher evaluation for professional development strongly promoted by Ministry of Education since 2007, the trial scheme has been further changed into normal scheme, hoping that the teacher's professional development can be promoted through teachers' participating in the process of evaluation activity. This research discusses the influence of teacher's personal factors and organizational change strategy on implementation effectiveness of teacher evaluation for professional development in elementary schools, so as to test, clarify and master the relationship between variables, which can help to research and formulate the thoughtful and feasible improvement method. The conclusions and suggestions in this research are illustrated as follows:

Conclusion

The conclusions for this research are as follows:

1. The research results show that teacher's personal factors and organizational change strategy have the significant direct effect on teacher evaluation for professional development, and teacher's personal factors also have significant indirect effect on implementation effectiveness of teacher evaluation for professional development through organizational change strategy, indicating that organizational change strategy has the significant mediating effect.

2. Attitudes towards teaching, demand for professional development, awareness concerns, consequence concerns, refocusing concerns, etc in teacher's personal factors are all the important factors influencing the implementation of teacher evaluation for professional development. It can be known from research results that "demand for professional development" and "refocusing concerns" are the two items with the highest factor loading in the teacher's personal factors, while teacher's "awareness concerns" has the lowest factor loading.

3. Analysis of change environment, organizational change team, construction of shared vision, inspiration of change and innovation and enhancement of teacher's empowerment in organizational change strategy are the important factors influencing the implementation of teacher evaluation for professional development. "Construction of shared vision" and "enhancement of teacher's empowerment" are the two items with the highest factor loading in the organizational change strategy, while "inspiration of change and innovation" has the lowest factor loading.

Suggestions

1. Teacher's "awareness concerns" has the lowest factor loading, indicating that teachers rarely concern for or participate in teacher evaluation for professional development. Therefore, only the elimination of misgiving and discomfort in teachers' heart, selection of proper contents, criteria and methods of teacher evaluation for professional development can reduce teacher's psychological obstacle of participating in evaluation so as to improve the effectiveness of teacher evaluation for professional development, which is also the urgent task of the government. Therefore, schools should assist in the teacher's professional development and provide various rewards to improve the effectiveness of teacher evaluation for professional development.

The understanding of relevant teacher's personal factors can help to increase the willingness to participate in evaluation or reduce the obstacle of participating in evaluation.

2. The subjects for this research are only restricted to teachers in public elementary schools, and the subjects will be expanded to teachers in public middle schools and even in private elementary and secondary schools in the follow-up research; after the cross validation is carried out for the research scale, the modeling stability for this research is further verified, and then whether the difference in teacher's factors in elementary and secondary schools with different levels will generate significant change in implementation effectiveness of evaluation is discussed.

3. This research is conducted in terms of teacher's personal factors and organizational change strategy; it is suggested to discuss the influence of organizational change background and other factors on implementation effectiveness of teacher evaluation for professional development in the follow-up research, so as to make the structural modeling more complete to give play to the best effectiveness of teacher evaluation for professional development.

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INFORMATION TECHNOLOGY AND HUMAN RESOURCE MANAGEMENT

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Abstract: The influence of information technology in human resource management cannot be over emphasized. Though, there have been a lot of substantial growth in the application of information technology in human resource development and management (HRM) over the years, yet, it seems the level of the information technology and its impact on human resource management has not been fully explored or researched. The objective of the study is to investigate the impact of information technology in human resource management. The research employed inferential statistics such as Chi-squared to analyze the important aspect of information technology in human resource management. Data was generated through the means of a questionnaire, which was questionnaire was distributed within random north Cyprus university students. Research observations, discovered that, improvement in information technology at any level or organization, and would have an enormous influence on the growth of the human resource of such organization or institution and help in achieving the stated organizational goals and objectives.

Keywords: Human resource, Technology, management, Chi- squared

INTRODUCTION

In the 21st century, digital age and its features has become essential part of the synchronic world. On the other hand, human resource management has globally affected both the individuals, firms, public and private enterprises, etc. in numerous ways through its affectation and implementation. The important aspect of information technology in human resource management cannot be overemphasized. Though, there have been a lot of substantial growth in the application of information technology in human resource development and management (HRM) over the years, yet, it seems the level of the information technology and its impact on human resource management has not been fully explored or researched (Adewoye,2012).

One of the basic expectations of information technology is to help in enhancing the performance and operation of human resource management, by repositioning its concentration from personnel or administrative management to a more strategic and improved human resource management. The strategic responsibility and role of human resource management is expected to add value to human resource function, and geared these human resource functions towards transformation (Yu, 2009).

In the study by Grensing, (2008) he affirmed that, human resource management through the information, the provider makes available holistic view of the entire process, which helps in evaluating most of the crucial knowledge and asset of any organization. However, information technology has recently been playing a crucial role in sorting, compiling, etc., adequate use of such information that was gathered, are used in making vital decisions in the day-to-day activities of any organization. Therefore, the systems of information are needed to communicate very well, and as well as work efficiently in any organization.

It became expedient to put into consideration organizational desires, goals, and needs and how to make it achievable, since changes in information system have a great influence on organizational operation, production and decision making. Therefore, firms must evaluate and find out any problem arising from their operations, and most importantly, those that affect the human resource management functions (Chambers, 2013).

LITERATURE REVIEW

A. Conceptual Framework of Human Management Resources

Liu et al. (2007) proposed that, right from 1970s to the late part of 1980s, there has been a tremendous movement which led to the birth of human resource department, which was formally known to be 'Corporation Personnel Department'. It was a movement which repositions employees as an integral aspect or part of an organization, rather than been seen or treated as a cost. There are important assets in which without them organizational

objectives cannot be achieved.

Hills and Jones (2004) argued that, human resource management of any organization could help to create and generate more value. Priti (2004) was also of the opinion that, these outcomes are feasible, when there is a proper management and development of human resource management efficiently and effectively in any organization. Noted by Werner and Desimone (2006) in their word, described human resource management as the utilization and effective selection of workforce to enhance the achievement of organization strategies, goals, and objectives, while on the other hand, needs and goals of the employees.

Human resource management in any organization have responsibilities of managing, recruiting, directing, organizing and controlling the workforce to perform according to prescription and organization structure in an organization. These functions could possibly be carried out by the line manager by performing personnel duties. An example of such could be, hiring, compensating, managing, monitoring performance, organization development, wellness, safety, benefits, communication, employee motivation, training and development and other administrative functions (Werner and Desimone, 2006).

Human resource management is a vital asset that can generate a continuous competitive merit for organization. The advantage of an organization stand to gain in HRM efficiency has been confirmed. The frequent deviations in an environment of business within the effect of globalizing enhanced focus on profitability through sustained growth, replacing demographic/population of workforce, technological advancement, never ending development/changes coupled with intellectual capital that organization nowadays are experiencing (Manjuri et al.,2006).

According to Schuler and Dowling (1990) in their research came up with a model, the kind of policy of workers that is suitable to gear actions necessary to reach the goals of the competition of strategic. Following them, the competition of strategic can be put to three basic groups. This are, creative strategy, reduction, and lastly strategy to enhance the quality

IMPORTANT ASPECT OF INFORMATION TECHNOLOGY IN HUMAN RESOURCE MANAGEMENT

The correlation that exists between human resource management and information technology cannot be over emphasized. Technology which is the fundamental of know- how helps managers and employee at large to have control over their benefits and training enrollment. The birth of a computerized employment office has been enhanced by technology. It streamlines the human resource management functions and responsibilities. It provides an information based foundation for make a decision (Cieri et al.2005).

According to Rowen et al (2002), the unique database introductions are an indicator of a prosperous human resource method application bundle.

There are pertinent problems, which any organization might have to face, especially as it is related to human resource management in the aspect of hiring, retaining and control of benefits, which includes:

- Hardship in making reference to the human resource records to pick good and efficient candidates needed to open job opportunities in the company.
- The desire of employing additional administrative workforce to update and maintain staff and history data for salary of the job, by not using the crude paperwork which seems to grow on a daily basis.
- The desire to acquire a sound data on the current and useful remuneration packages for difficult job description.
- The desire for an efficient information system through which cost and benefits associated with a product, educational program or early retirement plan reimbursement (Summer 2005).

Apart from keeping records on employees, skills, performance, applications and positions, human resource information system make available information that is in confronting with the style of managing the employee characteristics. The main goal of an efficient human resource strategy is mainly to obtain, train, place, and develop or build the employee in line with the needs of the organization. The managerial decision making needs are usually supported by the human resource management system, by offering report and query platform (Rowen et al 2002).

They also ensure simplification towards performance appraisal. Several software applications are employed to track basic competencies and make available to managers tips for staffs that need to be trained or improved. These systems can also serve as a means to update the superior in such a way that the need for management attention or training to serve the objectives or goals of the organization. These performance appraisal systems are

one tool that organization with several branches employs to install consistency over their operations (Davis, 2002).

RESEARCH DESIGN AND METHODOLOGY

This research employed the use of inferential statistics to analyze the important aspect of information technology in human resource management. To present a vivid conceptualization of issues raised in the work, the researcher will employ quantitative analytical methods for the purpose of clarity. Data will be generated through the means of questionnaires. The use of Chi-squared will be undertaken.

In the quest to investigate the important aspect of information technology in human resource management, it becomes expedient to come up with a model that will create a link between the variables in question, in order to justify the influence that exists between information technology and human resource management. Therefore, a research questionnaire was distributed within random north Cyprus university students with a good knowledge of English language. For purposes of research, questionnaires of about 15 research questions were formulated and distributed to 100 respondents.

A. Data Collection

Using probability theory, statisticians have devised a way to determine if a frequency distribution differs from the expected distribution. To use this chi-square test, we first have to calculate chi-squared. It is one of the major items in any research work that help us to establish the efficiency of the research questions and hypothesis earlier stated at the beginning of this research work. Since the data are non- parametric, the Chi-square ($\chi 2$) test of independence will be used in analyzing the data. The Chi-square ($\chi 2$) for each table will be calculated with respect to the hypothesis after presenting the data on a contingency table. To test the hypothesis, we are to compare the frequencies that were actually observed in the field with the frequencies that we think should have been observed (expected frequencies).

Therefore, the Chi-square test of independence is represented by a formula

$$\chi^2 = \sum \frac{(O - E)^2}{E} \quad \text{----------(1)}$$

Where,
$\chi 2$ = Chi-square
O = Observed frequency E = Expected frequency
$\sum$ = Summation.

The expected frequency is given by the formula

$$E = \quad \text{---------- (2)}$$

Where,
E = Expected frequency
RT = Row Total
CT = Column Total
GT = Grand Total

Method of Data Collection

The primary sources of data collection were adopted in this research work. Data in different category were gathered mainly through administration of questionnaires to the students. Caution was taken in building the questionnaire to reduce the incidence of bias (i.e. going out of the research objectives) or subjective views about the subject matter.

Other information for the research study has gathered within the review of associated literature; the related literatures had got from books, journals, and associated articles in this major. More so, in this era of globalization, information from the internet was also valuable.

DATA ANALYSIS AND FINDINGS

The data presentation of this research was based on the responds generated and collated from 100 respondents through the means of questionnaires. The research questionnaires were made up of 15 questions. All the questions were attended to and all the questionnaires were retrieved from the respondents.

The tables below where prepared based on each question and their responds.

Table 1: Organizational relationship between IT and HRM

Options	No of Respondents	Percentage of Respondents
Yes	80	80%
No	16	16%
Not sure	4	4%
Total	100	100%

Table 2: Impact of IT on HRM

Options	No of Respondents	Percentage of Respondents
Yes	78	78%
No	20	20%
Not sure	2	2%
Total	100	100%

Table 3: Improvement in IT has positive impact on HRM

Options	No of Respondents	Percentage of Respondents
Yes	82	82%
No	16	16%
Not sure	2	2%
Total	100	100%

Table 4: IT and its sizeable and magnitude influence on HRM

Options	No of Respondents	Percentage of Respondents
Yes	84	84%
No	13	13%
Not sure	3	3%
Total	100	100%

Table 5: Updating the level of IT capacity and its impact on HRM

Options	No of Respondents	Percentage of Respondent
Yes	96	96%
No	1	1%
Not sure	3	3%
Total	100	100%

Table 6: HRM influence on organization productivity and profitability

Options	No of Respondents	Percentage of Respondent
Yes	89	89%
No	5	5%
Not sure	6	6%
Total	100	100%

Table 7: Importance of IT in business world of today

Options	No of Respondents	Percentage of Respondents
Yes	77	77%
No	20	20%
Not sure	3	3%
Total	100	100%

Table 8: Long-run impact of IT on the organizational objectives.

Options	No of Respondents	Percentage of Respondents
Yes	93	93%
No	5	5%
Not sure	2	2%
Total	100	100%

Table 9: HRM and its impact on improving IT

Options	No of Respondents	Percentage of Respondents
Yes	80	80%
No	18	18%
Not sure	2	2%
Total	100	100%

Table 10: IT and its impact on Educational Career?

Option	No of Respondents	Percentage of Respondents
Yes	78	78%
No	20	20%
Not sure	2	2%
Total	100	100%

Table 11: IT and its impact on sound educational system

Option	No of Respondents	Percentage of Respondents
Yes	89	89%
No	7	7%
Not sure	4	4%
Total	100	100%

Table12: Improvement in Educational system and efficient HRM

Option	No of Respondents	Percentage of Respondents
Yes	94	94%
No	3	3%
Not sure	3	3%
Total	100	100%

Table 13: Improvement in HRM means better and reliable information Technology

Option	No of Respondents	Percentage of Respondents
Yes	78	78%
No	20	20%
Not sure	2	2%
Total	100	100%

Table 14: IT attract competent employee and retain them in an organization

Option	No of Respondents	Percentage of Respondents
Yes	86	86%
No	11	11%
Not sure	3	3%
Total	100	100%

Table 15: IT and its impact of Turnover and Productivities

Option	No of Respondents	Percentage of Respondents
Yes	88	88%
No	10	10%
Not sure	2	2%
Total	100	100%

In the Table 1, question one, 80 respondents stated that a relationship exists between information technology and the human resource management of an organization, 16 respondents disagree with it and 4 respondents were not sure of their relationship.

In Table 2, question 2, 78 respondents were of the opinion that information technology has impact on human resource management while 20 respondents disagree and 2 respondents were not sure of this possibility.

In Table 3, question 3, 82 respondents also agreed that improvement in information technology can affect human resource management positively while 16 respondents disagree and 2 respondents were not sure.

In Table 4, question 4, 84 respondents was of the opinions that, information technology so far have a sizeable and magnitude influence on human resource management while 13 respondents disagree and 3 respondents was not sure.

In Table 5, question 5, 96 respondents agreed that updating the level of information technology capacity of an organization would have a proportional effect on the human resource management while 1 percent or 1 respondent disagree and 3 respondents were not sure.
In Table 6, question 6, 89 respondents accepted the fact that human resource management of any organization have influence on an organization productivity and profitability while 5 respondents disagree and 6 respondents were not sure.

In Table 7, question seven, 77 respondents agreed that information technology is relevant in the business world of today while 20 respondents disagreed and 3 respondents were not sure.

In Table 8 question eight, 93 respondents agreed to the fact that information technology has a long-run impact on the organizational objectives and achievement or 5 respondents disagree while 2 respondents were not sure.

In Table 9, question nine, 80 respondents agreed that human resource management can be better by improving the level of information technology while or 18 respondents disagree and 2 respondents were not sure.

In Table 10, question ten, 78 respondents agreed that information technology has impacted on their career, while 20 respondents disagree and 2 respondents were not sure.

In Table 11, question eleven, 89 respondents agreed that improvement of information technology would help in delivery of sound educational system, while 7 respondents disagree and 4 respondents were not sure.

In Table 12, question twelve, 94 respondents agreed that improvement in educational system would produce better and efficient human resource managers while 3 respondents disagree and 3 respondents were not sure.

In Table 13, question thirteen, 78 respondents agreed that improvement in human resource management means better and reliable information system while 20 respondents disagree and 2 respondents were not sure.

In Table 14, question fourteen, 86 respondents agreed information technology would help to attract competent employee and retain them in an organization while 11 respondents disagree and 3 respondents were not sure.

In Table 15, question fifteen, 88 respondents agreed that information technology has impacted on their career, while 10 respondents disagree and 2 respondents were not sure.

A. Findings

Consequently, from the research findings above, it was discovered that information technology in one way or another has a direct and positive impact on human resource management. From the researcher observations, it is obvious and glaring that improvement in information technology at any level or organization, would have enormous influence on the growth of the human resource of such organization or institution and the help in achieving the stated organizational goals and objectives.

CONCLUSION

One of the basic expectations of information technology is to help in enhancing the performance and operation of human resource management, by repositioning its concentration from personnel or administrative management to a more strategic and improved human resource management. The strategic responsibility and role of human resource management is expected to add value to human resource function, and geared these human resource functions towards transformation (Yu 2009).

Human resource management is the basic and fundamental component of every organization that has succeeded in achieving their organizational goals, thus, there should be a frequent follow-up procedure to any information gathered and received, and such information should be well monitored, filtered and evaluated for an effective and profitable decision making. Nevertheless, there is a need to manage the information emanating from these many organizational activities, but this seems to be somehow difficult, and this is due to its volume.

The main aim of this research is to evaluate, if any, the role and influence of information technology in human resource management system. From the above finding, it was discovered that the information technology has a direct and Positive impact on human resource management. Therefore, it becomes expedient from the research to input the following recommendations for policy makers and future researchers in this field.

In order to achieve organizational goals and objectives through efficient human resource management, sound and efficient information technology should be put in place.

Information technology should be enhanced in such a way that it will stimulate changes in the societies and world economies by creating more ground to generate more income, enhances work, and permits access to vital information and making the world a global village.

The information technology industry such as electronics, broadcast, media, print, computer, e-commerce, telecommunication etc. should be more developed and updated with the latest technology to enhance effective delivery of the human resource management responsibilities.

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INVESTIGATION OF SLOSHING IN A PRISMATIC TANK FILLED WITH DIFFERENT LIQUID LEVEL

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Abstract: In this study, sloshing behavior in a prismatic tank that is approximately the same volume with a vehicle' s fuel tank is investigated by Computational Fluid Dynamics (CFD) method. Tank is modeled with vertical baffle and without baffle. The tank is filled with water where the rate of 50%-70% and the dynamic behavior of the system examined for both cases. The tank is subjected harmonic motion at the lateral direction, the velocity change of fluid and the pressure at the tank wall are examined.

Keywords: Sloshing, tank baffle, fuel tank

Introduction

The fuel tank is called tank which stores the fuel used to provide the energy required for operation of the vehicle. These tanks can be produced in different sizes and different materials. At last years, it can be said that the investigation of the sloshing event in the fuel tank has gained importance in the automotive industry because of more detailed analysis of vibration and noise in the vehicle (Jadon et al. 2014, Kingsley 2005, Wiesche 2003, Chitkara et al. 2013, Kılıç 2015).

Free liquid surface is formed on the liquid surface of the tank partially filled with liquid fluid. The movement of the surface is defined as sloshing. Free liquid surface shows various types of motion according to the shape of the tank movement and geometry of the tank. These can be classified such as simple planar, non-planar, random shock, symmetric, asymmetric, quasi periodic and chaotic. The amplitude of the sloshing movement depends on the shape of the actuation, the depth of the liquid in the tank, the geometry of the tank and the fluid properties (İbrahim et al. 2001, İbrahim 2005, Akyıldız et al. 2006).

The movement of the fluid in the tank is interested in many engineering systems such as fuel tank, space vehicles and high water towers. Pressure forces at the tank generated as a result of sloshing motion can lead to strain and security problems in mechanical systems. Therefore, determination of distribution of the hydrodynamic pressure and forces and natural frequency of the free liquid surface during sloshing is important (İbrahim 2005, Akyıldız and Ünal 2006). When evaluated according to the tank acceleration, external signals, tank settlement and liquid level of the tank, these loads should not exceed a certain maximum value and should remain within safety limits.

The studies done in the automotive field are investigated widely and summarized below. Wiesche (2003) made investigations from theoretical studies and industrial applications to calculate numerically the sloshing behavior of the viscous liquid in the fuel tanks with different geometries. The Volume of Fluid method (VOF) was used to calculate the free surface flow and prismatic, spherical and non-symmetric fuel tanks were analyzed. Jadon et al. (2014) used a multi physics based numerical method to estimate the sound change from sloshing behavior. During the study, the sloshing model was created by using Computational Fluid Dynamics (CFD), Finite Element Method (FEM) and the Boundary Element Method (BEM). The vibration calculations were carried out under LS-DYNA program. Many parameters such as tank surface pressure, surface integral force, momentum, the average kinetic energy were investigated together with these systems. Chitkara et al. (2013) investigated the sloshing for partially filled tanks using VOF method and analyzed two different geometries using computational simulations considering 40% of fuel and 60% of air inside a 40 liters fuel tank under longitudinal acceleration. Iu et al. (2004) studied on the noise caused by sloshing. Several baffle designs were investigated to suppress the fuel slosh by using FLOW-3D CFD software theoretically and experimentally. Estimated mean kinetic energy and average turbulent kinetic energy of the fluid obtained from the computer simulations were used to compare with sound measurements obtained from experiments. İbrahim et al. (2001) made a very large review study on dynamics of liquid sloshing. Information is given about 1319 publications on sloshing event made up to publication date. Akyıldız and Ünal (2006) were investigated the sloshing pressure variations and the three dimensional behavior of the liquid in the

partially filled prismatic tank by experimental and theoretical studies. Çelebi and Akyıldız (2001) investigated the sloshing event in the partially filled tank with and without baffle structure. Jung et al. (2012) analyzed the lateral oscillating movement of the partially filled fluid tank and investigated the effect of the length of baffle vertically placed into the tank. VOF method was used for monitoring the fluid motion and pressure changes were investigated according to the different baffle height. Kingsley (2005) made various sloshing optimization studies to develop the liquid tank design and analysis. In the study computational fluid dynamics and finite element methods were used.

In this study, sloshing behavior in a prismatic tank with 50 lt volume and 0.3-0.7-0.24 m the width, the length and height is investigated by CFD method. The tank is filled with water where the rate of 50%-70% and the dynamic behavior of the system examined for both cases. Tank is modeled with vertical baffle and without baffle, and subjected to the lateral harmonic movement. The velocity changes of fluid and the pressure values at the tank wall are examined.

Materials and Methods

1. Mathematical model of sloshing

In this section, basic equations of fluid motion and mathematical models of sloshing event are presented briefly. Basic equations for mathematical modeling of sloshing are continuity, momentum and fluid volume VOF equations.

The continuity equation for a control volume with dimensions dx, dy and dz in cartesian coordinate system can be defined generally as below (Çengel and Cımbala 2005, Umur 2009);

$$\frac{1}{\rho}\frac{D\rho}{Dt} + \nabla\vec{V} = 0 \tag{1}$$

Momentum equation with the assumption that the fluid is Newtonian, the flow is incompressible and working condition is isothermal can be written as;

$$\rho\frac{D\vec{V}}{Dt} = -\nabla\vec{P} + \rho\vec{g} + \mu\nabla^2\vec{V} + f \tag{2}$$

The terms defining irregular changes are added to the laminar momentum and continuity equations for turbulent flow and conservation equations for turbulent flow are obtained (Çengel and Cımbala 2005, Umur 2009).

The VOF method is an efficient multi-phase method used to simulate the flow of immiscible liquids (Vaishnav et al., 2014). This method is used for examining the movement of the free surface during sloshing of the liquid in the tank (Jadon et al., 2014). This method developed by Hirt and Nichols (1981) follow the upper surface of the liquid in the container or follow the interphase surface of the system in other words. The liquid defined by the mesh is divided to the fixed or moving small particles to make this follow.

According to linear wave theory, natural frequency of fluid for a rectangular prismatic shaped tank can be defined;

$$\omega_n^2 = g\frac{n\pi}{L}tanh\left(\frac{n\pi}{L}d\right) \tag{3}$$

Here, g: acceleration of gravity (m/s^2), L: tank length in the direction of the movement (m), d: fluid level in the tank (m) and n: mod number. Accordingly, it can be seen that the natural frequency of the fluid in the tank prismatic tank changes depending on the fluid level in the tank, the length of the tank in the direction of the warning (Abraham 2001, Kingsley 2005).

2. System Structure and Simulation

The tank that capacity is 50 lt and 0.3- 0.7- 0.24 m width, length and height, the placement of the baffle into the tank and the pressure measurement points are shown in Figure 1.

In this study, the baffle was placed in the middle of the tank and the height of the baffle is taken 42% of the tank height. Because the tank is symmetrical and homogenous, pressure measurement points are positioned only one side wall of the tank. Tank movement is provided so that it can oscillate in the lateral direction indicated by x. The equation of the acceleration representing the described input can be seen below;

$$\ddot{x} = -A\omega^2 sin(\omega t) \quad (4)$$

Here, A: amplitude of the movement (m), ω: angular frequency (rad/s). The input function is given as acceleration input and an appropriate program is written in C language for the analysis. The tank movement and angular frequency are taken as 2 cm, $\omega=\omega_n$ respectively for baffled and unbaffled cases. There are two different phase as air and water in the tank so multiphase flow model is used in the study. The node and element numbers used in modeling are given in Table 1. Analyses are performed using ANSYS Fluent program.

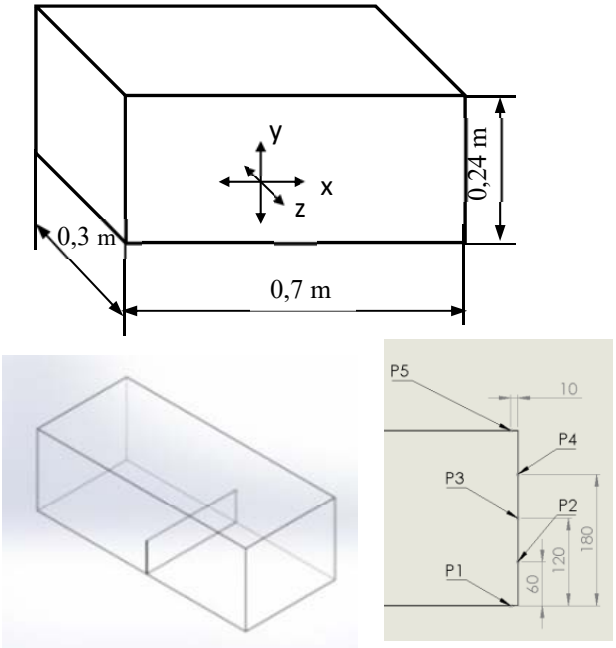


Figure 1. The size of the tank, placement of the baffle and pressure measurement points

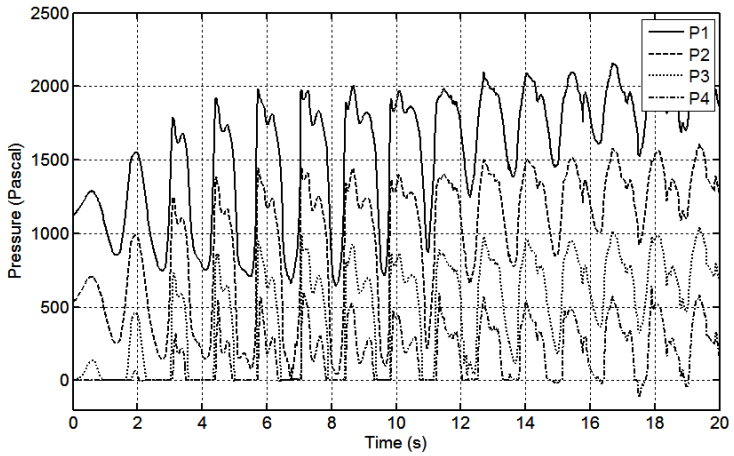
Table 1: The number of the node and element

Tank model	Node number	Element number
Tank with baffle	55025	50400
Tank unbaffled	55800	50730

3. Results and Discussion

In this study, the pressure changes at the wall of the tank and the instant pressure and velocity distribution of the liquid in the baffled and unbaffled tank for 50% and 70% filling rates are obtained as simulation results.

In Figure 2 and Figure 3, pressure changes at the P_1, P_2, P_3 and P_4 points and the pressure and velocity distribution at t=2.35 second for unbaffled tank filled 50% and 70% water are shown respectively.



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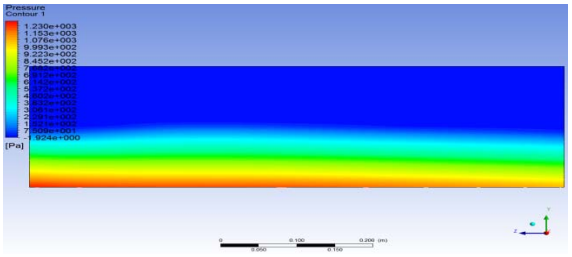

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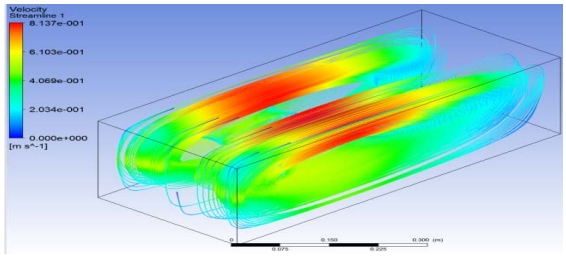
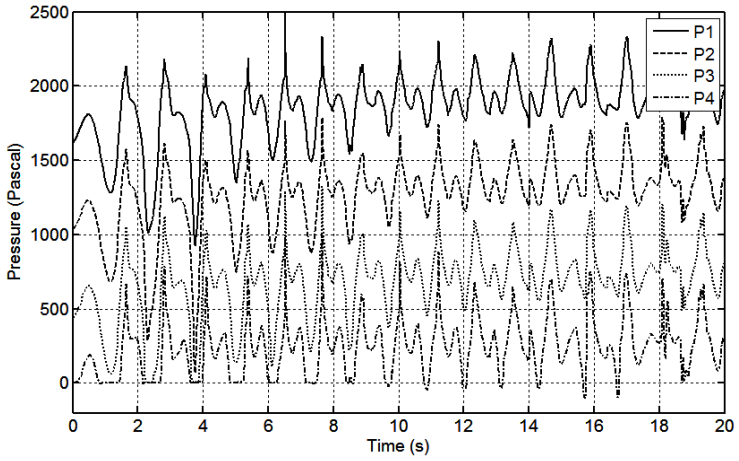


(c)

Figure 2. Unbaffled tank (50% filled)
a) Pressure-Time changes, b) Instant pressure distribution, c) Instant velocity distribution



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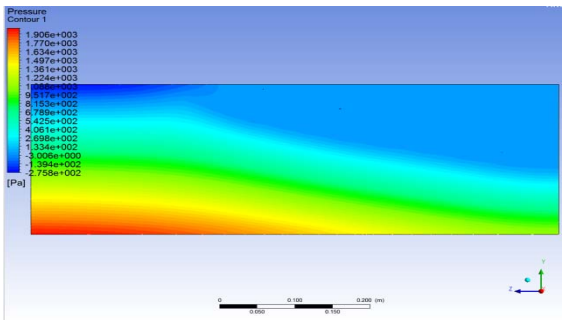

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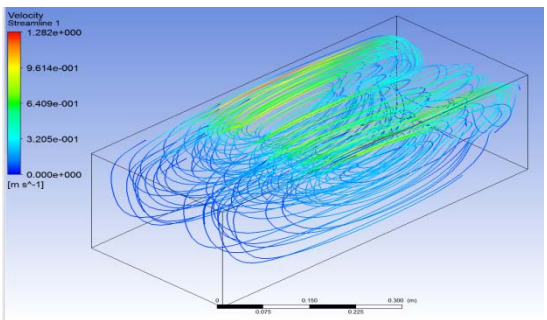
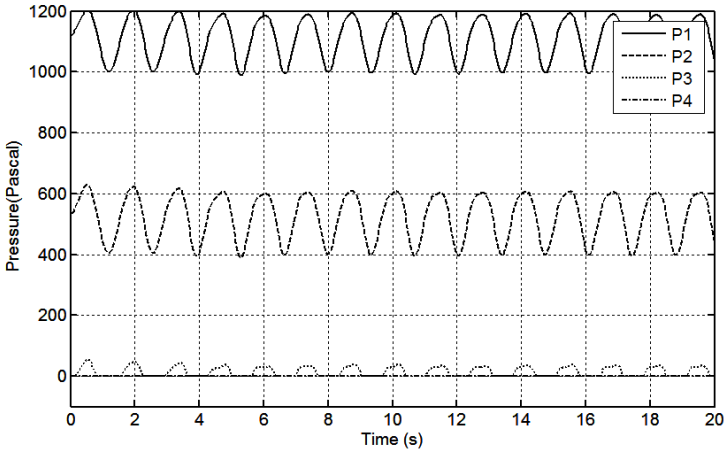


(c)

Figure 3. Unbaffled tank (70% filled)
a) Pressure-Time changes, b) Instant pressure distribution, c) Instant velocity distribution

In Figure 4 and Figure 5, pressure changes at the P_1, P_2, P_3 ve P_4 points and the pressure and velocity distribution at t=2.35 second for baffled tank filled 50% and 70% water are shown respectively.



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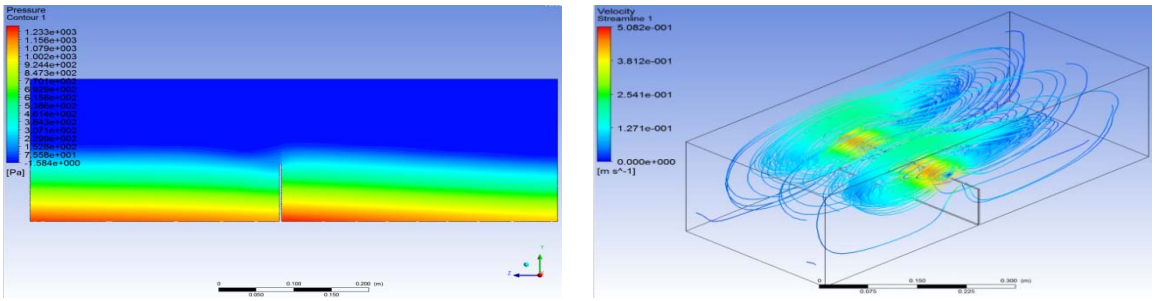
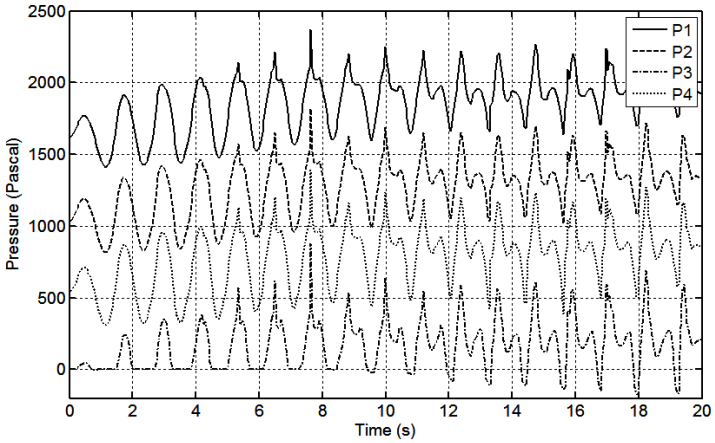
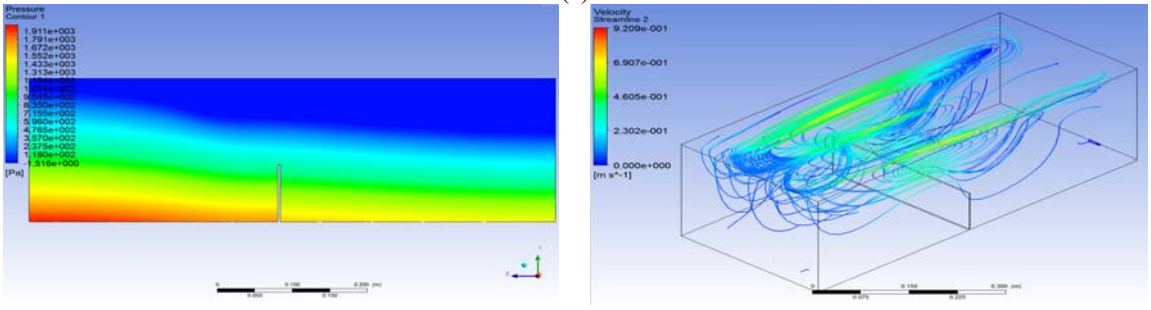


(b) (c)

Figure 4. Baffled tank (50% filled)
a) Pressure-Time changes, b) Instant pressure distribution, c) Instant velocity distribution



(a)



(b) (c)

Figure 5. Baffled tank (70% filled)
a) Pressure-Time changes, b) Instant pressure distribution, c) Instant velocity distribution

When Figure 2 and Figure 4 are examined, it can be shown that the sloshing behavior vary considerably between 50% filled baffled and unbaffled tanks. When the baffled tank case is investigated, it can be observed that the fluid cannot be reached to the pressure point 4 (P4) and the pressure distribution become more regular form. When the instant pressure and speed distribution are investigated for two cases, it can be shown that the maximum speed value of the baffled case is reduced at the rate of 62.5% approximately.

As it can be seen from Figure 3 and Figure 5, there are no big difference on the pressure values between baffled and unbaffled tanks. However, it can be said that the form of the sloshing behavior was changed and the maximum speed value is reduced at the baffled tank when the instant pressure and speed distribution are observed.

Conclusion

In this study, fluid sloshing behavior in a prismatic tank that has approximately the same volume with a vehicle fuel tank is investigated by CFD method, pressure and instant speed variations are obtained.

Two different tank configurations are modeled as tank with vertical baffle and unbaffled tank. The tank is filled with water where the rate of %50-70 and subjected harmonic motion at the lateral direction, the dynamic behavior of the system examined for both cases. It was seen from the results that the liquid level and the baffle in the tank affects the sloshing behavior of the fluid significantly. When making design studies, it is important to take into account these parameters such as fluid level and baffle structure placed in the tank.

Acknowledgments

The authors gratefully acknowledge the support of Turkish Technology and Science Minister under SAN-TEZ project 0157.STZ.2013-1.

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LIDAR DATA ANALYSIS WITH DIGITAL IMAGE CORRELATION (DIC) IN OBTAINING LANDSLIDE DISPLACEMENT FIELDS: A CASE OF GSCHLIEFGRABEN LANDSLIDE-AUSTRIA

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Abstract: Comparison of LIDAR datasets were shown as useful in obtaining information about displacement fields of active landslides. Iterative closest point (ICP) and digital image correlation (DIC) are two main approaches used for this aim. Whereas ICP is based on precisely matching point-clouds, DIC is based on cross-correlation of remotely sensed digital imageries. Although DIC is a popular application in fluid mechanics for quantifying flow velocity, its successful applications in estimating displacements resulted from landslides are available. Studies indicate that DIC is more suitable than ICP when computing displacements in the order of magnitude of several meters. DIC is applied to any raster dataset representing a surface property considering the specific advantages and disadvantages of these techniques. In the present study, DIC was applied for an active landslide (named Gschliefgraben) located in Upper Austria. Two time series of LIDAR data obtained in 11th February 2008 and 28th April 2008 was used. The precision of DEMs with 1*1m raster cell size is 20 cm (horizontal) and 15 cm (vertical). Because Gschliefgraben is a big landslide system, DIC analysis was only made for small part of landslide area located close to the crown (head). This part was selected because more activation was observed between two series with visual inspection. Within the study area two separate active parts were observed. According to results, between two time series, the mean displacement rates in these more active parts within study area were obtained 0.66 m (max. 2 m) with sub-pixel precision image matching.

Keywords: Digital image correlation, Displacement field, Landslide, LIDAR

Introduction

Understanding of landslides and their mechanisms is crucial for reduction of landslide hazard. Because landslides are responsible for human casualties, property damage and environmental degradation. Quantification of kinematics of the movement, mostly superficial displacements, is a way of monitoring of a landslide (Gili et al., 2000). Periodic acquisition and analysis of a series of observations over time are needed for monitoring landslides (Stumpf, 2013). Remote sensing is one of the most important technique used in landslide monitoring (Savvaidis, 2003), especially LIDAR systems have gained wider acceptance due to increasing availability, possibility of high density point clouds, and very high resolution 3D information of terrain with high accuracies (Baldo et al., 2009; Barnhart and Crosby, 2013; Jaboyedoff et al., 2012).

Comparison of LIDAR datasets have been shown as useful in obtaining information about displacement fields of active landslides. Iterative closest point (ICP) and digital image correlation (DIC) are two main approaches used for this aim (Daehne and Corsini, 2013). Whereas ICP is based on precisely matching point-clouds, DIC is based on cross-correlation of remotely sensed digital imageries. DIC is an image processing technique used to measure deformation by comparing two digital images (Take, 2015). This technique was originally developed in the field of experimental solid mechanics (Peters and Ranson, 1982). Although DIC is popular in fluid mechanics for quantifying flow velocity, beginning in the late 1990s, DIC was also noticed as well-suited technique to geotechnical engineering applications (White et al., 2001; Take, 2003; Sadek et al., 2003). Image correlation have currently become one of the most efficient techniques to determine horizontal ground displacements due to volcano (Walter, 2011), earthquakes (Van Puymbroeck et al. 2000), landslides (Delacourt et al., 2004; Aryal et al., 2012; Travelletti et al., 2012; Daehne and Corsini, 2013), glaciers (Kääb et al., 2005), ice flows or sand dune migrations (Rosu et al., 2014).

In the present study, two time series of LIDAR data obtained in 11th February 2008 and 28th April 2008 was used to apply DIC analysis in Gschliefgraben landslide. The precision of DEMs with 1*1m raster cell size is 20 cm (horizontal) and 15 cm (vertical). DIC analysis was applied by using image correlation software (CIAS), which matches offsets between two images based on normalized cross-correlation. DIC analysis was only made for small

part of landslide area (about 10 Ha) located close to the crown (head) of landslide.

Materials and Methods

Study Area and LIDAR Datasets

Gschliefgraben landslide system, located in Upper Austria (municipality Gmunden), was selected as study area (Figure 1). The top, left, right, and bottom coordinates of the area in MGI/Austria GK M31: EPSG Projection are 306000.25, 35399.75, 38500.25, and 303899.75, respectively. Detailed information on this landslide, an earth flow amounting about 3.8 million m^3 accumulated solids, was well represented by Marschallinger et al. (2009). In the present study, two time series of LIDAR data obtained in 11th February 2008 and 28th April 2008 was used. The precision of DEMs with 1*1m raster cell size is 20 cm (horizontal) and 15 cm (vertical) (Figure 2).

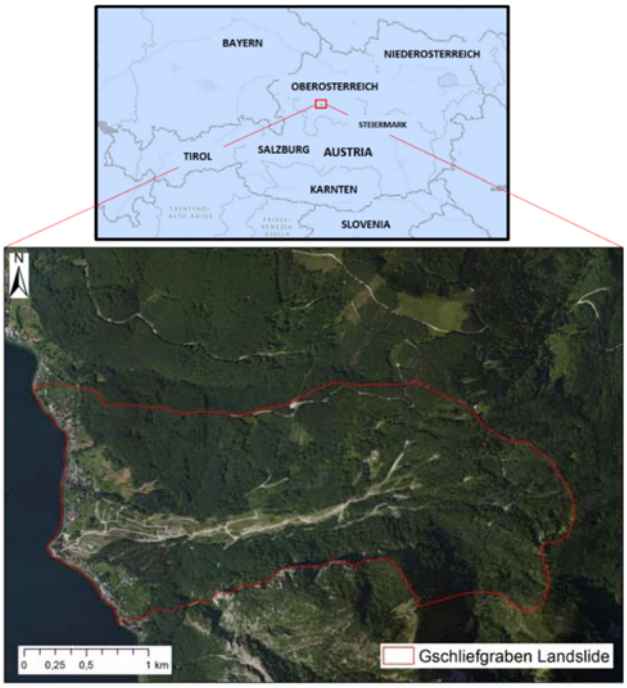

Figure 1. Location map of Gschliefgraben Catchment

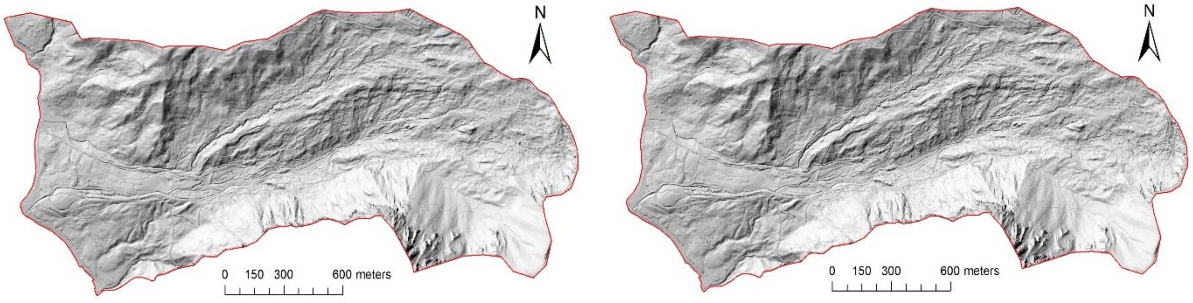

Figure 2. Shaded reliefs of LIDAR data: 11th February 2008 (left) and 28th April 2008 (right).

Digital Image Correlation

Digital image correlation (DIC) is a deformation measurement technique to obtain 2D/3D displacement field by correlating two image acquired at different time (Travelletti et al., 2012). The detailed description of cross-correlation applied to image can be found in the literature (Adrian, 1991). DIC uses pixel intensity values to calculate incremental displacements with subpixel accuracy (Take, 2015). The basic parameters of the correlation are the "sliding window", the "search space" and "step" (Rosu et al., 2014). One of images of the series is chosen as a reference image. All images are divided into small rectangular regions consisting of NxN pixels (vary from 7x7 pixels to 70x70 pixels and even more) (Malesa et al., 2011). DIC algorithm is then tracking the position of

each subset from the reference image in all other images of the series. Corresponding subsets are matched by finding the maximum of the normalized cross-correlation function coefficient. For each subset in-plane displacement vectors are then calculated. The basic working principle of DIC is given in Figure 3. In the present study, DIC was applied to image pairs of "hillshade" grayscale images, derived from LIDAR DTMs. Because Gschliefgraben is a big landslide system, DIC analysis was only made for small part of landslide area located close to the crown (head) (Figure 4). This area was selected because more activation was observed between two series with visual inspection. Within the study area two separate active parts were observed.

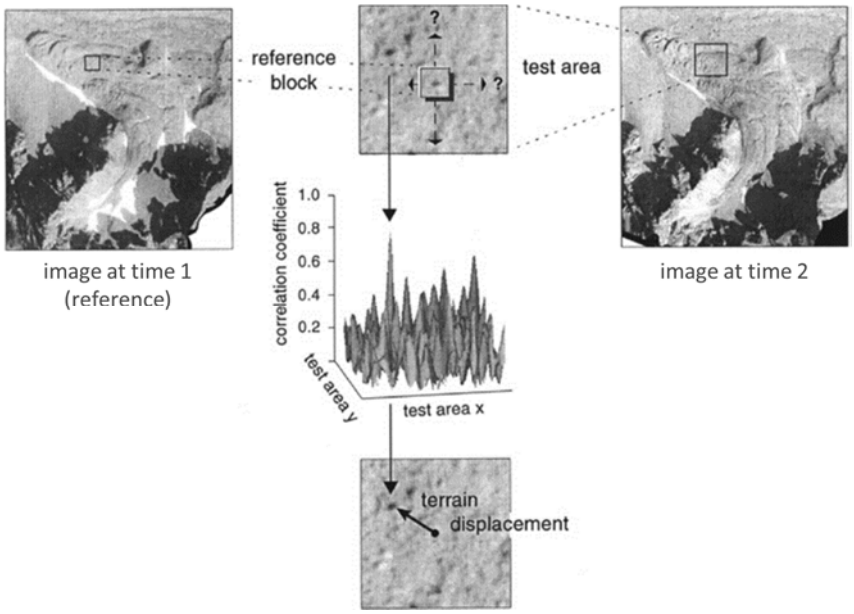

Figure 3. Schema of measuring surface displacements from two images acquired at different time by block-correlation techniques (Kääb and Vollmer, 2000)

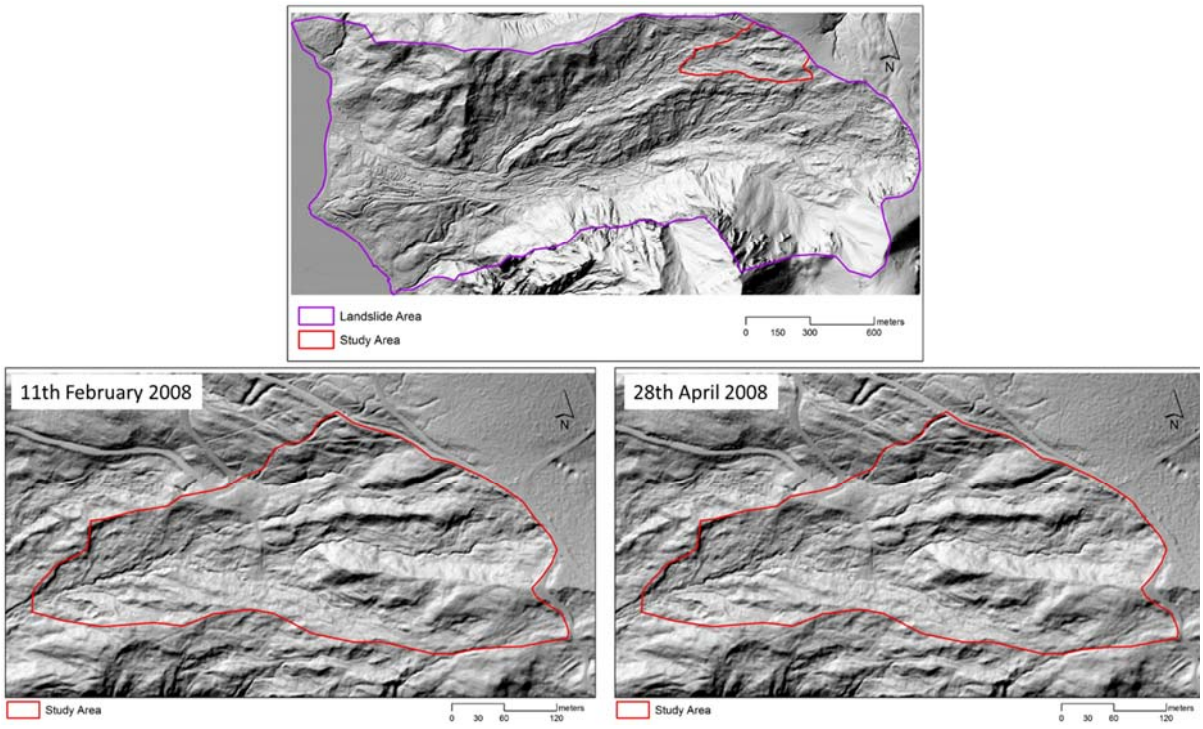

Figure 4. Selected active part of Gschliefgraben landslide for DIC analysis

DIC analysis was applied by using image correlation software (CIAS), which matches offsets between two images based on normalized cross-correlation. CIAS was originally written by M. Vollmer and A. Kääb (Kääb and

Vollmer, 2000). The inputs (i.e. both images need to be exactly same resolution and to be single channel (grayscale). The output is ASCII list of offsets in Cartesian and polar coordinates and correlation coefficients. Measuring an individual horizontal displacement vector basically follows two steps (Kääb and Vollmer, 2000): (1) choosing image section with sufficient contrast in image at time 1, called as "reference block", (2) searching the corresponding image section within a sub-area in the image at time. The ground coordinates of central pixel within the reference block are known due to usage of already georeferenced data ("Geotiff"). The difference of coordinates of central pixel within reference block and coordinates of corresponding location of central pixel in test block where correlation coefficient is maximum provides displacement. The size of the test area has to be chosen according to expected displacement. Also, textural characteristics of the ground surface have to be taken in to account for choosing the size of reference and test blocks (Kääb and Vollmer, 2000). In the present study, size of reference block was 16, and size of test block was defined as 64. Then, results from DIC was compared with displacements estimated from tracking well-constrained morphological features on shaded relief images (Daehne and Corsini, 2013; Esparmer, 2010).

Results and Discussion

DIC analysis was used to determine displacement fields from two time series (11th February 2008 and 28th April 2008) of LIDAR data with 1 m resolution in Gschliefgraben landslide. Between two time series there are 77 days. Shaded relief data with 1 m resolution were generated before DIC analysis was applied. CIAS software was selected, even though there are many other options (such as Cosi-corr, DPIVsoft Matlab, etc.) to apply DIC, because CIAS enables the users to use Geotiff data which is georeferenced, thus any further step is not necessary to convert the results to real world units. In the present study, there is no field check or any GPS surveying, however clearly identifiable features over the moving mass were tracked via visual inspection was carried out to get displacement rates in order to compare DIC results. The results were obtained as compatible with manually identified displacements rates.

Study area selected for DIC analysis is 10.19 Ha and there are two more active parts clearly identifiable by visual inspection. DIC analysis provided high displacements within these 2 more active parts of landslide (depicted in Figure 5) as expected. According to results, between two time series, displacement rates within study area were obtained between 0-32.2 m with sub-pixel precision image matching. DIC provided displacements for 25445 points. The mean displacement was obtained as 0.23 m. In the study area, 51 of all points have displacements higher than 2 m of which mean of maximum correlation coefficient is less than 0.70. Of these points, only 3 points showed displacement more than 30 m, 10 points showed displacement more than 20 m, 21 points showed displacements more than 10 m, and 17 points showed displacements more than 2 m. These points were interpreted as unrealistic (extreme) values of displacements which are not compatible with real situation.

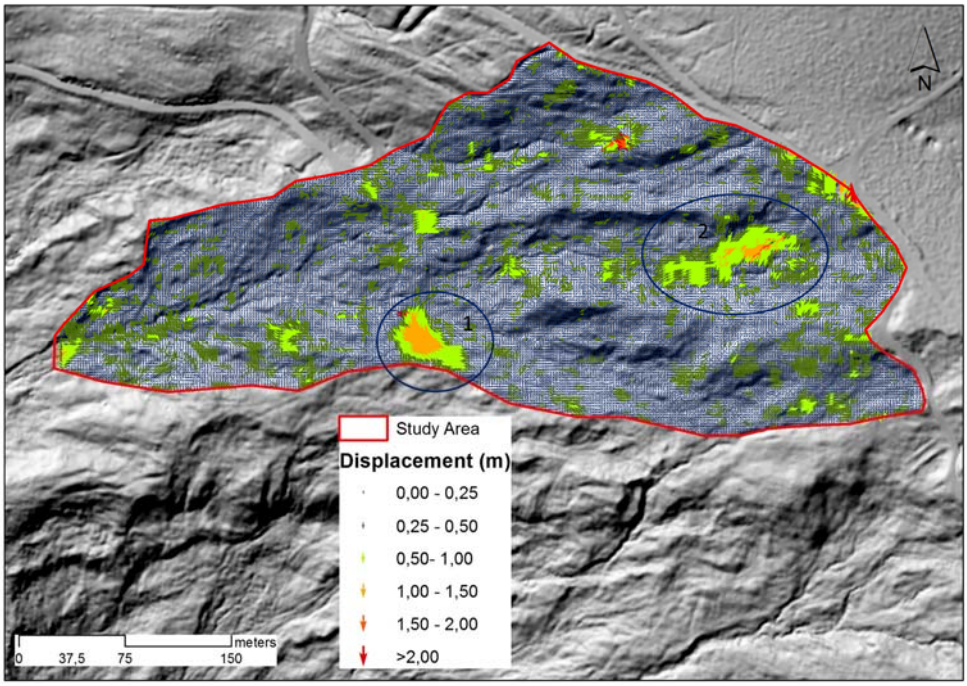

Figure 5. DIC results and two more active part of landslide (coded as 1 and 2)

Displacements obtained from DIC in two more active parts, coded as 1 and 2 (see Figure 5), were given in Figure 6 and Figure 7. Between two time series, the mean displacement rates in these more active parts within study area were obtained 0.66 m (max. 2 m) with sub-pixel precision image matching. In first active part of landslide (code no 1), displacements were observed as mean of 0.86 m and also higher than 2 m of displacements available (red circle in Figure 6) was interpreted as unrealistic. Movement direction was observed as NW, as expected due to topography. As similar to 1 coded active part of landslide, higher than 2 m of displacements was interpreted as unrealistic in 2 coded active part of landslide. Mean displacement in the 2 coded active part of landslide was obtained as 0.64 m. The movement direction in this active part of landslide was observed as SW within the upper slope, and as W within the lower slope.

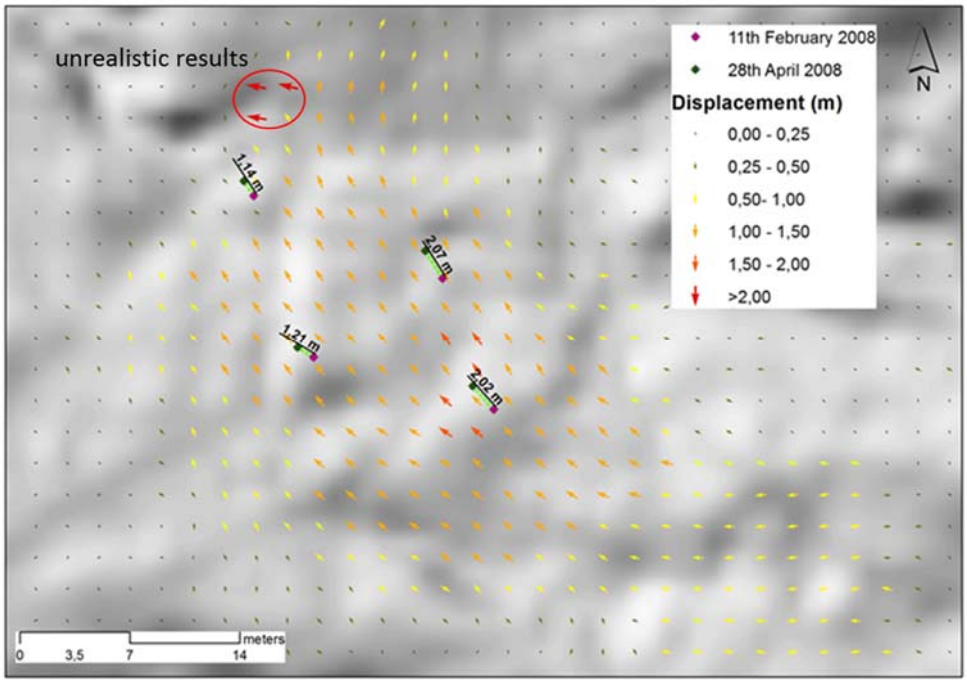

Figure 6. DIC results and displacements from manually tracked features on shaded relief within 1 coded active part of landslide

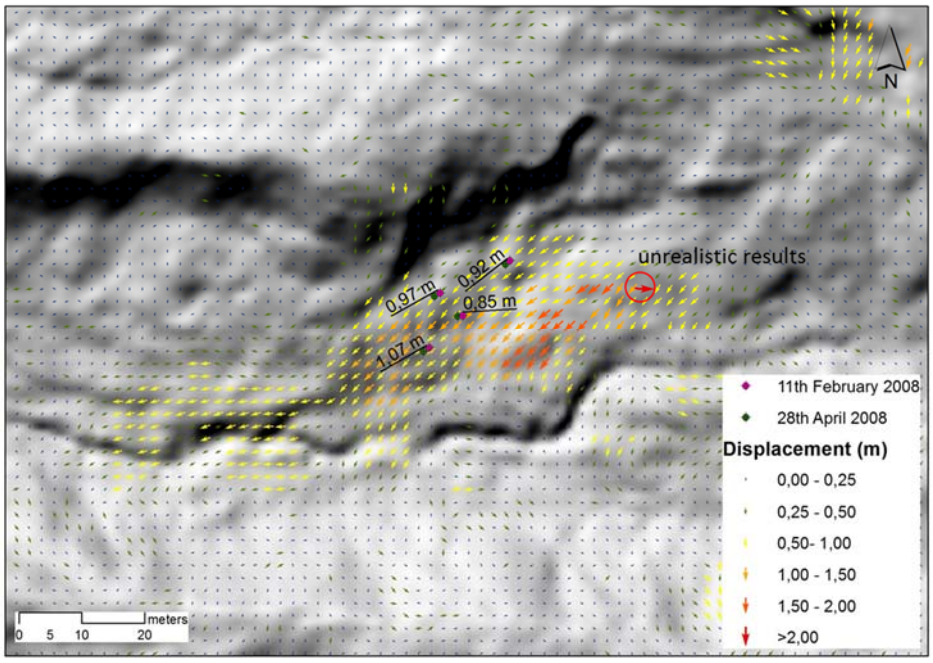

Figure 7. DIC results and displacements from manually tracked features on shaded relief within 2 coded active part of landslide.

Conclusion

Our study showed that the DIC analysis applied to shaded relief from LIDAR data can provide spatially continues, smooth, and compatible displacement fields with real situation. As Aryal et al. (2012) and Daehne and Corsini (2013) stated, the accuracy of DIC displacement measurements is of the order of a few meters, which might be an acceptable limit. The success of DIC applied to LIDAR data is closely related to presence of morphological features which must maintain their shape remaining identifiable in shaded relief maps (Daehne and Corsini, 2013). Because we couldn't have any information from field or any axillary data (such as GPS), the compatibility of displacements were evaluated by using displacements obtained by manual tracking of identifiable features over moving mass. Although the DIC analysis preferably requires having knowledge of displacement magnitude to constrain the parameters, the first-hand knowledge of displacement can easily be acquired by comparing positions of identifiable features over time (Aryal et al., 2012).

Acknowledgements

This study was granted by The Scientific and Technological Research Council of Turkey (TUBITAK) 2214/A-BIDEB Science Fellowship and Grant Program (Application No: 1059B141400900) and TUBITAK 2219-Post-Doctoral Research Scholarship (Application no: 1059B191500602). The authors would like to thank Gerhard Volk for supports in achieving data. In addition, special thanks to Forest Technical Service for Torrent and Avalanche Control (Section Upper Austria, Linz) for providing LIDAR data.

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MEASURING CORPORATE SUSTAINABILITY PERFORMANCE IN THE RUBBER COATING INDUSTRY: AN INTEGRATED MULTI-CRITERION FRAMEWORK

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Abstract: In today's competitive world, the success of firms is directly proportional to the extent to which sustainability is involved in business processes. Therefore, the sustainability performance evaluations of the firms have become a very important issue. In this study, it has been aimed to evaluate the corporate sustainability performance by using MCDM (Multi-Criteria Decision Making) methods. In this respect, the corporate sustainability performance of the firm Brisa, which operates in the international rubber and coating sector, has been evaluated on the basis of economic, environmental and social aspects. In the study on which the period of 2011-2015 has been taken as basis, the data needed has been obtained from the annual reports of the firm. In the study, only the objective weighting methods such as ENTROPY, CRITIC, SD (Standart Deviation) and MW (Mean Weight) techniques have been used in order to determine the relative importance of the criteria, while COPRAS and VIKOR methods have been used for the performance sequence on a yearly basis. An integrated single sequence has been obtained by combining the sequences obtained with the BORDA COUNT method, a data combining technique. As a result of the analysis, it has been concluded that the approach suggested in the study was an effective and appropriate approach that could be used in assessing the corporate sustainability performance.

Keywords: Corporate sustainability performance, mcdm, rubber coating industry.

INTRODUCTION

After Industrial Revolution, the rate of greenhouse gas emissions in the atmosphere increased due to the destruction of forests, the burning of fossil fuels, the use of land for different purposes, certain agricultural activities and increased industrialization. As a result, climate changes have come to the fore depending on the increase in global temperatures (DPT, 2000, p. 2). It has been emphasized in a United Nations Intergoverrmental Panel on Climate Change (IPCC) that people are responsible for the vast majority of the increase in gas emitted to the atmosphere (Black and Weisel, 2010, p. 8). This situation has increased the importance of sustainability in terms of society, state and businesses and has brought some debate on the agenda regarding to the sustainability.

The fundamental of sustainability concept is the idea of that while realizing the economic growth, the carrying capacity of the social and environmental factors must not be exceeded. It should be carried out without damaging the environment. In line with this, the carrying capacity can be defined as; the maximum number of people that can use an area without allowing any change in the physical environment and a decline in the quality of the recreational experience (Mathieson and Wall, 1982, p. 184).

The transport capacity should not be exceeded in order not to compromise from the ability of the natural systems to renew themselves and to sustain the existing lifestyle for a long time (Bayraktutan and Uçak, 2011, p. 18). Sustainable development may be defined as improvement of life standard without exceeding carrying capacity of natural systems needed for the life (Daly and Cobb, 1989).

The handling of the principles of sustainable development is defined as corporate sustainability (Signitzer and Prexl, 2008, p. 2). Corporate sustainability requires not only economic aspects but also social and environmental aspects of business activities to be taken into consideration. In this direction, there are three aspects of corporate sustainability: economic, environmental and social. The economic aspect, in short, can be defined as providing revenue to the shareholders over the average on one side and providing cash flow without facing liquidity shortage from other side in order for the businesses to be economically sustainable on the other side (Dyllick and

Hockerts, 2002, p. 133); environmental aspect can be defined as bringing hazardous wastes and emission rates to the lowest level in the production and facility planning of institutions and organizations, and increasing efficiency in resource utilization, and providing that future generations benefit from country resources in the best way (Mazurkiewicz, 2005, p. 7); social aspect can be defined as stakeholders' understanding of objectives of the business and their highly compliance with the value system of the business (Dyllick and Hockerts, 2002, p.134).

Recently, pressures increase on many firms around the world to become sustainable. In this direction, many firms share their economic, environmental and social performances with public and stakeholders at certain periods based on certain economic, environmental and social criteria by gathering them under the framework of the sustainability report and share them. Since the sustainability reporting which is based on volunteering rather than obligation come forward (Hu et al., 2011, p. 843), the profit-free global organizations and initiatives have formed and continue to form guidelines, principles and standards that guide businesses about how to do reporting (Önce et al., 2015, p. 231).

There are many different reporting frameworks globally accepted for the firms to be able to perform a clear, understandable and transparent sustainability reporting. However, the GRI guideline provides the most worldwide accepted international sustainability reporting framework (KPMG, 2008, p. 16). This guideline provides a framework which will be prepared by the firms at their own discretion, and by which the firms will be able to report their economic, environmental and social activities related to sustainability and the results of these activities. Firms, which prepare their reports based on GRI indicators, disclose them at various levels such as A, B, and C level. Each level of reporting criteria reflects a criterion related to the level or extent of implementation of the GRI Reporting Framework. Level A is the most comprehensive level of the GRI framework. Level A firms must respond to every core indicator, either reporting on it, or explaining why it is not material to their business. There must be minimum 20 indicators in the level B report, while 10 indicators in the level C being the lowest level (Tilt, 2009, p. 14). If the external audit has been utilized for the report, if the validation of the data in the report has been audited by another institution and the reliability approve has been taken, each level is declared as A+, B+ and C+. GRI has five versions as G4, G3, G3.1, G2, G1. The latest updated G4 guideline has published and put into effect in May 2013.

Firms share with public their sustainability performance through various reporting frameworks, but there are some challenges encountered in measuring corporate sustainability. Because corporate sustainability is a concept that includes conflicting criteria and decision points, therefore, the sustainability performance evaluation problem to be addressed is a typical MCDM problem, as these methods are a process that allows to make decisions in the presence of multiple, usually conflicting criteria (Hwang and Yoon, 1981, p. 1). The purposes of a MCDM are to classify and sort alternative options and to evaluate their consequences according to the criteria established and to define the parameters of the model (Zopounidis and Doumpos, 2002, p. 231). Alternatives are generally first evaluated explicitly with respect to each of the criteria to obtain some sort of criterion specific priority scores which are then aggregated into overall preference values (Choo et al., 1999, p. 527).

In this study, it has been aimed to evaluate the corporate sustainability performance of the firm Brisa by using MCDM methods. The other aim intended to be obtained in the study is; the comparison of the sequence values obtained as a result of the implementation of the different MCDM methods and the evaluation of the sequences put forwarded by the methods. With this regard, in this study firstly suitable indicators have been determined in terms of availability and data availability. Obtained indicators have been weighted by the Entropy, Critic, SD and MW techniques among the objective weighting techniques and through the help of the obtained weights, the performance sequence of Brisa firm has been performed by means of the help of Copras and Vikor methods. The obtained sequences have been combined with the Borda Count method, a data combination technique, and an integrated single sequence has been obtained.

The rest of the paper is organized as follows. The findings of previous studies have been presented in the first part of the study. In the second part, the mathematical notations and approaches of MCDM methods used in the study have been explained. Method and findings of the study have been presented in the third part and in the last part the results have been given.

LITERATURE REVIEW

This part, which has been created by compiling the related domestic and foreign literature, includes two stages. In the first stage, the studies under the sustainability heading where MCDM methods have been used, while in the second stage the studies covering the hybrid uses of the objective weighting methods have been referred to.

Studies Under the Sustainability Heading Used By the MCDM Methods

Alp, Öztel and Köse (2015), based on their studies where they took environmental and social aspects of the corporate sustainability as basis, measured the corporate sustainability performance of Linde, an international firm operating in the chemical sector, between the years 2009 and 2013 by means of MAUT (Multi Attribute Utility Theory) method, one of the MCDM methods. They determined the weights of criteria by the Entropy method. At the end of the study, the highest environmental sustainability performance has been found to be reached in the year 2011, while the highest social sustainability performance has been found to be reached in the year 2013.

Erol and Özmen (2008), evaluated the environmental sustainability of the three firms operating in the retail sector by using AHP (Analytic Hierarchy Process) and Topsis methods. In the study, the firms operating in and around İstanbul has been coded as A, B and it has been found the firm A has highest performance at the end of the analyzes.

Acar et al. (2015), evaluated the environmental sustainability performance of a corporate firm in the textile industry between 2008-2012 by using Topsis among the MCDM methods. Topsis analyzes have been conducted over two sets where different indicators have been used, and in both cases the highest performance year has been found to be the year 2010.

Yeh and Xu (2012), assessed the recycling sustainability performance of an electronic waste recycling firm operating in Australia by using Fuzzy Pairwise Comparison and Fuzzy Topsis method. In the study, e-waste products have been handled in 6 categories, and 8 criteria including 3 economical, 3 social and 2 environment criteria related to these categories have been determined. Criteria have been weighted in two different ways; optimal and equal weighting. As a result of these two cases, different sequences have emerged. In the case where the optimal weight has been used, the computer has been found to be the highest performance product, while the mobile phone used in equal weighting has been found to be the highest performance product.

Hsu et al. (2015), evaluated the corporate sustainability performance of the 30 high tech listed firms in 2011 using the modified Topsis method. They determined the weights of the criteria by means of Grey Entropy, Critic, Grey Relational Matrix Method and Combined Weight Method developed. Sensitivity analysis has been performed and as a result of this analysis it has been concluded that the results achieved by the Topsis analysis were reliable.

Rajesh and Ravi (2015), evaluated the sustainability performance of the 'ABC' firm in India based on six suppliers with the help of the GRA (Grey Relational Analysis) method. In addition, while the AHP (Analytic Hierarchy Process) and ANP (Analytic Network Process) method has been used in the study to compare the results obtained by the GRA method, the reliability of the results has been tested by using different weights by means of Sensitivity Analysis. As a result of the study, it has been observed that the sequences obtained by GRA, AHP and ANP were different.

Studies Covering the Hybrid Uses of the Objective Weighting Methods

When the studies of objective weight methods, in which hybrids have been used, have been taken into consideration, though low number of studies have been noted, it has been determined that the so-called studies have been performed for the performance evaluation purposes.

Diakoulaki et al., (1995), used the PCA (Prinicpal Component Analysis) method to measure financial performance of 8 Greek pharmaceutical firms. They preferred to use Critic, SD and MW methods, one of the objective weighting methods, for the weighting the three evaluation criteria they used. At the end of the study, it has been concluded that Critic method can be used easily in comparison between firms on the basis of multi-financial ratios.

Deng et al., (2000), weighted the evaluation criteria with Critic, Entropy, SD and MW methods in the study where they measured the performance of seven firms operating in Chinese textile industry, they ranked the firms by means of Topsis method according to their performances. At the end of the study, it has been concluded that the proposed approach was an appropriate approach in terms of performance comparisons between firms.

Wang and Luo (2010), weighted the evaluation criteria with CCSD (Correlation Coefficient (CC) and Standard Deviation (SD) integrated approach) method, which is among the objective techniques, in their study to compare 16 municipalities in China based on five economic indicators. They also compared the results obtained by the CCSD method with those obtained by the Entropy, Critic, SD and Ideal Point Method (Ma et al., 1999) techniques. At the end of the study, though it has been determined that the CCSD method was not sufficient to determine the weights of the criteria alone but was effective, this method has been found to be superior to the other methods since it does not require normalization.

Kılıç and Çerçioğlu (2016), made prioritization for railway connections in 78 locations such as Organized Industrial Zone, which has a high cargo carrying capacity of the State Railways of Republic of Turkey, factory. Criteria used in the evaluation of railway connections have been weighted by three different weighting methods: Critic, SD and MW. Six different orders of priority for these 78 locations have been identified by applying the Topsis and Vikor method from the MCDM methods. The determined sequences have been combined with the Borda Count method, and an integrated single sequence has been obtained. The sequences obtained by the MCDM methods have been compared according to the SSKK (Spearman's Rank Correlation Coefficient) method. At the end of the study, it has been determined that the Vikor sequence, in which criteria are weighted by MW method, is the closest sequence to the integrated sequence.

METHODOLOGY

Determining Sample of Research

Brisa firm has been selected for this study and the corporate sustainability performance of the firm has been evaluated through MCDM methods. Brisa, founded in 1974 under the brand name of Lassa and operating in the international tire and coating sector, Brisa leads the sector by means of many brands, services, trainings and alternative sales channels (http://www.brisa.com.tr). Brisa, whose first sustainability report published in 2012 according to the principles of the GRI Global Reporting Initiative, published the 2013 sustainability report by meeting the A+ level requirements of the GRI standard. The last sustainability report was published based on the GRI G4 guidelines in 2015.

Selecting Alternatives

One of the most fundamental features of the MCDM methods is that they have multiple options and multiple qualifications (Tabucanon, 1988, p. 5). In line with this, at least two alternatives for more than one contradictory criterion and decision must exist in order for the MCDM problem to occur. Thus, the decision maker can decide by choosing one among them. In this study, five years being 2011, 2012, 2013, 2014 and 2015 has been alternatively taken as basis in order to rank the corporate sustainability performance.

Selecting Performance Indicators

The data required for this study, where the economic, environmental and social aspects of the corporate sustainability have been taken into account, has been obtained from Brisa's annual reports (http://www.brisa.com.tr/brisa-way-of-sustainability/our-sustainability%E2%80%8B-reports). The economic, environmental and social indicators used in this study as well as their units and optimization status have been given in Table 1, Table 2 and Table 3, respectively. Based on the relevant year, criteria (EC1 ,…, EC7) given in Table 1 and given by the TL (Turkish Lira) have been converted to USD by benefiting from the information in the archive of the Central Bank of Republic of Turkey to avoid the adverse effect resulted from the inflation difference.

Table 1. Economic Indicators

Economic Indicators	Unit of Measure	Optimization State
EC1: Income	(USD)	Max
EC2: Operating Costs	(USD)	Min
EC3: Employee Wages and Other Provided Benefits	(USD)	Min
EC4: Payments to Pecuniary Resource Providers	(USD)	Min
EC5: Payments to the State	(USD)	Max
EC6: Social Investments	(USD)	Max
EC7: Protected Economic Value	(USD)	Max

Table 2. Environmental Indicators

Environmental Indicators	Unit of Measure	Optimization State
EN1: Energy Consumption	(GJ/ton)	Min
EN2: Energy Savings	(GJ/ton)	Min
EN3: Total Well Water Consumption	(m^3)	Min
EN4: Carbon Dioxide Emission	(ton CO_2-e/ production ton)	Min
EN5: Other Related Indirect Greenhouse Gas Emissions	(ton CO_2-e/ production ton)	Min
EN6: Air Emissions	(ton CO_2-e/ production ton)	Max
EN7: Total Waste Amount	(ton)	Min
EN8: Environmental Protection and Investment Expenditures	(USD)	Min

Table 3. Social Indicators

Social Indicators	Unit of Measure	Optimization State
SO1: Employee Trainings	(person/hour)	Max
SO2: Incidence Rate	(%)	Min
SO3: Severity Rate	(%)	Min
SO4: Absentee Rate	(%)	Min
SO5: Entry Level Wage by Minimum Wage	(%)	Max

Weighting of Criteria

The methods developed for Criterion weighting in the literature, have been categorized into three categories as subjective, objective and integrated. In subjective methods, the evaluation criteria are weighted according to the preferences and judgments of the decision makers, whereas in the objective methods, weighting is performed only by the help of decision matrix elements without referring to the judgments of the decision makers. In the integrated methods, on the other hand, weighting is made by using both the judgments of the decision makers and the decision matrix data together (Wang and Luo, 2010, p. 1). The subjective weighting which is made based on the knowledge of the decision maker is important in terms of the decision maker's statement of his/her expertise and experience on concerned subject; however in situations where the decision maker or the ideas change, certain question marks emerge towards solution of the problem and the problems arises in terms of reliability. The negative effects of subjective weighting are minimized by objective methods. Shannon's Entropy Method (Shannon, 1948), Critic Method (Diakoulaki et al, 1995), Multi Target Programming (Choo and Wedley, 1985), SD Method (Diakoulaki et al, 1995), MW Method (Diakoulaki et al, 1995), Maximizing Deviation Method (Wang, 1998) ve Ideal Point Method (Ma et al., 1999) can be given as an example for the objective methods.

Using objective methods that do not take into consideration the judgments of decision maker in the weighting of criterion gives more realistic outputs. Therefore, only the Entropy, Critic, SD and MW method, which considers the elements of the decision matrix and is among objective weighting methods, has been preferred in the determination of the weightings of the criteria.

Entropy Method

This concept proposed by Shannon (1948) has been developed by Wang and Lee (2009) as a weight calculation method. The Entropy method is an objective evaluation method because it calculates the criteria weights by considering the data without the subjective judgments of the decision makers in determining the importance levels of the criteria. The steps of the method are as follows (Hwang and Yoon, 1981, p. 128):

Step 1: The decision matrix D of multicriteria problem with m alternatives and n criteria is shown as follows:

$$D=\begin{array}{c} \\ A_1 \\ A_2 \\ . \\ . \\ . \\ A_m \end{array}\begin{array}{c} \begin{array}{cccc} K_1 & K_2 & .... & K_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

X_{ij}: is the value of success of alternative (i) according to the criterion (j).

Alternatives: $A=\left\{A_i \middle| i=1,2,...,\mathrm{m}\right\}$

Criteria: $K=\left\{K_j \middle| j=1,2,...,\mathrm{n}\right\}$

Step 2: Normalization of the decision matrix as:

$$NS_{ij}=\frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad \textbf{(1.1)}$$

NS_{ij} gives the value of normalized decision matrix elements.

Step 3: Calculate Entropy measure of every criteria using the following equation:

$$E_j=-k\sum_{i=1}^{m} NS_{ij} InNS_{ij}\ \forall_j \quad \textbf{(1.2)}$$

In the equation **(1.2)**, k; represents a constant and $k=\frac{1}{\ln(m)}$.

E_j the Entropy value of criterion (j) is referred.

Step 4: Define the divergence through:

$$d_j=1-E_j,\ \forall_j \quad \textbf{(1.3)}$$

d_j indicates a contrast intensity existing within the nature of j. Entropy value of criteria is referred with E_j.

Step 5: Obtain the normalized weights of criteria as:

$$w_j=\frac{d_j}{\sum_{j=1}^{n} d_j}\forall_i \quad \textbf{(1.4)}$$

$0\le w_j\le 1$ and $\sum_{j=1}^{n} w_j=1$ is obvious.

Critic Method

The Critic method is the abbreviation of Criteria Importance Through Intercriteria Correlation. It determines the weights of attributes by considering not only the standard deviation of each attribute, but also the correlations

among the attributes (Wang and Luo, 2010, p. 8). The steps of the method are as follows (Diakoulaki et al., 1995, p. 764-765; Jahan et al., 2012, p. 413).

Step 1: Normalize the decision matrix
Decision matrix elements are normalized by using the equations (**2.1**) and (**2.2**).

$$r_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}} \quad \text{for benefit criteria} \qquad \textbf{(2.1)}$$

$$r_{ij} = \frac{x_j^{\max} - x_{ij}}{x_j^{\max} - x_j^{\min}} \quad \text{for cost criteria} \qquad \textbf{(2.2)}$$

$i = 1,...,m \;\; j = 1,...,n$

$x_j^{\max}$: best performance in criterion j,

$x_j^{\min}$: worst performance in criterion j.

Step 2: Calculate the correlation coefficients
The linear correlation coefficients (ρ_{jk}) are calculated with the help of equation **(2.3)** to measure the degree of relation between the evaluation criteria.

$$\rho_{jk} = \frac{\sum_{i=1}^{m}(r_{ij} - \bar{r}_j)(r_{ik} - \bar{r}_k)}{\sqrt{\sum_{i=1}^{m}(r_{ij} - \bar{r}_j)^2 \sum_{i=1}^{m}(r_{ij} - \bar{r}_k)^2}} \; j,k = 1,...,n \qquad \textbf{(2.3)}$$

Step 3: Calculate the amount of information (C_j) andstandard deviation (σ_j)
Total information (C_j) in the criterion is calculated according to equation **(2.4)**; whereas the standard deviation (σ_j) is calculated according to equation (**2.5**).

$$C_j = \sigma_j \sum_{k=1}^{n}(1 - \rho_{jk}) \qquad \textbf{(2.4)}$$

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}(r_{ij} - \bar{r}_j)^2}{m}} \qquad \textbf{(2.5)}$$

Step 4: Determine the criteria weigts (w_j)
The weights of the evaluation criteria are calculated with the help of equation **(2.6)**.

$$w_j = \frac{c_j}{\sum_{j=1}^{n} c_j} \quad (j = 1,2,...,n) \qquad \textbf{(2.6)}$$

SD Method
SD (Standart Deviation) method determines the weights of the criteria in terms of their standart deviations. The steps of the method are as follows (Diakoulaki et al., 1995, p. 766).

Step 1: Normalization of the decision matrix
In the first stage, the decision matrix consisting of (m) number of alternative and (n) number of evaluation criteria is normalized through equations (2.1) and (2.2) which are available in the steps of Critic method.

Step 2: Calculation of standard deviation (σ_j) and criteria weights (w_j)

Standard deviation is calculated by means of equation **(2.5)** and criteria weights are calculated by means of equation **(3.1)**.

$$w_j = \frac{\sigma_j}{\sum_{j=1}^{n} \sigma_j} \quad j = 1,...,n \qquad \textbf{(3.1)}$$

MW Method

MW (Mean Weight) method is based on the assumption that all of the attributes are of equal importance. MW method should be used either when there is no information from the decision maker or when there is not enough information to distinguish the relative importance of criteria (Jahan et al., 2012, p. 413). The steps of the method are as follows (Jahan et al., 2012, p. 413).

$$w_j = \frac{1}{n} \qquad \textbf{(4.1)}$$

where n is the number of criteria.

Copras Method

The Copras method is processed based on step by step sequencing and evaluation process of alternatives in terms of importance and utility ratings (Özdağoğlu, 2013, p. 5). This method is used to evaluate the criteria values, and to increase the benefit criteria to the highest level and to evaluate the useless criteria by reducing them to the minimum level (Podvezko, 2011, p. 137). The steps of the method are as follows (Das et al., 2012, p. 237; Chatterjee et al., 2011, p. 853; Özdağoğlu, 2013, p. 6-7).

Step 1: The formation of decision matrix

Decision matrix, consisted of X_{ij} values and denoted by D, is indicated in equation **(5.1)**.

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ . \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \qquad \textbf{(5.1)}$$

A_i :i th alternative $i = 1,2,...,m$; C_j : j th evaluation criteria $j = 1,2,...,n$

Step 2: Construction of the normalized decision matrix

Decision matrix is normalized with the help of equation (5.2).

$$x_{ij}^{*} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad (\mathrm{j} = 1,2,...,\mathrm{n}) \qquad \textbf{(5.2)}$$

Step 3: Determining of the weighted normalized decision matrix D'

The weighted normalized decision matrix, which is denoted as D and includes d_{ij}, is formed by using the decision matrix normalized with weighted value of each evaluation criterion.

$$D' = \left[d_{ij} \right]_{mxn} = x_{ij}^{*}.\mathrm{w}_j \qquad \textbf{(5.3)}$$

where x_{ij}^{*} is the normalized performance value of ith alternative on jth criteria and w_j is the associated weight of the jth criteria.

Step 4: Calculation of the sums of weighed normalized criteria describing the *i*-th alternative

The sums S_{i+} and S_{i-} of weighted normalized values are computed for both beneficial and non-beneficial criteria respectively. For beneficial criteria, higher value is better and for non-beneficial criteria, lower value is better for the attainment of goal. These sums S_{i+} and S_{i-} are calculated using the following equations:

$$S_{i+} = \sum_{j=1}^{k} d_{ij} \quad j = 1,2,...,k \qquad \text{for beneficial criteria} \qquad \textbf{(5.4)}$$

$$S_{i-} = \sum_{j=k+1}^{n} d_{ij} \quad j = k+1, k+2,...,n \qquad \text{for non-beneficial criteria} \qquad \textbf{(5.5)}$$

Step 5: Calculation of the relative weight (Q_i) of each alternative

The relative weight Q_i of *i*-th alternative is calculated as follows:

$$Q_i = S_{i+} + \frac{\sum_{i=1}^{m} S_{i-}}{S_{i-} \sum_{i}^{m} \frac{1}{S_{i-}}} \qquad \textbf{(5.6)}$$

The alternative which gains the highest relative importance value as a result of calculations is determined as the best alternative.

Step 6: Determine the priority order of alternatives

The highest relative importance value is found with the help of equation **(5.7)**.

$$Q_{\max} = \max\left(Q_i\right) \forall i = 1,2,...,m \qquad \textbf{(5.7)}$$

Step 7: Calculation of performance index value (P_i) for alternatives

Performance index (*Pi*) specified for each alternative is calculated with the help of equation (**5.8**).

$$P_i = \frac{Q_i}{Q_{\max}}.100\% \qquad \textbf{(5.8)}$$

The alternative whose performance index value (*Pi*) is 100, is the best alternative. The result is obtained by sorting the performance index value from biggest to smallest value.

Vikor Method

The Vikor method proposed by Serafim Opricovic (1998) has been started to be used in the solution of the MCDM problems with the study performed by Opricovic and Tzeng (2004). The name of the method, Vikor (VlseKriterijumska Optimizacija I Kompromisno Resenje), has been created by abbreviating the initials of the expression in Slavic origin. Its meaning in Turkish language can be expressed as multi-criteria optimization and compromise solution (Görener, 2011, p. 100). The basic concept of Vıkor lies in first defining the positive and negative ideal solutions. The positive ideal solution is the alternative with the highest value while the negative ideal solution is the one with the least test value (Chu et el., 2007, p. 1012). The steps of the method are as follows (Opricovic and Tzeng, 2007, p. 447-448):

Step 1: Determination the best (f_i^*) and the worst (f_i^-) values of all criterion functions

$$f_i^* = \max_j f_{ij}, \; f_i^- = \min_j f_{ij}, \qquad \text{If the i-th function represents a benefit} \qquad \textbf{(6.1)}$$

$$f_i^* = \min_j f_{ij}, \; f_i^- = \max_j f_{ij}, \qquad \text{If the i-th function represents a cost} \qquad \textbf{(6.2)}$$

i is the comparison criterion ($i = 1,2,...,n.$), j is the alternatives ($j = 1,2,...,\mathrm{m}$).

Step 2: Computation the values S_j and R_j

S_j value refers to average group value; R_j refers to the worst group value.

$$S_j = \sum_{i=1}^{n} w_i(\mathrm{f}_i^* - f_{ij}) / (\mathrm{f}_i^* - f_i^-), \qquad \textbf{(6.3)}$$

$$R_j = \max_i \left[w_i(\mathrm{f}_i^* - f_{ij}) / (\mathrm{f}_i^* - f_i^-) \right], \qquad \textbf{(6.4)}$$

Here w_j are the weights of criteria, expressing their relative importance.

Step 3: Computation the values Q_j

Q_j values are found according to evaluation criteria by means of equation (**6.5**) for each alternative.

$$Q_j = v(S_j - S^*)/(S^- - S^*) + (1-v)(R_j - R^*)/(R^- - R^*) \quad \textbf{(6.5)}$$

Where;

$$S^* = \min_j S_j \; S^- = \max_j S_j \; R^* = \min_j R_j \; R^- = \max_j R_j$$

Value (v) refers to the weight for the strategy that provides the maximum group benefit, while value (1 - v) refers to the weight of the minimum regret of those having opposite views (Opricovic and Tzeng, 2007, p. 516). Usually v = 0.5 is used (Opricovic and Tzeng, 2004, p. 451).

Step 4: Ranking the alternatives, sorting by the values S_j, R_j ve Q_j

The S_j, R_j ve Q_j values calculated for each alternative are sorted from small to large. The alternative with the smallest value of *Qj* is considered to be the best alternative.

Step 5: Determination of the acceptable advantage (C_1) ve acceptable stability in decision making (C_2)
The alternative with the minimum *Qj* value is recommended as a compromise solution, if it meets the following acceptable advantage (C_1) and acceptable stability (C_2) conditions.

C1: "Acceptable Advantage"
For any alternative to be within C_1 cluster, such alternative should meet the condition indicated in equation (**6.6**).

$$Q(a'') - Q(a') \geq DQ \quad \textbf{(6.6)}$$

where a'' is the alternative with second position in the ranking list by Q; $DQ = 1/(J-1)$; J is the number of alternatives.

C2: "Acceptable Stability in Decision Making"
The alternative a′ must also be the best ranked by S or/and R. Alternatives available within both C_1 and C_2 clusters indicate the stable decision points according to the sense of sequence. If one of these two conditions is not provided, the set of compromise solution is proposed as follows:

Alternatives a' and a'' if only condition C2 is not satisfied, or
Alternatives $a', a'', ..., a^{(M)}$ if condition C1 is not satisfied; and $a^{(M)}$ is determined by the relation $Q(a^{(M)}) - Q(a^1) < DQ$ for maximum M. **(6.7)**

The best alternative, ranked by Q, is the one with the minimum value of Q.

Borda Count Method
The Borda Count method, one of the voting methods in social election theory, has been developed by Jean-Charles de Borda (1784). The Borda count is originally a voting method in which each voter gives a complete ranking of all possible alternatives (Erp and Schomaker, 2000, p. 444). In this method, a score zero (0) is assigned the least preferred alternative, one (1) for the next alternative and (n-1) (n refers to the number of alternatives) for the most preferred alternative.Then, alternatives are ranked as per their Borda scores.

APPLICATION

In this study, it has been aimed to measure the corporate sustainability performance of Brisa firm, which operates in the international tire and coating sector, by using MCDM techniques. In a study based on three aspects of corporate sustainability, the required data have been obtained from the annual reports of the said firm. Accessibility and data availability have been taken as basis in the determination of data. The economic, environmental and social aspects decision matrix and the weights calculated according to Entropy, Critic, SD

and MW methods by using the equations **(1.1-4.1)** related to these aspects have been given Tables 4, 5 and 6, respectively.

Table 4. Economic Dimension Decision Matrix and Weights

		EC1	EC2	EC3	EC4	EC5	EC6	EC7
	ENTROPY	0,0039	0,0185	0,0080	0,0653	0,0643	0,5887	0,2513
	CRITIC	0,1463	0,2182	0,1272	0,1273	0,1062	0,1155	0,1593
	SD	0,1470	0,1424	0,1337	0,1397	0,1477	0,1466	0,1429
	MW	0,14286	0,14286	0,14286	0,14286	0,14286	0,14286	0,14286
	2011	890.248,13	696.144,62	107.632,84	51.904,92	13.318,63	310,93	20.936,19
	2012	768.658,67	544.027,41	99.799,94	64.960,41	12425,63	174,94	47270,34
	2013	856.228,93	578163,92	113580,08	74.012,69	13.676,42	714,39	87.695,38
	2014	808.831,68	533.760,80	111.010,86	84.070,57	11.476,62	213,05	76.653,51
	2015	795.351,80	504.419,12	125653,75	98925,45	7.127,02	119,04	59107,41

Table 5.Environmental Dimension Decision Matrix and Weights

		EN1	EN2	EN3	EN4	EN5	EN6	EN7	EN8
	ENTROPY	0,0134	0,0470	0,8208	0,0318	0,0175	0,0211	0,0107	0,0377
	CRITIC	0,1054	0,1021	0,0978	0,0996	0,0868	0,0944	0,1979	0,2160
	SD	0,122807	0,118743	0,121216	0,139141	0,121048	0,121048	0,121309	0,134688
	MW	0,125	0,125	0,125	0,125	0,125	0,125	0,125	0,125
	2011	201	830	567.362	265	217	178	6841	880.195
	2012	248	968	530.738	276	235	221	6933	1.098.097
	2013	213	1086	443.755	221	221	183	7035	1.198.410
	2014	202	1222	438,486	204	177	167	7279	847.566
	2015	198	1313	490.120	202	196	166	8393	869.000

Table 6. Social Dimension Decision Matrix and Weights

		SO1	SO2	SO3	SO4	SO5
	ENTROPY	0,4230	0,2527	0,2018	0,0531	0,0694
	CRITIC	0,2283	0,2371	0,1815	0,1398	0,2133
	SD	0,2048	0,2077	0,2002	0,1934	0,1939
	MW	0,20	0,20	0,20	0,20	0,20
	2011	76,59	0,74	15,13	5,36	7,85
	2012	77,96	0,69	14,79	5,68	7,31
	2013	89,3	0,71	13,42	5,09	7,31
	2014	102,2	0,86	12,27	5,34	6,98
	2015	94,02	0,82	14,62	5,61	6,94

Weighting of Criteria

The first step of application is to determine the weights of the performance evaluation criteria. The weight values obtained for each of the three aspects by using four different objectives weight methods are shown in Table 4, Table 5 and Table 6.

Performance Measurement by Copras and Vikor Methods

Firm performance has been measured with Copras and Vikor methods by using weights obtained by means of Entropy, Critic, SD and MW methods in the second phase of application.

Application of Copras Method

In the application conducted with Copras method, first of all, the criteria have been normalized by means of equation **(5.2)**. Normalized values are shown on the Table 7. The same process is repeated for other dimensions.

Table 7. Normalized Decision Matrix

	EC1	EC2	EC3	EC4	EC5	EC6	EC7
2011	0,2161	0,2437	0,1930	0,1388	0,2295	0,2029	0,0718
2012	0,1866	0,1905	0,1790	0,1737	0,2141	0,1142	0,1621

2013	0,2079	0,2024	0,2037	0,1980	0,2357	0,4662	0,3007
2014	0,1964	0,1869	0,1991	0,2249	0,1978	0,1390	0,2628
2015	0,1931	0,1766	0,2253	0,2646	0,1228	0,0777	0,2027

Then, weighted standard decision matrix has been formed by multiplying decision matrix elements normalized by equation (**5.3**) with four different weight sets obtained. The weights obtained by using the Entropy method are given at Table 8. The same process was repeated for other weighting techniques.

Table 8: Weighted Standart Decision Matrix

		EC1	**EC2**	**EC3**	**EC4**	**EC5**	**EC6**	**EC7**
	2011	0,0008	0,0045	0,0015	0,0091	0,0148	0,1194	0,018
	2012	0,0007	0,0035	0,0014	0,0113	0,0138	0,0672	0,0407
	2013	0,0008	0,0037	0,0016	0,0129	0,0152	0,2744	0,0756
	2014	0,0008	0,0035	0,0016	0,0147	0,0127	0,0818	0,066
	2015	0,0008	0,0033	0,0018	0,0173	0,0079	0,0457	0,0509

By using the weighted standard decision matrix formed and by taking into account the optimization aspects of the criteria, useful and useless criteria have been determined with the help of equations **(5.4)** and **(5.5)** and given at Table 9.

Table 9. Useful and Useless Criteria

		S_+	S_-		S_+	S_-		S_+	S_-		S_+	S_-
	2011	0,153	0,015	**CRITIC**	0,091	0,095	**SD**	0,106	0,080	**MW**	0,103	0,082
	2012	0,122	0,016		0,089	0,086		0,099	0,075		0,097	0,078
	2013	0,366	0,018		0,157	0,095		0,177	0,084		0,173	0,086
	2014	0,1613	0,020		0,108	0,095		0,116	0,085		0,114	0,087
	2015	0,1053	0,022		0,083	0,101		0,087	0,092		0,085	0,095

After calculating the relative importance levels Q_i with the help of equation (**5.6**), the final sequence has been performed by finding performance indexes with the help of equality (**5.8**).

Table 10. Relative Importance Value and Ranking

		Q_i	**P_i**	**Rank**		**Q_i**	**P_i**	**Rank**		**Q_i**	**P_i**	**Rank**		**Q_i**	**P_i**	**Rank**
	2011	0,1748	45,52	3		0,1843	73,51	4		0,1919	74,09	3		0,1919	74,46	3
	2012	0,1428	37,16	4	**CRITIC**	0,1922	76,64	3	**SD**	0,1904	73,52	4	**MW**	0,1910	74,11	4
	2013	0,3841	100	1		0,2508	100	1		0,2589	100	1		0,2577	100	1
	2014	0,1780	46,33	2		0,2018	80,46	2		0,1973	76,22	2		0,1975	76,65	2
	2015	0,1200	31,25	5		0,1710	68,17	5		0,1615	62,38	5		0,1620	62,87	5

Application of Vikor Method

The best (f_i^*) and the worst (f_i^-) values in the Vikor method application have been determined by the help of equations **(6.1)** and **(6.2)**. This application was implemented for each dimension.

Table 11: The Best and Worst of Each Criterion

	EC1	**EC2**	**EC3**	**EC4**	**E5**	**EC6**	**EC7**
f^+	890.248,13	504.419,12	99.799,94	51.904,92	13.676,42	714,39	87.695,38
f^-	768.658,67	696.144,62	125653,75	98925,45	7.127,02	119,04	20.936,19

Then, S_j ,R_j, and Q_j scores have been calculated for each alternative by using equations **(6.3)**, **(6.4)** and **(6.5)**.While the weight values obtained with Entropy, Critic, SD and MW methods have been used in the calculation of the S_j and R_j scores, (v) has been taken as 0.5 in the calculation of values of Q_j by adopting the general practice in the literature.

Table 12: The Value of S_j , R_j, Q_j

	S_j	R_j	Q_j		S_j	R_j	Q_j		S_j	R_j	Q_j		S_j	R_j	Q_j
2011	0,675	0,399	0,728		0,500	0,218	0,805		0,433	0,143	0,663		0,434	0,143	0,693
2012	0,724	0,533	0,879		0,448	0,146	0,473		0,463	0,147	0,719		0,455	0,143	0,715
2013	**0,043**	**0,031**	**0,00**	**CRITIC**	**0,253**	**0,084**	**0,00**	**SD**	**0,233**	**0,071**	**0,00**	**MW**	**0,238**	**0,076**	**0,00**
2014	0,612	0,496	0,775		0,433	0,098	0,274		0,470	0,123	0,570		0,469	0,120	0,559
2015	0,837	0,589	1		0,659	0,1273	0,662		0,744	0,148	1		0,744	0,143	1

Two conditions to be satisfied in step 5 of the VIKOR method have been met in all sequences.

Application of Borda Count Method

In the last stage of the application, a single integrated performance sequence has been formed with the Borda Count algorithm from the eight sequence lists obtained for each aspect by means of Copras and Vikor methods by using four different weight sets in the previous step. In this direction, first of all, score 4 has been given to the alternative that has the highest performance for all the sequences obtained, and score 0 has been given to the alternative that is ranked last. Then, the obtained sequence scores have been added and a single score has been obtained. This has been repeated for three aspects. According to the total scores, the alternative that received the highest score was the first and the alternative that received the least score was the last. The results obtained by the Copras and Vikor methods and the integrated sequence results obtained by the Borda Count Method according to four different objective weight methods are given in Table 13.

Table 13. Copras, Vikor, Borda Count Method Analysis Results and Performance Ranking

ECONOMIC DIMENSION																		
	ENTROPY				**CRITIC**				**SD**				**MW**				**BORDA COUNT**	
	COPRAS		**VIKOR**		**COPRAS**		**VIKOR**		**COPRAS**		**VIKOR**		**COPRAS**		**VIKOR**			
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank		
2011	45,52	3	0,73	2	73,51	4	0,81	5	74,09	3	0,66	3	74,46	3	0,69	3	14	3
2012	37,16	4	0,88	4	76,64	3	0,47	3	73,52	4	0,72	4	74,11	4	0,72	4	10	4
2013	100	1	0,00	1	100	1	0,00	1	100	1	0,00	1	100	1	0,00	1	32	1
2014	46,33	2	0,78	3	80,46	2	0,27	2	76,22	2	0,57	2	76,65	2	0,56	2	23	2
2015	31,25	5	1	5	68,17	5	0,66	4	62,38	5	1	5	62,87	5	1	5	1	5
ENVIRONMENTAL DIMENSION																		
	ENTROPY				**CRITIC**				**SD**				**MW**				**BORDA COUNT**	
	COPRAS		**VIKOR**		**COPRAS**		**VIKOR**		**COPRAS**		**VIKOR**		**COPRAS**		**VIKOR**			
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank		
2011	12,36	5	1	5	86,37	2	0,09	3	82,15	2	0,38	3	82,17	2	0,55	3	15	3
2012	13,02	4	0,96	4	81,12	5	0,59	4	78,64	5	1	5	78,83	5	1	5	3	5
2013	14,93	2	0,78	2	81,78	4	0,06	2	80,75	4	0,08	1	80,77	3	0,08	1	21	2
2014	100	1	0,00	1	100	1	0,05	1	100	1	0,30	2	100	1	0,5	2	30	1
2015	13,79	3	0,88	3	83,34	3	1	5	81,26	3	0,59	4	80,75	4	0,82	4	11	4
SOCIAL DIMENSION																		
	ENTROPY				**CRITIC**				**SD**				**MW**				**BORDA COUNT**	
	COPRAS		**VIKOR**		**COPRAS**		**VIKOR**		**COPRAS**		**VIKOR**		**COPRAS**		**VIKOR**			
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank		
2011	89,02	5	1	5	94,46	3	0,75	3	94,29	3	0,75	3	94,40	3	0,76	3	12	3
2012	90,89	4	0,88	4	94,40	4	0,78	4	93,88	4	0,90	4	93,85	4	0,85	4	8	4
2013	97,97	2	0,07	1	100	1	0,00	1	100	1	0,00	1	100	1	0,00	1	31	1
2014	100	1	0,13	2	98,42	2	0,70	2	98,63	2	0,68	2	98,65	2	0,68	2	22	2
2015	94,21	3	0,35	3	94,01	5	0,89	5	93,74	5	0,93	5	93,73	5	1	5	4	5

CONCLUSIONS

The importance of sustainability increases for the businesses day by day. Businesses, which want to survive in today's highly competitive environment, involve the sustainability into their business processes and share their progress on the way to sustainability with the public and stakeholders. At this point, the evaluation of corporate sustainability performance of the firms has become important and a number of methods have been developed to measure sustainability performance. In line with this, in this study, MCDM methods, which provide an appropriate framework for corporate sustainability measurement, have been applied.

In this study, in which the corporate sustainability performance of the firm Brisa has been assessed by using the MCDM methods, first of all, appropriate indicators have been determined for three aspects of corporate sustainability. After calculating the determined weights of the indicators by using the Entropy, Critic, SD and MW objective weight methods, the performance sequence for the years 2011-2015 has been made by means of Copras and Vikor methods. According to the results obtained, it has been seen that MCDM methods give close results for their performance sequences when they are compared with each other.

When the results in Table 13 are examined, it has been determined that Copras and Vikor sequences obtained by different weighting techniques have generally similar results and close to the sequence obtained according to the Borda Count method . In the economic aspect, in all of the Copras and Vikor sequences obtained by four different weighting methods, the year 2013 has been found to have the highest performance. According to the Borda Count method and the integrated counting method conducted, the year 2013 has been found to have the highest performance, whereas the year 2015 has been found to be the last.

When the environmental aspect results have been evaluated, except for the Vikor sequence weighted by SD and MW method, the year 2014 has been found as the year with the highest performance in all other sequences. In the SD and MW based Vikor sequence, the year 2013 has been found as the year with the highest performance. According to the Borda Count method and the integrated counting method conducted, the year 2014 has been found to have the highest environmental sustainability performance, whereas the year 2012 has been found to be the last.

When the sequence results have been evaluated in terms of social aspect, except for the Copras sequence weighted by Entropy method, the year 2013 has been found as the year with the highest performance in all other sequences. In the Entropy based Copras sequence, the year 2013 has been found to be second rank. According to the Borda Count Method and the integrated counting method conducted, the year 2013 has been found to have the highest performance, whereas the year 2015 has been found to be the last rank.

It has been found that the trends obtained are similar, but there were some minor deviations in the sequences reached as a result of the MCDM methods. In this respect, in order to obtain a more rational result, a single sequence has been obtained by integrating the sequence list achieved by using Copras and Vikor methods with the help of different weighting techniques with the Borda Count method.

Since the methods used in the evaluation of sustainability performance in this study were mathematical methods, which are out of judgement, objective and precise results have been achieved. Therefore, it can be said that the proposed method is a suitable method for analyzing corporate sustainability performance. The use of only objective weighting methods for the weighting of the indicators can be shown as a limitation of study. In future studies, performance evaluation can be carried out with integrated methods in which both objective and subjective techniques are evaluated together. Furthermore, the sensitivity analysis of the study can also be achieved by changing and reducing some of the selected criteria or by assigning values ranging from 0 to 1 to the (v) weight value used in the Vikor method.

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PHENOLIC COMPOUNDS IN POMEGRANATE VINEGARS

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Abstract: Pomegranates are widely researched fruits for their nutritional and health benefits as well as their organoleptic properties. Pomegranate juices are rich in vitamins, minerals and phytochemicals. In addition, pomegranate juices contain potentially bioactive compounds and they are a great source of phenolic compounds such as flavonoids and phenolic acids. The use of second quality pomegranate for vinegar production can be a proper method to reduce losses due to discard of fruits. There has been growing interest in the beneficial health effects of certain fruits, wines and their by-products, like vinegars. In this study, the main phenolic compounds of pomegranate vinegars were determined by HPLC–DAD–ESI-MS. Diode-array detection (DAD) has been used for screening of the different classes of phenolic compounds, whereas MS and MS^n fragmentation data were employed for their structural characterization. Most of the compounds detected were mainly anthocyanins such as delphinidin, cyanidine and pelargonidine, and ellagitannins such as ellagic acid, punicalagin and punicaline. Additionally, phenolic acids were detected. Antioxidant activities of pomegranate vinegars were measured by using the DPPH (2,2-diphenyl-1-picryl hydrazyl) and ABTS (2,2′-azino-bis-3-ethyl-benzothiazoline-6-sulphonic acid) assays. The results showed strong correlations between antioxidative capacities and total phenolic content of pomegranate vinegars.

Keywords: Pomegranate vinegars; phenolic compounds; antioxidant capacity; DPPH.

Introduction

Modern life styles have driven consumers away from healthy dietary routines. In point of fact, their increasing concern about their health has prompted the industry to become involved in the need for food products which contribute to the prevention of illness. Pomegranate fruits are widely consumed fresh and in other processed forms as juice, jam, jelly, vinegar, wine, oil and in extract supplement. Actually, pomegranate fruits are a source of carbohydrates, minerals, crude fibres, and various biologically active compounds, such as vitamin C, and certain phenolic compounds as punicalagin, ellagic acid, gallotannins, anthocyanins (Zaouay et al., 2012). Brewed vinegar, a commonly used condiment of food, also has medicinal uses by virtue of its physiological effects, such as promoting recovery from exhaustion, regulating blood glucose, blood pressure, aiding digestion, stimulating the appetite, and promoting calcium absorption (Xu et al., 2007). Vinegar is traditionally produced from grapes by means of double fermentation (alcoholic and acetic acid). There are several advantages of using fruits for vinegar production, such as their health and organoleptic properties. The quality of vinegars changes according to the raw material, acidification system and ageing procedure (Tesfaye et al., 2002). The consumer demands for natural and high quality food products have increased the characterization and quality control these products (Cerezo et al., 2008). Nonetheless, there is no detailed information on phenolic and antioxidant properties of pomegranate vinegar. Therefore, the objectives of the present study were to evaluate phenolic profiles and antioxidant capacities of pomegranate vinegar. In addition, antioxidant capacity was measured using two common antioxidant activity methods (DPPH and ABTS).

Material and Methods

Samples and Chemicals

Pomegranate vinegar sample was obtained from domestic markets in Adana, Turkey. HPLC-grade solvents; methanol, acetonitrile, formic acid, and cyclohexane were purchased from Riedel-deHaen (Switzerland). All other reagents used were of analytical grade. Ultrapure water generated by the MilliQ system (Millipore, Bedford, MA) was used. Phenolic were obtained from Sigma-Aldrich (Steinheim, Germany).

LC-DAD-ESI-MS/MS analysis of phenolic compounds

Samples were filtered through a 0.45-µm pore size membrane filter before injection. An Agilent 1100 HPLC system (Agilent Technologies, Palo Alto, California, USA) operated by Windows NT-based ChemStation software was utilized; the HPLC equipment was used along with a diode array detector (DAD). The system comprised a binary pump, degasser, and auto sampler. The column used was a Phenomenex reversed-phase C-18 column (4.6 mm × 250 mm, 5 µm) (Torrance, California, USA). The mobile phase consisted of two solvents: Solvent A,

water/formic acid (99.5:0.5; v/v) and Solvent B, acetonitrile/solvent A (60:40; v/v). Phenolic compounds were eluted under the following conditions: 0.5 ml min^{-1} flow rate with temperature set at 25 °C; isocratic conditions from 0 to 5 min with 0% B; gradient conditions from 0% to 5% B in 20 min; from 5% to 15% B in 18 min; from 15% to 25% B in 14 min; from 25% to 50% B in 31 min; from 50% to 100% B in 3 min; followed by washing and reconditioning of the column. The ultra-violet-visible spectra (scanning from 200 nm to 600 nm) were recorded for all peaks. Triplicate analyses were performed for each sample. The identification and assignation of each compound was performed by comparing retention times and UV spectra to authentic standards; and confirmed by an Agilent 6430 LC-MS/MS spectrometer equipped with an electrospray ionization source. The electrospray ionization mass spectrometry detection was performed in negative ion mode with the following optimized parameters: capillary temperature 400°C, N_2 12 L/min; nebulizer pressure, 45 psi (Kelebek et al., 2015a). Data gaining was performed using the Multiple Reactions Monitoring (MRM) method that solely monitors specific mass transitions during preset retention times.

Individual compounds were quantified using a calibration curve of the corresponding standard compound. When reference compounds were not available, the calibration of structurally related substances was used, including a molecular weight correction factor. The stock solution was diluted to a series of appropriate concentrations with the same solvent, and an aliquot of the diluted solution was injected into the HPLC apparatus for analysis. The limits of detection (LOD) and quantification (LOQ) under the present chromatographic conditions were determined at a signal-to-noise ratio (S/N) of about 3 and 10, respectively.

Measurement of antioxidant activity

DPPH Assay: 0.1 mL of diluted vinegar was mixed with 3.9 mL of DPPH solution (2.36 mg/100 mL methanol) and vigorously vortexed. The solution was held in the dark at ambient conditions for 15 min. The absorbance was measured at 517 nm by a UV-Visible spectrophotometer (Shimadzu UV-1201, Kyoto-Japan). Trolox calibration curve was used to calculate the antioxidant activity of the vinegar extracts and to express the antioxidant capacity in mM Trolox equivalent per l of vinegar. The mean and standard deviation were calculated for the three replicates.

ABTS Assay: The ABTS solution was created at a concentration of 7 mM and mixed with 2.5 mM of potassium persulphate, and stored after incubation at 23 °C in the dark for 12–16 h. The ready-made solution was diluted with 80 % methanol to measure an absorbance of 0.7±0.01 at 734 nm. Then, 3.9 mL of ABTS solution was added to 0.1 mL of the vinegar samples and mixed vigorously. Finally 10 min. were waited to ensure reaction and the absorbance was monitored at 734 nm. The calibration curve equations related to the Trolox standard were $y=0.0004x + 0.0089$ with $R^2= 0.9996$ for ABTS and $y=0.0004x + 0.0082$ with $R^2= 0.9995$ for DPPH within a concentration range from 5 to 150 µmol/L.

Results and Discussion

Phenolic compounds of pomegranate vinegar

The phenolic compounds belonging to different families were identified according to the information provided by HPLC-DAD-ESI-MS/MS analysis: retention time, λ_{max} in the ultraviolet region, molecular ion, main fragment ions in MS/MS, and tentative identification as listed in Table 1. A total of 23 compounds were identified, including six anthocyanins (delphinidin-3,5-glycosides, cyanidin-3,5-glycoside, pelargonidin-3,5-diglucoside, cyanidin-3-glycoside, pelargonidin-3-glycoside and cyanidin pentoxide), two hydrolysable tannins (galloyl hexose and digalloyl hexose), ten ellagic tannins (ellagic acid, HHDP-hexoside, ellagic acid-hexose, ellagic acid pentose, ellagic acid-deoxyhexose, galloyl-HHDP-hexose, bis-HHDP-hexose, digalloyl-HHDP-hexose, ellagic acid derivative and galloyl-HHDP-glycoside), two gallagyl esters (gallagyl-hexose and HHDP-gallagyl-hexose) and three hydroxycinnamic acids (caffeic acid-hexose, caffeic acid-hexose derivative and caffeic acid derivative). Composition of phenolic compounds in pomegranate vinegar was similar to fruit and juice of the fruit.

Anthocyanins are natural colorants belonging to the flavonoid family. LC-ESI-MS/MS MRM chromatograms of some of the identified anthocyanins in pomegranate vinegar were shown in Figure 1. As displayed in Table 1, the molecular ion and its fragments were used to confirm the identity of the anthocyanins isolated. The retention time 26.5 minutes, showed a molecular ion m/z 449, suggesting the presence of cyanidin-3-O-glucoside, which was confirmed by the fragment ion m/z 287, which corresponds to aglycone cyanidin.

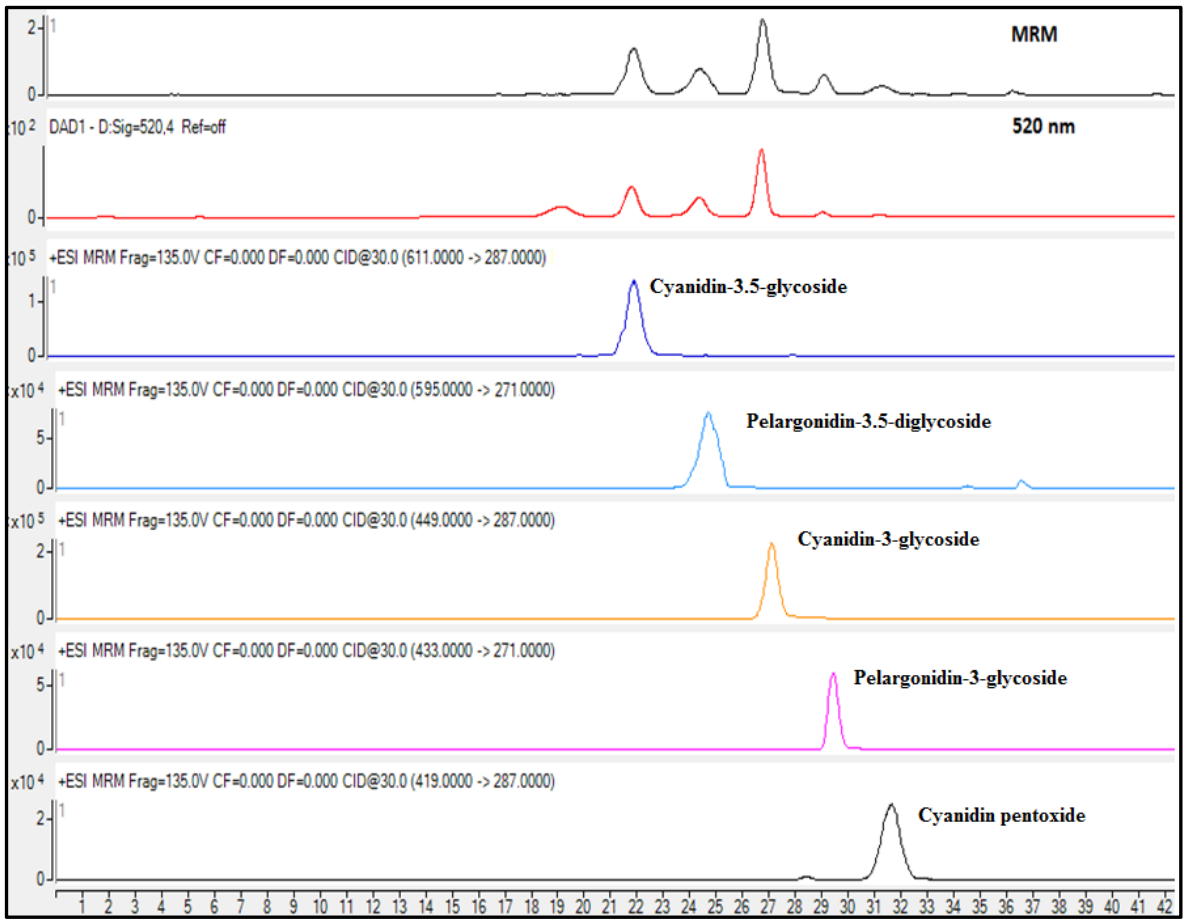

Figure 1. LC-DAD and LC-ESI-MS/MS MRM chromatograms of the identified anthocyanins. Peaks correspond to compounds in Table 1.

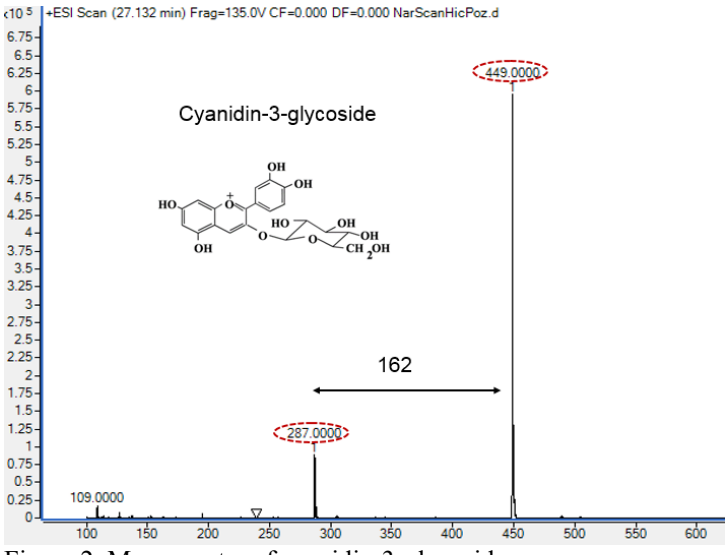

Figure 2. Mass spectra of cyanidin-3-glycoside

Anthocyanins are widely distributed among flowers, fruits (particularly in berries), and vegetables (Wang et al., 1997). Total amount of anthocyanins was found as 11.86 mg l^{-1} in pomegranate vinegar. In the study about functional constituents comparison of pomegranate juices after alcoholic and acetic acid fermentation by Ordoudi et al. (2011), total anthocyanin content of pomegranate vinegar was found close to fresh juice composition. This result displays that anthocyanins penetrate from the pomegranate to vinegar. Among the identified anthocyanins, cyanidin-3-glycoside was the major phenolic compound in vinegar followed by cyanidin-3,5-glycoside and pelargonidin-3,5-diglucoside as they constituted the large proportion of total anthocyanin content. These

compounds have already been identified by previous studies in different parts of pomegranate. Cyanidin-3-glycoside (C3G), also known as kuromanin, is probably the most notable compound among the investigated cyanidin-glycosides. Generally, this compound exists as a free form that would be of sure benefit to its antioxidant activity. Due to their strong antioxidant properties, anthocyanins are of considerable interest to the scientific community and consumer market. The naturally electron- deficient chemical structure of anthocyanins makes them highly reactive toward free radicals and, consequently, makes them powerful natural antioxidants (Nasr et al., 1996; Gómez-Caravaca et al.,2013).

Ellagitannins were the most abundant group of the pomegranate vinegar phenolic composition. Ellagitannins and hydrolysable ellagitannins are both implicated in protection against atherogenesis, along with their potent antioxidant capacity. It has been suggested that ellagitannins may prevent chronic diseases such as cancer and cardiovascular diseases. These protective activities are attributed to both classes of phytochemicals, which are thought to provide antiproliferative, anti-inflammatory, and antioxidant activities and to function as glycemic regulators (Aviram and Rosenblat, 2013). Similar to our study, ellagitannins have been found as the major phenolic group of the pomegranate juice (Gómez-Caravaca et al., 2013). Among this group galloyl-HHDP-hexose was overwhelmingly the major compound having a concentration 11.10 mg l^{-1}. The compound followed by an ellagic acid derivative, bis-HHDP-hexose and galloyl-HHDP-glycoside with the concentration 8.18 mg l^{-1}, 6.90 mg l^{-1} and 6.23 mg l^{-1} respectively.

Gallagyl-hexose (punicaline) and HHDP-gallagyl-hexose (punicalagin) compounds were identified as gallagyl esters. Between these compounds punicalagin has the majority having a concentration of 13.90 mg l^{-1} (Fig 3). Among the phenolic compounds detected in the pomegranate, highest antioxidant activity was observed for punicalagin. This compound is also abundant in the fruit husk and during processing is extracted into pomegranate juice in significant quantities reaching levels of > 2 g/L juice (Gil et al., 2000).

Antioxidant activity of pomegranate vinegar

Antioxidant capacity was measured by two methods namely, ABTS and DPPH assays. The results were found as 9.78 mM Trolox/l vinegar using DPPH assay and 12.87 mM Trolox/l vinegar by ABTS assay in average while the maximum values were 9.84 mM Trolox/l and 13.01 mM Trolox/l respectively. As it can be seen from the results, ABTS assay stated better the antioxidant activity of phenolic compounds than DPPH assay as the method gave higher values. DPPH is a free radical scavenging method, being simple, rapid and repeatable, preferably used in determining the antioxidant activity of compounds. On the other hand, ABTS is used more in the food and agriculture industry which is clearly the better method for evaluating the antioxidant capacity of pomegranate vinegar (Kelebek et al, 2015b). Zaouay et al. (2012), studied antioxidant activity of different cultivars of pomegranates. In this research antioxidant activity of the fruits were detected between 11.24-21.52 μM Trolox/l with ABTS and 11.91-22.50 with DPPH methods. Likewise, a strong correlation was observed between phenolic contents and antioxidant activities. Ordoudi et al. (2014) determined the phenolic content and antioxidant activity of pomegranate juice, wine and vinegar in comparison of two methods (DPPH and CUPRAC). Reported results displayed that antiradical potential of pomegranate vinegar showed a decrease about 55% from the fruit juice. This loss can imply that radical scavengers may degrade during fermentation. This information also shows parallelism with our results. In the very same study, punicalagin and cyanidin-3-glycoside were reported to be the main contributors in antioxidant activity. Pomegranate vinegars are stated to have higher antiradical potential from apple vinegar whereas persimmon vinegars have the highest activity among this group (Sakanaka et al., 2007; Ordoudi et al., 2014).

Conclusion

In this study, the main phenolic compounds and antioxidant activities of pomegranate vinegars were determined by HPLC–DAD–ESI-MS. Various phenolics were determined in the sample and ellagitannins were responsible for the majority with a concentration of 44.42 mg l^{-1}.Ellagitannins are known to have beneficial effects to human health due their antioxidant activities. Punicalagin were the most abundant compound in overall phenolics, hence the highest antioxidant activity was observed for this compound. Antioxidant activities of pomegranate vinegars were measured by using the DPPH and ABTS assays. ABTS method was found to evaluate better the antioxidant activity of pomegranate vinegars. The results showed correlations between antioxidative capacities and total phenolic content of pomegranate vinegars. It is deducible that the change in antioxidant activity of pomegranate vinegars depends on the phenolic content and concentration of pomegranates. However, further researches are advised to have a better understanding in pomegranate vinegars.

Table 1. HPLC-DAD-ESI-MS/MS identification of phenolic compounds

Peak	Compounds	λ (nm)	Precursor ion	Quantitative transition (m/z)	Amount (mg/l)
	Anthocyanins				
1	Delphinidin-3.5-glycoside	519, 277	627	627>303	0.74±0.01
2	Cyanidin-3.5-glycoside	513, 277	611	611>287	3.24±0.00
3	Pelargonidin-3.5-diglycoside	499, 274	595	595>271	1.00±0.00
4	Cyanidin-3-glycoside	516, 280	449	449>287	6.05±0.01
5	Pelargonidin-3-glycoside	503, 274	433	433>271	0.57±0.00
6	Cyanidin pentoxide	513, 277	419	419>287	0.24±0.00
	Total				**11.86±0.01**
	Hydrolysable tannins				
7	Galloyl hexose	375, 266	331	331>169	1.84±0.01
8	Digalloyl hexose	363, 264	483	483>331	0.81±0.01
	Total				**2.65±0.02**
	Ellagitannins				
9	Ellagic acid	367, 275	301	301>229	1.69±0.01
10	HHDP-hexoside	267	481	481>301	1.72±0.01
11	Ellagic acid-hexose	363, 252	463	463>301	1.59±0.01
12	Ellagic acid pentose	359, 255	433	463>301	0.66±0.01
13	Ellagic acid-deoxyhexose	360	447	447>300	1.31±0.01
14	Galloyl-HHDP-hexose	365	633	633>301	11.10±0.40
15	bis-HHDP-hexose	377, 253	783	783>481	6.90±0.07
16	Digalloyl-HHDP-hexose	272	785	785>633	5.04±0.03
17	Ellagic acid derivative	265	799	799>479	8.18±0.02
18	Galloyl-HHDP-glycoside	250	649	649>301	6.23±0.01
	Total				**44.42±0.37**
	Gallagyl esters				
19	Gallagyl-hexose (punicaline)	371, 262	781	781>601	3.05±0.01
20	HHDP-gallagyl-hexose (punicalagin)	378, 258	1083	1083>601	13.90±0.02
	Total				**16.95±0.02**
	Hydroxycinnamic acids				
21	Caffeic acid-hexose	293	341	341>179	6.76±0.55
22	Caffeic acid-hexose derivative	293	451	451>341	1.40±0.02
23	Caffeic acid derivative	260	299	299>137	1.26±0.01
	Total				**10.43±0.03**

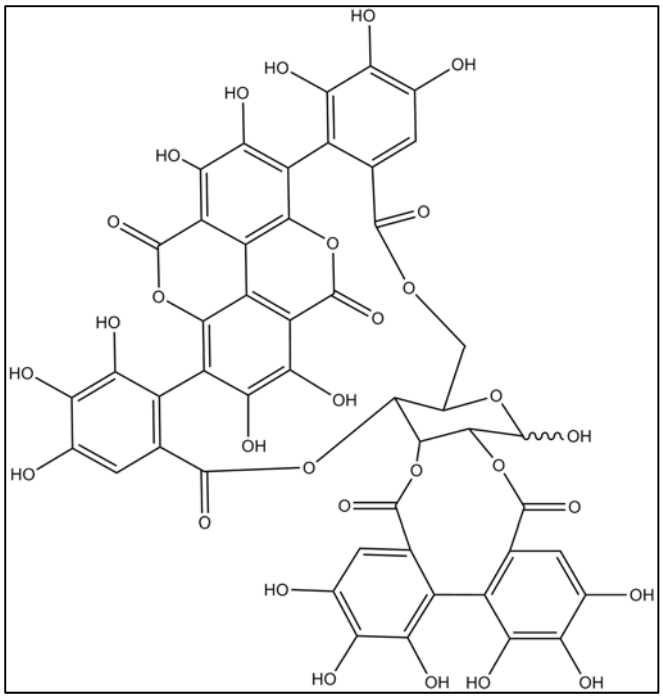

Fig 3. Structure of punicalagin, the major phenolic compound in pomegranate vinegar

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RELATIONSHIP BETWEEN STOCK MARKET INDICES AND GOOGLE TRENDS

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Abstract: This study analyzes the relationship between stock market indices and Google trends. For this purpose, 12 stock market indices whose domestic market capitalization values are more than 1.5 billion USD were chosen. Their historical adjusted close values were collected in weekly basis for 2014 and 2015. Additionally, for the same period, weekly Google search data for those indices were collected. Results showed strong correlations between number of searches and rates of stock market indices. Correlation coefficients for relations are mostly positive which implies that the stock market indices are searched more while stock market values are increasing.

Keywords: stock market, stock market index, Google trends, search query

Introduction

Recent technological developments have connected people all around the world more than ever before and provide latest information about any progress instantly. People are likely to surf the web for information retrieval using search engines. Search engines have also been used for financial issues. Stock market movements are one of the popular topics that people especially investors want to monitor.

In June 2016, 70.16 percent of worldwide Internet users searched the web without bots using online search engine Google (NetMarketShare, 2016). It is claimed in literature that large scale online data can be the predictor of public perception on various contexts such as presidential elections (Tumasjan et al., 2010), commercial sales (Mishne & Glance, 2006; Choi & Varian, 2012), and influenza epidemics (Culotta, 2010). Thus, each rise or fall in stock markets may be reflected in Google searches by investors. The volume of queries in search engine can be used as a measure of investors' attention on the stock market (Da, Engelberg & Gao, 2011).

The volume of search queries for Dow Jones reached to eleven times greater than average search volumes when its volatility has become an almost record high of over 150% annualized on October 10, 2008 (Dimpfl & Jank, 2016). When Lehman Brothers disclosed bankruptcy in September 2008, the volume of Google searches on "Lehman" was 24 times higher than the average (Ramos, Veiga & Latoeiro, 2013). In November 2009, the number of submitted searches for "Dubai World" increased six-fold, when Dubai World rescheduled a debt due to accumulated losses (Ramos, Veiga & Latoeiro, 2013). After a year, when British Petroleum caused an environmental disaster in the Gulf of Mexico, the frequency of Google searches on "BP" became three-fold during this period (Ramos, Veiga & Latoeiro, 2013).

These facts show that financial actions may cause collective behavior in online environments. Therefore, the relationship between financial events and online behaviors has become an attractive topic for researchers. Various online data sources such as social media platforms and search engines were used to analyze different relationships. Twitter is one of the mostly used social media platform for this purpose. For instance, public mood states which were measured from Twitter were found as the predictive of changes in Dow Jones Industrial Average closing values (Bollen, Mao &, Zeng, 2011). Zhang, Fuehres and Gloor (2011) collected six-month Twitter feeds and analyzed collective hope and fear for each day. It is found that emotional tweet percentage significantly negatively correlated with Dow Jones, NASDAQ and S&P 500, but displayed significant positive correlation to VIX (Zhang, Fuehres & Gloor, 2011).

Online news sources are also analyzed whether they are the predictor of financial metrics. Gilbert and Karahalios (2010) used a blog dataset consisting a stream of all LiveJournal posts and shown that a broad index of mood from an online community has novel predictive information about the stock market. In another study, a positive correlation was found between the daily number of mentions of a company in the Financial Times and the daily transaction volume of a company's stock both on the day before the news is released, and on the same day as the news is released (Alanyali, Moat & Preis, 2013).

Search engine queries are other sources of information that can be used as the predictor of fluctuations in stock market indices. It was found that weekly transaction volumes of S&P 500 companies were correlated with weekly search volume of corresponding company names (Preis, Reith & Stanley, 2010). In a sample of S&P 500 firms over the period 2005-2008, it was found that, over a weekly horizon, online search intensity reliably predicts abnormal stock returns and trading volume, and that the sensitivity of returns to search intensity is positively related to the difficulty with which a stock can be arbitraged (Joseph, Wintoki & Zhang, 2011). Bordino and his colleagues (2012) shown that daily trading volumes of stocks traded in NASDAQ-100 were also correlated with daily volumes of queries related to the same stocks. In another study, the volume of Google search queries were found as the predictor of foreign currency rates (Smith, 2012). Another interesting study in 2013 showed that there is a relationship between subsequent stock market moves and the historic data relating to politics or business from the search engine Google and online encyclopedia Wikipedia, as well as judgments from the service Amazon Mechanical Turk (Curme et al., 2014). In particular, they found that increase in search volume of the topics tends to precede stock market falls. Arditi, Yechiam, and Zahavi (2015) analyzed the relationship between stock-specific events and associated Google searches using daily data of 13 stocks from the Dow-Jones and NASDAQ100 indices, over a period of 4 trading years. They found a correlation between the magnitude of stock returns at the beginning of the period and the volume, peak, and duration of search generated during that period. That study revealed that losses improved the fit between people's search behavior and the extent of real-world events triggering the search (Arditi, Yechiam & Zahavi, 2015).

In this study, the relationship between stock market indices and Google trends is analyzed. Since previous studies have mostly focused on stock market indices in USA such as NASDAQ or S&P500, this study aims to analyze stock indices from different countries.

Materials and Methods

As it is mentioned before, the main aim for this exploratory study is to find out possible correlations between stock market indices and Google Trends for a period of two years, 2014 and 2015. For this purpose, the biggest stock markets were chosen according to their market capitalization. Thus, December 2015 market capitalization value of 1.5 million USD was chosen as the cut off point for market capitalization. Then, based on the World Federation of Exchanges Members statistics, 12 stock market indices from America, Europe and Asia were chosen with domestic market capitalizations listed in Table 1 (WFE, 2016).

Table 1: Chosen Stock Market Indices and Countries

Stock Market Index	Country	Domestic Market Capitalization Value (Dec, 2015)
NYSE	USA	17,786,787.40
NASDAQ	USA	7,280,752.17
Nikkei225	Japan	4,894,919.10
SSE Composite Index	China	4,549,288.00
LSE.L	England	3,878,774.20
Shenzhen Stock Exchange	China	3,638,731.30
Euronext 100	European Union	3,305,901.40
HKEX	Hong Kong	3,184,874.20
Deutsche Boerse AG	Germany	1,715,800.50
TMX Group Limited	Canada	1,591,928.60
SIX Swiss Exchange	Switzerland	1,519,323.50
S&P BSE SENSEX	India	1,516,216.70

After stating the stock market indices for the study, the weekly adjusted close values of them were collected for a chosen time interval of 104 weeks, from first week of 2014 to last week of 2015. Since the trending search data for terms can be collected from Google Trends web site (GoogleTrends, 2016) in weekly time interval, the stock market data was collected in same proportion.

There are several sources in the World Wide Web for collecting finance data but for being consistent and reliable in the analysis, the most popular finance data source Yahoo Finance (YahooFinance, 2016) was chosen. The historical prices of the chosen stock markets were collected for 104 weeks from first week of 2014 to last week of 2015.

After collecting weekly stock market index data of those 12 biggest markets, the trending search data of them were gathered from Google Trend web site. In this perspective, the keywords were stated carefully for those stock markets. Accordingly, first of all, the official web sites of those stock markets were examined. Then, the official abbreviations of those stock market indices were used as trending data keyword. In fact, Google also informs users about the type of keyword while searching. Therefore, Google trend keyword type "stock exchange" and related country were chosen during trend data search.

Moreover, it should be stated that Google gives the search trend data in 1-100 scale. This means Google standardizes the search trend of the chosen term for the chosen time interval into a scale of 1 to 100. The most popular (trending) week is given a value of "100" and the others are declared accordingly.
Lastly, the main purpose of this study is to examine the possible predictive effect of Google trend on stock market indices. For this purpose, Google trend and following week's adjusted close values of stock market indices were gathered.

Results

Results showed the existence of correlation between adjusted closed values of stock market indices and their Google search volumes. Out of 12 separate correlations of different indices, 6 of them were positively correlated, 3 of them were negatively correlated and remaining 3 were not correlated with Google search volume data.

Table 2: Google Searching Trend vs. Adjusted Closed Values of Stock Market Indices

Stock Market Index	Country	Correlation Results		
		Pearson Correlation Coefficient	Significance (2 Tailed)	Direction of Relation
NYSE	USA	-0.076	0.445	-
NASDAQ	USA	-0.789	0.000**	Negative
Nikkei225	Japan	0.358	0.001**	Positive
SSE Composite Index	China	0.661	0.000**	Positive
LSE.L	England	-0.508	0.000**	Negative
Shenzhen Stock Exchange	China	0.211	0.033*	Positive
Euronext 100	Europe	0.452	0.000**	Positive
HKEX	Hong Kong	0.498	0.000**	Positive
Deutsche Boerse AG	Germany	-0.125	0.209	-
TMX Group Limited	Canada	-0.197	0.047*	Negative
SIX Swiss Exchange	Switzerland	-0.159	0.107	-
S&P BSE SENSEX	India	0.360	0.000**	Positive

* significant at 5% alpha level; ** significant at 1% alpha level

When domestic results sorted in terms of their correlation values, the most significant and the correlated one appears as NASDAQ. This result shows that NASDAQ index has the most impact on Google in terms of peak and trough points. Another finding for NASDAQ is that the correlation is negative which explains that when people search NASDAQ more, the adjusted close value decreases.

SSE Composite Index with correlation value 0.661 follows NASDAQ as the second mostly correlated index. However, its direction of correlation is positive which means when people search this index more than the adjusted close score is also increasing.

LSE.L which is London stock market index is negatively correlated with a correlation value of -0.508. HKEX, Euronext 100, S&P BSE SENSEX, Nikkei225, and Shenzen stock market indices are significantly correlated with related Google search volume data in a positive manner. Lastly, TMX Group Limited is negatively correlated with a correlation value of -0.197.

Discussion and Conclusion

Search engine query data provides great insights into many areas such as presidential elections, commercial sales, and influenza epidemics. Financial issues have been also studied with the data from search engines. In this study, the relationship between adjusted closed values of stock market indices and the search volume of related indices has been investigated. For this purpose, correlation analysis between adjusted close values of 12 stock market indices, of which daily domestic market capitalization values are more than 1.5 billion USD, and Google search volume data for those indices has been applied for the two year period, 2014 to 2015 on weekly basis.

The results of the correlation analysis showed that out of 12 market indices, 9 of them were significantly correlated and 3 of them were not.

One of the uncorrelated indices was NYSE. This might be because of the global structure of NYSE where the investment funds in NYSE are more about global companies and firms rather than individual players. The other two uncorrelated indices were Deutsche Boerse and SIX Swiss Exchange. The reason for these results could be the effect of Euronext that has been formed as a merger of the Amsterdam, Brussels, and Paris Bourse, in order to take advantage of the harmonization of European Union financial markets and which has become the possessor of the market capitalization value in Europe. Hence foundation of Euronext might have decreased the attractiveness of these two indices and therefore has affected their correlations with the Google search volume data.

When the significantly correlated market indices are considered, it was seen that, in line with the previous studies (Curme et al., 2014; Arditi, Yechiam & Zahavi, 2015), there were negative correlations for indices that have dominancy in the stock market. These indices are NASDAQ, LSE.L and TMX Group Limited.

For other countries rather than USA, Canada and England, positive correlations were found between stock market indices and Google search volume data which implies when there is an increase in search volume this may indicate an increase in stock market indices.

The main limitation of the study is the weekly collection of stock market index value due to the weekly retrieval ability of Google search volume data. For this reason daily correlation analysis could not be applied.

In this study, Google search volume data was used as the predictor of stock market index which was measured one week after Google trends. In future studies, this analysis may be applied for other time horizons. On the other hand, only the names of stock market indices were used as the keywords in Google search queries. Other keywords such as names of companies related to those indices can also be used and their effect can be investigated.

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SYNTHESIS AND CRYSTAL STRUCTURE OF HG(II) COORDINATION POLYMER WITH THE RIGID 4,4'-ABPY

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Abstract: The new coordination polymer with saccharinate (sac) and 4,4'-azobispyridine (azpy), namely $[Hg(sac)_2(\mu\text{-azpy})_2]_n$ was synthesized and single crystal X-ray diffraction. Single crystal X-ray analysis reveals that sac ligand acts N-coordinated and 4,4'-abpy ligand exhibits as bridging ligand. In complex**,** the Hg(II) ion and all ligands are linked by coordination bonds and 4,4'-abpy ligands connect the Hg(II) centers forming a one-dimensional coordination polymer. In complex, the sac ligands N-coordinated to the Hg(II) ion and distorted tetrahedron geometry of Hg(II) ion is completed by bridging 4,4'-abpy ligands.
Keywords: 4,4'-Azobispyridine; Saccharinate complexes; Coordination polymers

Introduction

Saccharine is an important molecule in biological systems and forms a number of complexes with different metal ions rather easily. Moreover, it contains three functional groups, namely imino nitrogen, carbonyl and sulphonyl oxygen (Baran, 2005). All these properties make it a quite preferable ligand in coordination chemistry. The deprotonated form of this molecule, saccharinate anion, usually connected to the metal centers via negatively charged nitrogen atom (Bıyık, 2007). This mode is typically observed in the aquabis (saccharinato) complexes of transition metals (Baran, 2005). This type of metal saccharinates may be useful starting materials for the preparation of mixed-ligand saccharinate complexes. Our interest has been focused on metal–saccharin–azobispyridine system, in which azobispyridine plays an important role in the construction of supramolecular architectures organized by coordinated covalent or supramolecular contacts (such as hydrogen-bonding, π-π interaction etc.) (Li, 2001; Zhuang, 2006). Since, 4,4'-abpy possess a special structure with a larger π-bond conjugated system and two active nitrogen atoms, it is especially suitable to connect remote metal centers in the stepwise construction of polynuclear arrangements (Launay, 1991). 4,4'-abpy ligand has four possible sites of coordination, namely the two pyridine nitrogens and the two azo nitrogens. Pyridine nitrogens are much more accessible for coordination for sterical reasons.

Materials and Methods

All chemicals used were of analytical reagent quality. The 4,4'-abpy ligand was synthesized by oxidation of the 4-aminopyridine with NaOCl according to literature (Kirpal-Reiter method) (Baldwin, 1969). The X-ray diffraction data of complexes were collected with a Bruker Kappa Apex2duo diffractometer. The structures were solved and refined by full-matrix least-squares techniques on F^2 by using the SHELX-97 program (Sheldrick, 1997]. The absorption corrections were done by the multiscan technique. All non-hydrogen atoms were refined anisotropically. All non-water hydrogen atoms were included in the refinement process by using a riding model.

Results and Discussion

Experimental

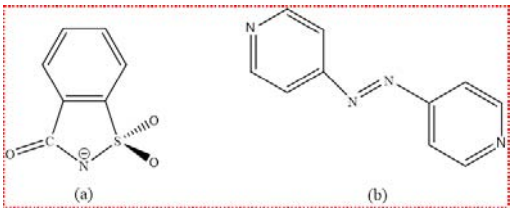
Synthesis of 4,4'-azobispyridine

4,4'-abpy was prepared by oxidative coupling of 4-aminopyridine by hypochlorite, using Kirpal-Reiter method (Baldwin, 1969). Sodium hypochlorite (50 ml) was cooled in the solid CO_2-methyl alchol bath. A solution of 4-aminopyridine (2 g) in water was added dropwise to stirred hypochlorite solution. 10 minutes later the resulting deep red solution was immediately extracted with diethyl ether. The solvent evaporated and the solid was recrystallized from petroleum ether.

Synthesis of $[Hg(sac)_2(\mu\text{-azpy})_2]_n$

For the synthesis of mixed-ligand saccharinate complex with Hg(II), it is a common strategy to apply $[Hg(sac)_2(H_2O)_4]\cdot 2H_2O$ as synthetic precursors. To prepare it, sodium saccharine was dissolved in water and added to the hot water solution of Hg_2SO_4 . The mixture was stirred at 80 °C for 3 h and then cooled to room temperature. The precipitate formed was filtered out and washed with water and dried in a vacuum. The complex was prepared by the direct reaction of 4,4'-abpy with this starting aqua-saccharinate complex in solution. A solution of 4,4'-abpy

in ethanol was added dropwise to stirred aqueous solution of $[Hg(sac)_2(H_2O)_4]\cdot 2H_2O$. The mixture was heated under reflux for 2h and afterwards cooled to room temperature. After nearly a couple of weeks, well-formed crystals were selected for X-ray studies.



Scheme 1. (a) Schematic structure of saccharinate anion (sac); **(b)** Schematic structure of 4,4'-azobispyridine (azpy)

Description of Crystal Structures

A summary of crystallographic data, experimental details, and refinement results for the complex is given in Table 1. Selected bond lengths, angles and the hydrogen bonding geometry is given in Table 2.

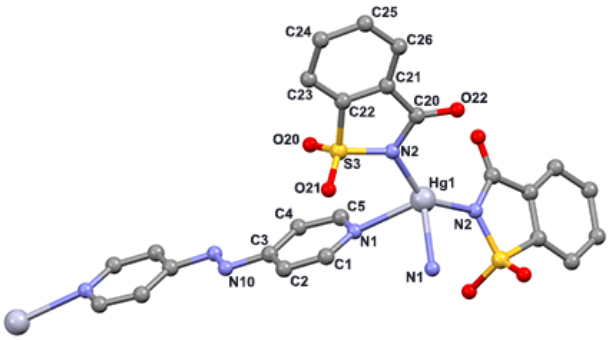


Fig. 1. The crystal structure of the complex showing the atom numbering scheme.

The asymmetric unit of the complex contains one Hg(II) ion, two sac and two 4,4′-abpy ligands (Fig. 1). In complex, the 4,4'-abpy ligands bridge the Hg(II) centers through the nitrogen atoms to form a one-dimensional polymeric structure (Fig. 2.). The sac anions connects to the metal center via the negatively charged nitrogen atom.

Table 1. Crystal data and structure refinement parameters for complex.

Crystal data	Complex
Empirical formula	$C_{24}H_{16}N_6O_6S_2Hg$
Formula weight	749.13
Crystal system	Orthorhombic
T (K)	100 (2)
λ (Å)	0.71073
Space group	P c c n
a (Å)	19.697(2)
b (Å)	8.4999(8)
c (Å)	15.3059(15)
V (Å3)	2562.5(4)
Z	4
Dc (gcm^{-3})	1.942
μ (mm^{-1})	6.222
Measured ref.	2471
q Range (º)	2.61–30.50
Crystal size (mm)	0.34 × 0.20 × 0.04
Rint	0.0815
R, Rw[I>2s(I)]	0.0699, 0.0807

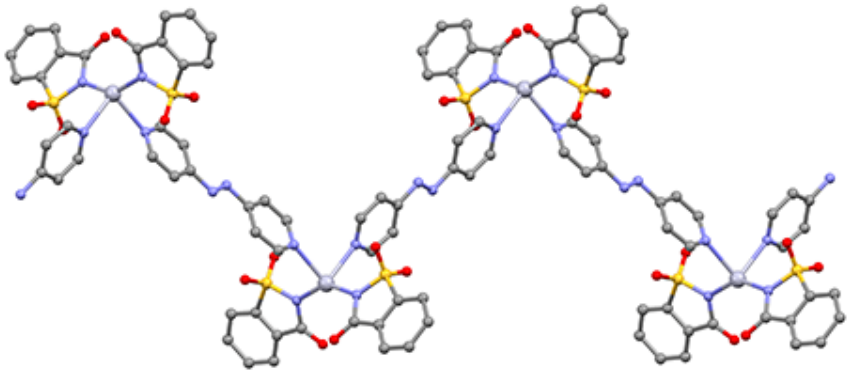


Fig. 2. View of the infinite 1D chain structure of the complex.

Table 2. Selected bond distances and angles for complex (Å, º)

Hg1-N2	2.111(4)	Hg1−N1	2.399(4)
N2-Hg1-N2	145.0(2)	N2-Hg1-N1	108.23(13)
N2-Hg1-N1	97.04(13)	N1-Hg1-N1	87.24(18)

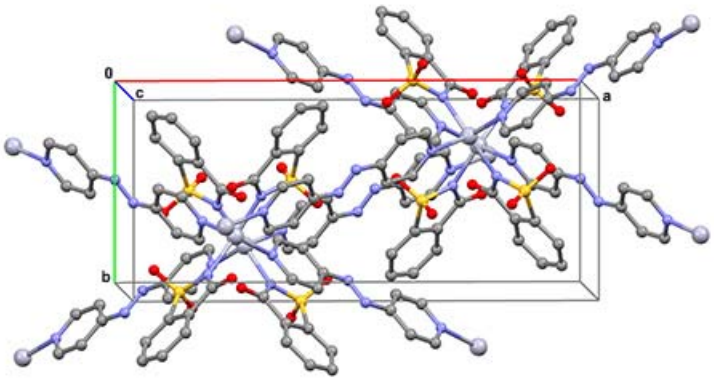


Fig. 3. View of the unit cell in the complex.

Conclusion

The new coordination polymer, $[Hg(sac)_2(\mu\text{-azpy})_2]_n$, was synthesized and structurally characterized by single crystal X-ray diffraction. Azobispyridine plays an important role in the construction of supramolecular architectures organized by coordinated covalent or supramolecular contacts.

Acknowledgements

We thank Dr. Wolfgang Frey for crystallographic data collection.

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SYNTHESIS, IN VITRO INHIBITION EFFECT AND STRUCTURE-ACTIVITY RELATIONSHIP OF NEW THYMOL DERIVATIVES ON CHOLINESTERASES

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Abstract: Alzheimer's disease (AD) is a progressive neurodegenerative disease and the most common form of dementia that affects aged people. Acetylcholinesterase is a hydrolase involved in the termination of impulse transmission at cholinergic synapses by rapid hydrolysis of the neurotransmitter ACh in the central and peripheral nervous system. Thymol is a main bioactive monoterpene isolated from many medicinal herbs, such as Thymus vulgaris, Monarda punctate and Origanum vulgare spp. Thymol has been widely used as an active anti-inflammatory ingredient, which can inhibit the isoproterenol induced inflammation in myocardial infarcted rats. Moreover, many studies have reported that thymol has various bioactivities, such as anticancer, anti-bacterial, and antioxidant properties. In this paper, a series of 12 novel thymol substituted carbamate derivatives (**2a-l**) was synthesized and their inhibitory activities on AChE and BuChE were evaluated. Among them, **2k** exhibited the strongest inhibition against AChE with an IC_{50} value of 2.498 μM, which was 183-fold more than that of thymol (IC_{50} = 458.23 μM). The structure-activity relationship were also investigated.

Keywords: Thymol, Cholinesterases, Inhibitor

Introduction

Thymol is a main bioactive monoterpene isolated from many medicinal herbs, such as Thymus vulgaris, Monarda punctate and Origanum vulgare spp. Thymol has been widely used as an active anti-inflammatory ingredient, which can inhibit the isoproterenol induced inflammation in myocardial infarcted rats, attenuate collagenase-induced osteoarthritis, and alleviate allergic airway inflammation in ovalbumin-induced Mouse asthma. Moreover, studies have reported that thymol has various bioactivities, such as anticancer, anti-bacterial, and antioxidant properties. Recent studies focusing on the neuroprotective activities of thymol have shown that it attenuates amyloid or scopolamine induced cognitive impairment in rats (Deng, 2015)

Numerous plants and their constituents have been reputed in traditional practices of medicine to enhance the cognitive function and to alleviate other symptoms of AD, including depression. Besides the *Salvia* species are known as a remedy for cognitive disorders, research on *Thymus vulgaris* essential oil also indicates their neuroprotective effects. Due to their small molecular size and lipophilicity, volatile constituents of essential oils and liberated volatile aglycones from glycosides are likely to readily cross the blood–brain barrier (Jukic, 2007). Alzheimer's disease (AD) is a progressive neurodegenerative disease and the most common form of dementia that affects aged people (Ruiz, 2005). Acetylcholinesterase (AChE; EC 3.1.1.7) is a hydrolase involved in the termination of impulse transmission at cholinergic synapses by rapid hydrolysis of the neurotransmitter ACh in the central and peripheral nervous system. AChE inhibitors (AChEI) inhibit the hydrolysis of ACh improving both the level and of duration of neurotransmitter (Citron, 2004). Another cholinesterase, butyrylcholinesterase (BuChE; EC 3.1.1.8), primarily localized in plasma, liver and muscle tissues, able of hydrolyzing ACh and other acylcholines differs from AChE for tissue distribution and sensitivity to substrates and inhibitors (Wu, 2012). AChE inhibitors such as galantamine, rivastigmine, and donepezil are the main stay drugs for the clinical management of AD in the early to moderate stage (Catto, 2013).

In this study, a novel series of 12 thymol derivatives (**2a-l**) was synthesized and their inhibitory effects on AChE and BuChE were evaluated. Structure-activity relationship was also investigated.

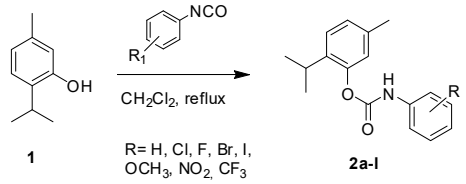
Materials and Methods

Synthesis of thymol derivatives: Thymol (1 mmol) was dissolved in CH_2Cl_2, then Et_3N (1 mmol) and isocyanate derivatives (1.25 mmol) were added to the solution, respectively. The mixture was refluxed for overnight, cooled and washed with water. The organic layer was dried over Na_2SO_4, and concentrated in vacuo. *2-isopropyl-5-methylphenyl-4-nitrophenylcarbamate (**2k**)*: ^{1}H NMR ($CDCl_3$, 300 MHz) δ/ppm: 1.21 (6H, d, J=7.0 Hz), 2.33 (3H, s), 3.05-3.10 (1H, m), 6.92 (1H, s), 7.07 (1H, d, J=8.0 Hz), 7.23 (1H, d, J=8.0 Hz), 7.53 (1H, s, NH), 7.59 (2H, d, J=9.4 Hz), 8.19 (2H, d, J=9.4 Hz); ^{13}C NMR ($CDCl_3$, 75 MHz) δ/ppm: 21.1, 23.4, 27.3, 118.3, 122.9, 125.4, 126.9, 127.9, 137.1, 137.6, 143.5, 143.8, 147.4, 151.8.

Anticholinesterase activity assays: Acetyl- (AChE) and butyryl-cholinesterase (BuChE) inhibitory activities of the synthesized compounds were determined according to Ellman's method (Ellman, 1961). The IC_{50} was determined by constructing an absorbance and/or inhibition (%) curve and examining the effect of five different concentrations. IC_{50} values were calculated for a given antagonist by determining the concentration needed to inhibit half of the maximum biological response of the agonist. The substrates of the reaction were acetylthiocholine iodide and butyrylthiocholine iodide. 5,5'-dithio-bis(2-nitrobenzoic) acid (DTNB) was used to measure anticholinesterase activity. Stock solutions of the compounds and galanthamine in methanol were prepared at a concentration of 4000 µg/mL. Aliquots of 150 µL of 100 mM phosphate buffer (pH 8.0), 10 µL of sample solution and 20 µL AChE ($2.476x10^{-4}$ U/µL) (or $3.1813x10^{-4}$ U/µL BuChE) solution were mixed and incubated for 15 min at 25ºC. 10 µL of DTNB solution was prepared by adding 2.0 mL of pH 7.0 and 4.0 mL of pH 8.0 phosphate buffers to a mixture of 1.0 mL of 16 mg/mL DTNB and 7.5 mg/mL $NaHCO_3$ in pH 7.0 phosphate buffers. The reaction was initiated by the addition of 10 µL (7.1 mM) acetylthiocholine iodide (or 0.79 mM butyrylthiocholine iodide). In this method, the activity was measured by following the yellow colour produced as a result of the thio anion produced by reacting the enzymatic hydrolysis of the substrate with DTNB. Also, methanol was used as a control solvent. The hydrolysis of the substrates was monitored using a BioTek Power Wave XS at 412 nm.

Results and Discussion

The synthetic procedures to obtain the target compounds **2a-l** are depicted in Scheme 1.



Scheme 1. Synthesis of novel thymol derivatives

The IC_{50} values for AChE and BuChE inhibitions are summarized in Table 1. IC_{50} values against AChE ranges from 2.498 µM to 288,46 µM. Compound **2k** exhibited the strongest inhibition against AChE with an IC_{50} value of 2.498 µM, which was 183-fold more than that of thymol (IC_{50} = 458.23 µM). Also, it approached that of galantamine (IC_{50} = 2.051 µM). Furthermore, most of the synthesized carbamate derivatives (**2a**, **2c**, **2d**, **2e**, **2f**, **2g**, **2h**, **2i**, **2j**, **2k**, and **2l**) exhibited better AChE inhibition (IC_{50} = 2.498 µM – 288,46 µM) than thymol, by 0.6-183 fold. All of the synthesized compounds inhibited BuChE. Compound **2a** exhibited the strongest inhibition against BuChE with an IC_{50} value of 1.65 µM, which was 137-fold more than that of thymol (IC_{50} = 226.13 µM).

The following conclusions should be noted regarding the ChEs inhibitory data of Table 1: (i) Moving the fluorine atom at the phenyl ring from the meta-position to the para-position led to a major decline of the inhibitory activity for both ChEs (compared **2c** (R=3-F, IC_{50} = 88.52 and 3.85 µM for AChE and BuChE, respectively) and **2d** (R=4-F, IC_{50} = 288.46 and 405.15 µM for AChE and BuChE, respectively)). (ii) The same decrease of the inhibitory activities of **2a-b** was indicated against both ChEs with moving methoxy group from the meta-position to the para-position (compared **2a** (R=3-OMe, IC_{50} = 154.32 and 1.65 µM for AChE and BuChE, respectively) and **2b** (R=4-OMe, IC_{50} = n.a and 59.96 µM for AChE and BuChE, respectively)). (iii) The presence of chlorine atom at the meta-position of phenyl ring led to an increase of the inhibitory activity for both ChEs (compared **2e** (R=3,4-diCl, IC_{50} = 89.53 and 2.54 µM for AChE and BuChE, respectively) with **2f** (R=4-Cl, IC_{50} = 269.8 and 137.41 µM for AChE and BuChE, respectively)).

(iv) Moving the nitro group at the phenyl ring from the meta-position to the para-position led to a major decrease of the inhibitory activity for AChE (compared **2j** (R=3-NO_2, IC_{50} = 82.88 µM) and **2k** (R=4-NO_2, IC_{50} = 2.498 µM)). The opposite effect was observed for inhibition of BuChE (compared **2j** (R=3-NO_2, IC_{50} = 3.31 µM) and **2k** (R=4-NO_2, IC_{50} = 37.71 µM)) (v) Electron-donating groups (methoxy group) at the meta- position of the phenyl

ring exhibited lower inhibitory activity than halogens and electron-withdrawing group for AChE (compared **2a** (R=3-OMe, IC_{50} = 154.32 µM) with **2c** (R=3-F, IC_{50} = 88.52 µM) and **2e** (R=3,4-diCl, IC_{50} = 89.53 µM) and **2j** (R=3-NO_2, IC_{50} = 82.88 µM)). On the contrary, methoxy group at the meta position increased the BuChE inhibitory activity (compared **2a** (R=3-OMe, IC_{50} = 1.65 µM) with **2c** (R=3-F, IC_{50} = 3.85 µM) and **2e** (R=3,4-diCl, IC_{50} = 2.54 µM) and **2j** (R=3-NO_2, IC_{50} = 3.31 µM)). (v) The inhibitor activity on both ChEs seems to be strongly dependent on the size and polarizability of the halogen substituent at the para-position of the phenyl ring (for size and polarizability, I > Br > Cl > F; for AChE inhibitory activity, **2h** (R=4-I, IC_{50} = 31.61 µM) > **2g** (R=4-Br, IC_{50} = 98.56 µM) > **2f** (R=4-Cl, IC_{50} = 269.80 µM) > **2d** (R=4-F, IC_{50} = 288.46 µM); for BuChE inhibitory activity, **2h** (R=4-I, IC_{50} = 4.77 µM) > **2g** (R=4-Br, IC_{50} = 107.22 µM) > **2f** (R=4-Cl, IC_{50} = 137.41 µM) > **2d** (R=4-F, IC_{50} = 405.15 µM)).

Table 1. In vitro inhibition IC_{50} values (µM) and selectivity of compounds **6a-l** for AChE and BuChE.

Compound	R	Yield (%)	Mp (°C)	AChE (IC_{50}, µM)[a]	BuChE (IC_{50}, µM)[a]	Selectivity index[b]
2a	**3-OCH_3**	42	182.6	154,32±1,745	**1,65±0,014**	0.01
2b	4-OCH_3	60	136.1	na	59,96±1,542	-
2c	3-F	73	111.3	88,52±1,253	3,85±0,457	0.04
2d	4-F	72	119.0	288,46±1,124	405,15±1,452	1.40
2e	3,4-diCl	74	113.5	89,53±1,248	2,54±0,568	0.03
2f	4-Cl	81	163.0	269,8±1,560	137,41±2,014	0.51
2g	4-Br	76	176.2	98,56±1,263	107,22±1,785	1.09
2h	4-I	74	179.6	31,61±0,952	4,77±0,748	0.15
2i	H	54	75.2	197,99±1,542	5,02±0,879	0.03
2j	3-NO_2	38	177.5	82,88±1,224	3,31±0,564	0.04
2k	**4-NO_2**	54	152.8	**2,498±0,012**	37,71±1,022	15.10
2l	4-CF_3	89	156.1	98,53±1,114	147,85±1,567	1.50
Thymol	**-**	**-**	**-**	**458,23±1,745**	**226,13±1,214**	**0.49**
Donezepil[c]	-	-	-	0.03±0.0005	4.66±0.503	155.30
Galantamine	-	-	-	2,051±0,011	18,13±0,457	8.84
Rivastigmine[c]	-	-	-	12,4±1,011	1,00±0,251	0.08

[a] IC_{50} values represent the means ± S.E.M. of three parallel measurements ($p < 0.05$).
[b] Selectivity index = IC_{50} (BuChE) / IC_{50} (AChE).
[C] (Kurt et al., Eur. J. Med. Chem., 2015)

Conclusion

A series of 12 novel thymol substituted carbamate derivatives (**2a-l**) was synthesized and their inhibitory activities on AChE and BuChE were evaluated. Among them, **2k** exhibited the strongest inhibition against AChE with an IC_{50} value of 2.498 µM, which was 183-fold more than that of thymol (IC_{50} = 458.23 µM). Additionally, **2a** exhibited the strongest inhibition against BuChE with an IC_{50} value of 1.65 µM, which was 137-fold more than that of thymol (IC_{50} = 226.13 µM).Generally, the presence of carbamate moiety at the thymol increased the both ChEs inhibition. This finding can provide guidance for researches to design new efficient ChEs inhibitors in the future works. The SAR revealed that the inhibitory activity of the synthesized compounds could also be affected by the type and position of the halogen and electron-donating and electron-withdrawing groups substituent on the phenyl ring. Overall these derivatives could be recommended as new chemotypes to develop new ChEIs for the treatment of AD disease by suitably modulating the substitution pattern also in the perspective of multifunctional anti AD agents.

Acknowledgments

This work was supported by the Sakarya Research Fund of the Sakarya University. Project Number: 2016-28-00-002.

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TACTILE SENSOR DESIGN FOR LUMP DETECTION IN BREAST TISSUE

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Abstract:The purpose of this study is the development of a novel system for detection of breast tumors in non-invasive way that can be used by doctors or patients. Our study consist of two parts. The first part is a specialized sensor containing an inductive sensor inside of a tissue-like silicon rubber robotic fingertip and a square shaped multi-metal-array to increase sensitivity. The whole system designed as a probe which has compact design and mobility. The system provides 16-bit resonance impedance and 24-bit inductance values, enabling sub-micron resolution for position-sensing in application. The tissue-like silicon properties were simulated and the linearity of the probe design against the pressure was analyzed. Tissue-like silicon rubber has hyper-elastic specifications. Force-displacement analysis showed %100 linear behavior. Tissue-like rubber silicon has also elastomer properties. The stress-strain analysis was made for 8 different point that showed non-linear behavior. With the current probe design, our detecting system is easy to use for every patients and health clinicians due to its mobility and easy access for different clinical environment. For the second part, to measure our system performance's sensitivity and specificity, comparison simulations will be performed.
In the simulation experiments, tumor-like inclusions embedded in tissue-like cylindrical silicon samples to make Phantom tissue in Virtual environments (VEs) will be designed. In VEs, the tumor-like tissue samples will be used in a various combination of stiffness and depth in phantom tissues. In real phantom experiments, the simulated phantoms will be created by the same silicon-rubber in similar conditions. The system will be embedded with the camera for tracking the every movement of robotic fingertip. The camera will record every location information (x,y) and combine it with the relative stiffness value which is taken from the sensor. And the topographical information of the tissue-like phantoms turned in to 2-D image. Breast examination can be done by human hands which have unique mechanism to sense vibrations called Pacinian corpuscle (response 60-700 Hz) and these sensory systems can be measured around the 200 Hz. In clinics, even though the clinical procedures are performed by the experts, it's difficult to detect small tumors and quantify the shape, location and stiffness. Because of these difficulties, tactile imaging sensors need to be used for diagnosis. As a future study, human palpation performance will be compared by our novel tactile sensor design embedded on a robotic fingertip.

Key words: Medical imaging, tactile sensor, lump detection, breast tumor.

Introduction

In recent years Breast cancer is the leading cause of death in western women aged 35-54. It is expected to reach 1 in 7 women by the year 2000 (American Cancer Society, 1997). Survival rates are highest when it is detected early and still confined to the breast. According to the statistics reported in 2008, breast cancer diagnosis has been made with an estimated 1.38 million new cases (23 percent of all the cancers) and the second most common cancer worldwide in both sexes (J.Ferley, 2010). About 1,685,210 new cancer cases are expected to be diagnosed in 2016 and invasive breast cancer will be diagnosed in about 246,660 women and 2,600 men. An additional 61,000 new cases of in situ breast cancer will be diagnosed in women. Breast cancer is the most frequently diagnosed cancer in women (American Cancer Society, 1997). It is crucial to detect Breast cancer in early stages. There are many ways to detect Breast cancer. Breast self-examination (BSE), clinical breast examination (CBE), Mammography, Ultrasound and MRI have important role for detecting breast cancer.

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Mammography is a low-dose x-ray procedure used to detect breast cancer at an early stage. Numerous studies have shown that early detection with mammography helps save lives and increases treatment options. However, like any screening tool, mammography is not perfect. For example, it can miss cancers, particularly those in women with very dense breasts, and also detects cancers that would never have caused harm, resulting in some over-diagnosis. And also differences in breast tissue, inefficient sensitivity, and small tumor size can cause false-diagnosis which can cause over-diagnosis. Some of the unwanted results of over diagnosis are increasing number of biopsies, higher-rate of invasive procedures, psychological effects of a patient and higher cost. Mammography is not recommended who is under 30 and have breastfed previous year. Because of the age breast tissue is dense and is hard to detect any cancerous tissue with mammography.

Magnetic resonance imaging (MRI) is a noninvasive method that reveals anatomical details in vivo and detects lesions for diagnosis. Although standard breast MRI cannot clearly delineate breast cancer, contrast-enhanced MRI enables the detection of breast masses with high sensitivity. MRI uses a powerful magnetic field and radio waves to produce images of the body. MRI is good at imaging dense breasts of younger women, breasts containing implants, which are often a problem for mammography owing to possible leak in the implant or rupture due to the squeezing, and smaller lesions often missed by mammography. MRI also helps to determine the stage of breast cancer. However, MRI requires the patient to lie down for half an hour to an hour and half without moving, which can be uncomfortable (Kuhl.JK, 1997). The identification of breast cancer using MRI is largely dependent on the enhancement of malignant lesions after IV administration of contrast agent, resulting in visible areas with both morphologic and kinetic features. However, enhancement on MRI is not limited to malignancies or discrete benign lesions of the breast (Müller-Schimpfle M ,1997, Reichenbach JR ,1999, Delille JP,2005). One of the main disadvantages of the MRI is that limiting specificity is the incidence of benign enhancing lesions and benign background enhancement that may be misdiagnosis that leading to an increased false-positive biopsy rate (Imaginis, 2001). Also during the MRI process patients have to lie down without a movement about half an hour which gives them discomfort and with the smallest movement the procedure needs to be repeated.

Ultrasound is a method that uses high frequency sound waves to detect tumors in tissue. There are several types of Ultrasound modes: B-mode, Doppler mode etc. B-mode capture reflected sounds and create and matrix format for the image (C.M. Sehgal,2006, C.F. Nemec,2007). And it can be used in pregnant women whom cannot use Mammography. And the results are depends on the experience of the clinical expert and the situation of the patient. Also clinical procedures have a standardization and interference in procedures have different results. In Doppler mode veins and tissue used for detecting tumors. Frequency shift calculated with the Doppler Effect so that flow can be estimated and visualize the breast tissue(D.O. Cosgrove,1993 , S. Raza,1997).

Microwave imaging and Elastography are used for breast cancer detection. Elestography detect different roughness between the tissues. Microwave imaging detect the dielectric constant and conductivity difference between the tissues (G.A. Ybarra, 2007).

Breast Self Examination and Computed Breast Examination uses human palpation. Human sensory feedback has a really important role in human interactions (B. Güçlü,2005, Bolanowski SJ,1988). Unlike the vision of that Human eyes provide us the sensory system in our body (haptic) can sense and respond in their own unique way towards to every interactions (Gescheider GA,1988, 2002). Haptic systems needs to obtain more data from sensory systems. Haptic system inputs; force, movement needs to be converted as an input/output form for interactions. Developing a sensor with a tactile feedback has some challenges. Vibrations and sensing has its unique values in human touch (M.Z Yıldız,20013, B. Güçlü,2005, Bolanowski SJ,1988, Gescheider GA,1988 & 2002) and making a prosthetic finger human-like modeling is a challenging area which has obstacles like sensing a high frequency vibrations. Human hands have unique mechanism to sense vibrations called Pacinian corpuscle (response 60-700 Hz) and these sensory systems can be measured around the 200 Hz (V. B. Mountcastle 1972, G. Westling 1987, A. J. Brisben 1999). Because of these challenges artificial sensing system development researches has been made which is named Tactile İmaging (TI).

Tactile imaging is a non-invasive procedure that used for detecting cancerous tissue. TI used for mapping the interested area with sensors. TI is superior to BSE and CBE because every examiner can sense different shapes and geometries in different areas so the results are quantative and subjective. Sensors can detect difference between

the cancerous tissue and healthy tissue with different sensor types (A. Samani, 2003, P.S. Wellman, 1999, A. Sarvazyan, 1994). With TI size, shape and depth of the cancerous tissue can be detected. Geometric properties and stiffness vary between the benign and malignant tissues as reported in (A.R. Skovorda, 1995) and (T.A. Krouskop, 1998). TI is a method that newly exploited. There is a limited number of device that commercially available (Medical Tactile Inc, 2012). Some study groups work on different sensor types. Accelerometers (R. D. Howe, 1989), piezoelectric polymers (P. Dario, 1994, J. S. Son, 1994, Y. Yamada, 1994 , P. Dario, 1994) magneto-inductance (J. Vranish, 1986), and ultrasonic technologies (B. Hutchings, 1994) , (S. Ando, 1995) sensor array with the photo detector (] M. Ayyıldız, 2013). These sensors used variety of applications however those sensors have some fragile sensing mechanism. With the (Medical Tactile Inc, 2012) product a study has been made about 110 patient (V. Egorov, 2008) and a study has been made with the silicon model along with the patients (C.S. Kaufman, 2006). Their experiments was performed in two consecutive steps: 1) a general examination by linear sliding of the probe, and then 2) a local examination by making circular motions. If any suspicious tissue have seen then the second step performed.

In current design we propose single point tactile detection robotic fingertip embedded with the high resolution camera. The designed probe's every movement is going to be tracked with the camera. The high resolution inductive sensors value combined with the location information which is obtained from the camera. With this method the topographical shape of the interested area is going to be mapped. And 2-D image of the interested area will be revealed without any quantative results. For the experiment part tumor-like properties is going to be placed in tissue-like silicon rubber phantoms. The tumor-like tissue samples used in a various combination of stiffness and depth in phantom tissues. Every sample will be examined according to their relative stiffness. Human hands unique sensing mechanism to sense small objet. An expert clinician can detect some of the lumps in the soft tissue but most of them pass through without any detection. And human palpation can change according to every person which means the results will be subjective if any of the procedure only done by the human hands because of these challenges we designed a system with high sensitivity and specificity. After the ethical committee permission to make non-invasive human studies. The performance will be compared by human hands.

Materials and Method

2.1. Design of our TI system

Our tissue-like silicon rubber robotic fingertip designed as a probe. Simulated all probe dimensions and materials are corresponding to the manufacturing technology and available materials on the market. The outer skeleton of probe is produced in 3D printer (thermoplastic polymer. In this part, we focused on design and analysis of a tactile probe molding and mechanical analysis by using Solid works program. SolidWorks is a solid modeler, and utilizes a parametric feature-based approach to create models and assemblies. The outer skeleton of probe we are fabricated in 3D printer (thermoplastic polymer). In this study we also needed a material that is similar to human skin on that part the device should come into contact with a cancerous tumor. But there are ethical and safety issues associated with obtaining alternative method human tissue. However after reviewing, we find dragon skin silicon on the market. Dragon skin silicones are used for a variety of applications ranging from creating skin effects and making production molds for casting a variety of materials. Due to the superior physical properties and flexibility, we decided to use this material in our project. It must be said that, it is used for medical prosthetics and cushioning applications. Particular focus was shown to find a robust tactile sensor that has the sensitivity and response to all tactile sensing modalities found in the human fingertip. Our TI system consist of %100 integrated sensor elements (TI LDC1000 EVM) arranged in a single point shape inductive sensor. The side length and the height of our TI sensor are 1.6 and 2.1 cm, respectively and sensor element is located in 1.4 cm of the silicon layer. Typical characteristic of the sensor shown in Figure 1 and Figure 2 shown the axial sensing of a sensor. Our sensor measures the parallel impedance of an LC resonator and has an Inductance-to-Digital Converter for the task. It accomplishes this task by regulating the oscillation amplitude in a closed-loop configuration to a constant level, while monitoring the energy dissipated by the resonator. The sensor element are powered by an external, regulated power supply (5V DC). Metal pieces was located above and bottom of the sensor and silicon tween them as shown in Figure 3 and characteristics of tactile probe are in table 1. Inductive proximity sensors are used for non-contact detection of metallic objects. The system provides 16-bit resonance impedance and 24-bit inductance values,

enabling sub-micron resolution for position-sensing to locate metal array inside of the silicon. After 10 mm of silicon the sensor is not capable of sensing the outside metals.

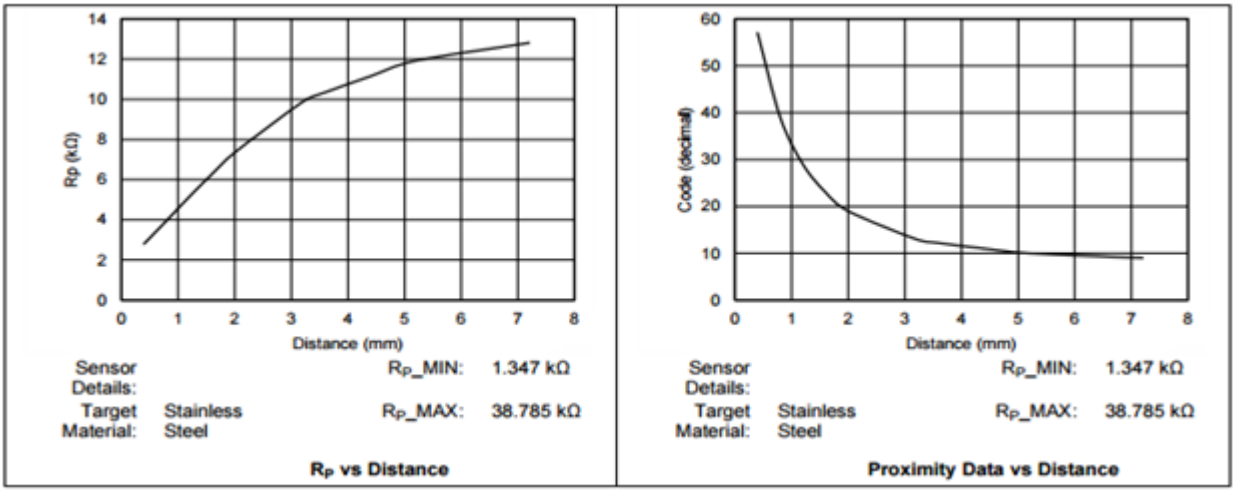


Figure 1. Typical characteristic of an inductive sensor.

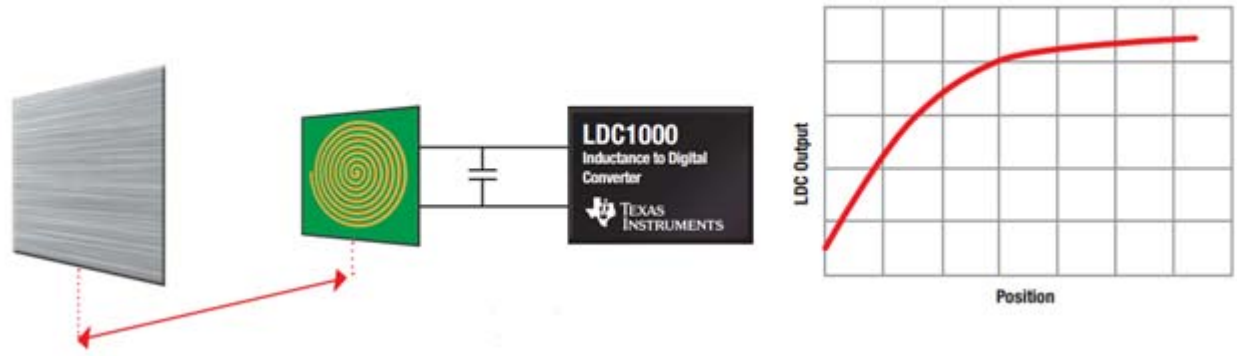


Figure 2. Axial sensing of a Sensor.

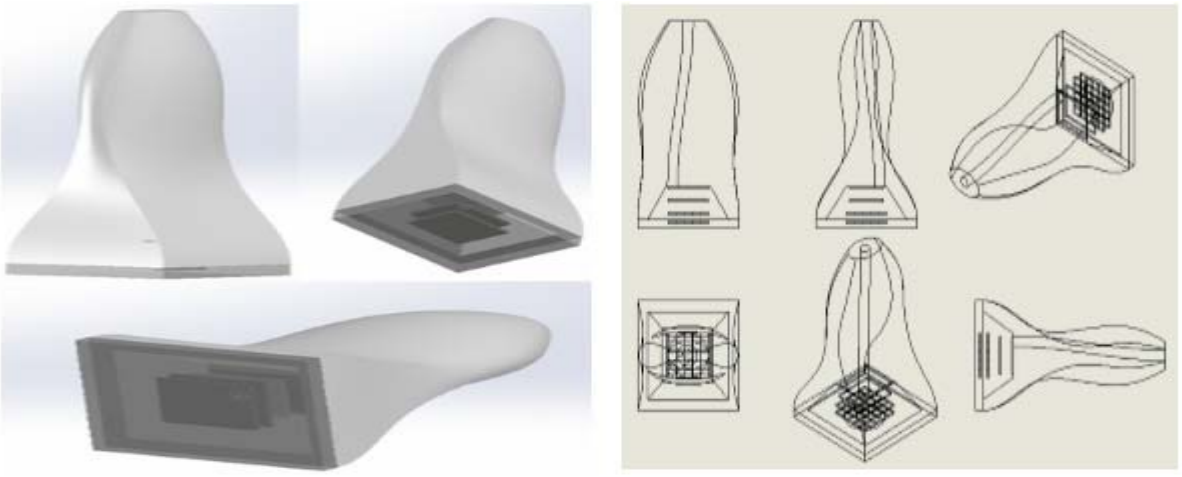


Figure 3. Geometric view of tactile probe/Metal array shape inside of a tissue-like silicon.

Table 1. Characteristics of tactile probe.

Thickness of silicon	19 mm

Dimension of large metal piece	16mm × 21mm × 1mm
Dimension of each small metal pieces	5mm × 5mm × 1mm
Dimension of sensor	16mm × 21mm × 1mm
Dimension of probe touch section	50 mm × 50 mm
Length of probe	94 mm
Total number of small metal pieces	50
Exoskeleton material	Thermoplastic polymer
Silicon material	Rubber

In this system Data acquisition hardware acts as the interface between the computer and the outside world. It primarily functions as a device that digitizes incoming analog signals so that the computer can interpret them. Other data acquisition functionality includes the following:

· Analog input/output

· Digital input/output

· Counter/timers

· Multifunction - a combination of analog, digital, and counter operations on a single device

In this case our changeable value is Eddie current which happen to change when the metal array moved inside of the tissue-like silicon shown in Figure 4-5.

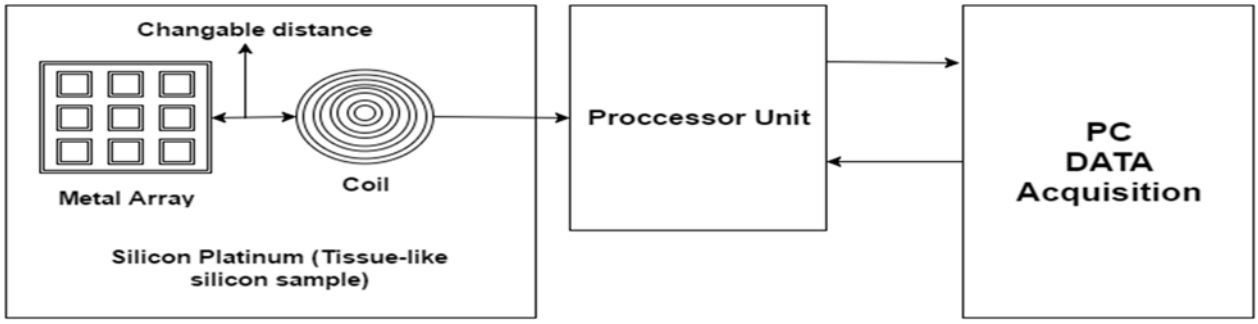


Figure 4a. Data acquisition units of the proposed TI system.

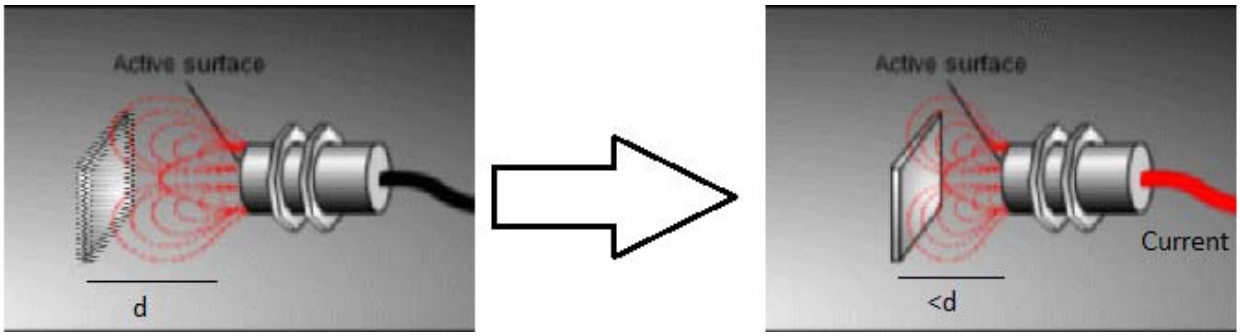
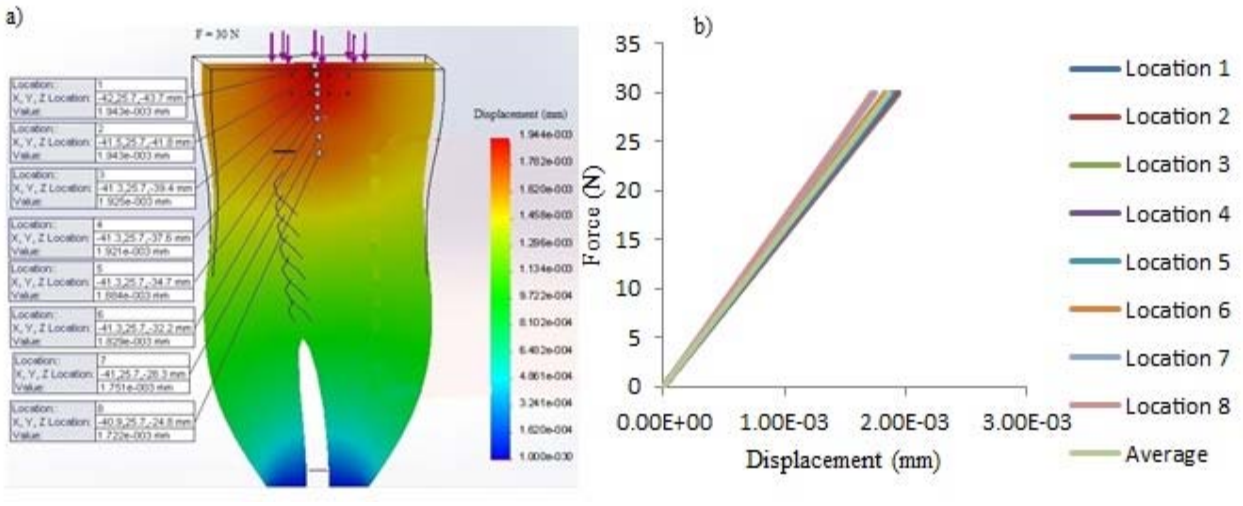


Figure 4b. Eddie current change due to metal array movement.

Results

In this section, the simulation results of the proposed sensor are shown. The silicon rubber that used in this study has the hyper-elastic material behavior and by the finite element method, stress and strain relations and displacement-force graphs were plotted. By giving the correct Poisson ratio from the datasheet of the materials to the software (Solid Works), the material showed isotropic linear property. Because the forces were quite low, the silicon rubber stay in the elastic region of the material. Therefore, a multilinear elastoplastic model was not chosen for the static analysis.

Figure 5. a) Static force (F =30 N) is applied to the silicon. b) Displacement graph of Dragon Skin silicon in the



results of applied forces

Elastomers have the non-linear elastic stress-strain behavior and the term “elastomer” is basically used for materials which shows silicon-rubber properties. The reason for this behavior can be explained that, as it is shown on the stress-strain curve, the maximum force applied to the sensor is 30 N. This force is considered quite low level. Upon unloading this small force, there will be any permanent deformation on the material. In practice, this material behavior is considered as incompressible. On the Figure 6, the simulation results shows the stress-strain behavior of our sensor upon the applied forces between 0.1-30 N.

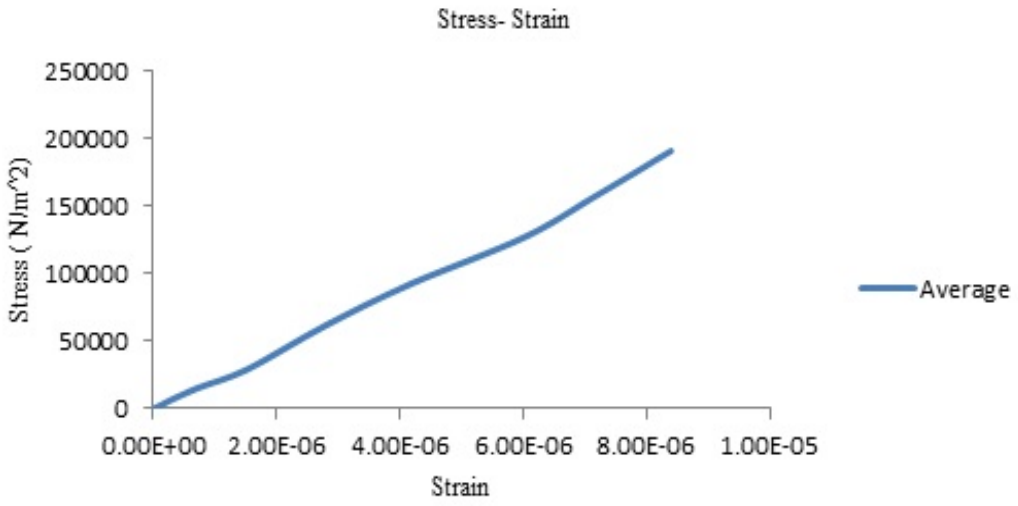


Figure 6. Dragon Skin silicon material behavior.

Elastomers (like Dragon Skin is platinum silicon) typically have considerable strains at small loads (means a very low modulus of elasticity, for example just 30 N). The material is nearly incompressible, so the Poisson's ratio is very close to 0.5. Their loading and unloading stress-strain curve is not the same, depending on different influence factors (time, static or dynamic loading, frequency etc.). In Figure 7, all the stress-strain relation curves were shown for the different depths at the center of the sensor.

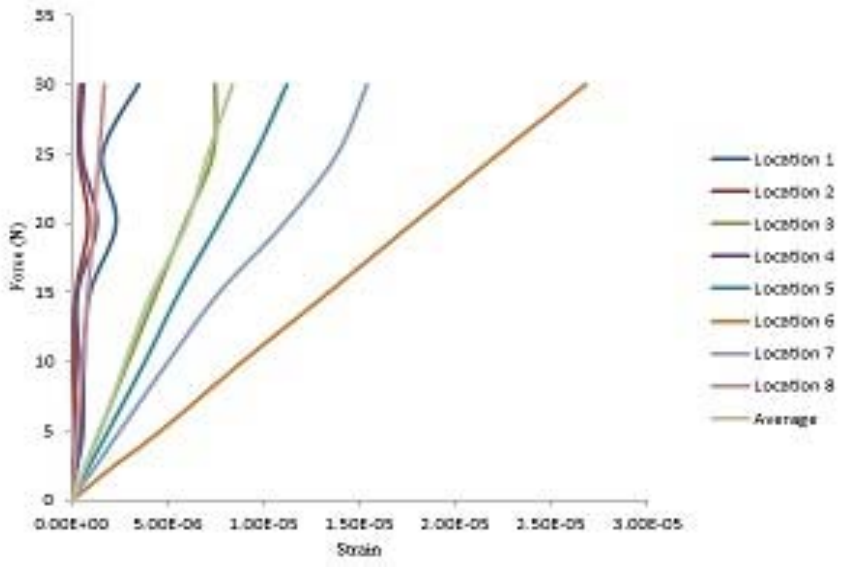
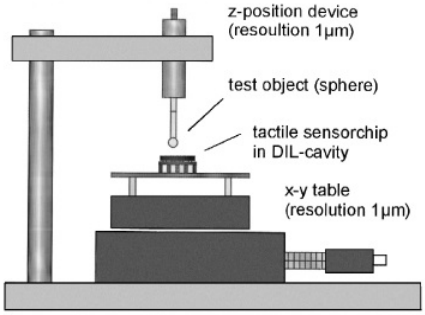


Figure 7: The results of strain in different applied forces to Dragon Skin (platinum silicone) material.

Discussion

We carried out our probe simulation in the SolidWorks, because the SolidWorks simulation uses the displacement formulation of the finite element method to calculate component displacements, strains, and stresses under external loads. In the SolidWorks analysis results non-linear hyperelastic materials behavior was observed. The analysis of rubber parts should be carried out using nonlinear stress analysis methods, due to their complex load deformation relationship. Due to the use of low loads, we thought in this area elastic behavior of materials would be remained on the upshot we use SolidWorks module for isotropic materials. In the next stage we are focused on design and analysis of multi module hyperelastic material models. In table 2, we will discuss how the different groups are studied and how we can do it.

Ref.	Method	Figure	Explanation
M. Leineweber et al, 200.	New tactile sensor chip with silicone rubber cover		Actually, the tactile sensor was used in that paper is based on the FhG-IMS pressure sensor and it has advantage and disadvantage. Sensor output is equal to mechanical analysis but the sensor needs to be calibrated for all different geometry.

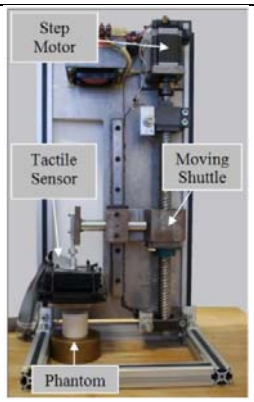
M. Ayyıldız et al, 2013.	Tactile sensor array with photodiode and tissue like phantom		Sensor array used with led potodetector and with this way the tissue like phantom can be mapped.

Table 2. Different study group that has made tactile sensor for lump detection.

Our current design have some advantages comparison to the other study groups that shown in Table 2. Tissue-like silicon rubber as shown in Figure.8 is 100% linear which means that after the acceptable force (0-30N similar to the human finger) the material will turn in to previous state of the matter. So it can be called as a finger-like probe that can be used numerous times. İnductive sensing is capable of sensing sub-micron changes in distance. And accurate sensing is possible with inductive sensing. With our design we can detect even the smallest particle because our sensor and metal array placed 0-0.5 cm distance to each other as shown in Figure.9. And isolated from the outside interference with our silicon properties which means even the smallest lump detection in soft tissues will be possible.

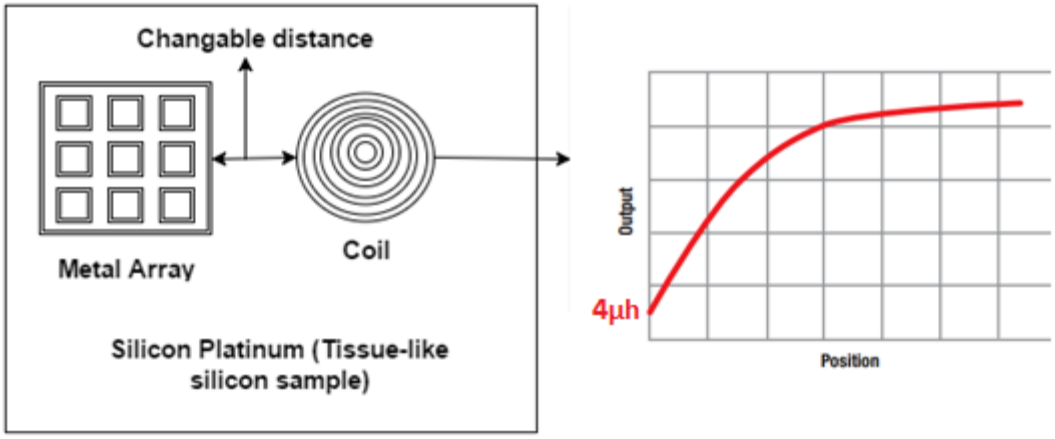


Figure 8. Because of our probe design The starting point of the sensor is 4µh and the our measurement points inside of the linear area of the sensor.

Conclusions

In this study, our choice to carry out the probe simulation was the SolidWorks, because the SolidWorks simulation uses the displacement formulation of the finite element method to calculate component displacements, strains, and stresses under external loads. In the SolidWorks analysis results non-linear hyperplastic materials behavior was observed. The analysis of rubber parts should be carried out using nonlinear stress analysis methods, due to their complex load deformation relationship. Due to the use of low loads, we thought in this area elastic behavior of materials would be remained on the upshot we use SolidWorks module for isotropic materials. In the next stage we are focused on design and analysis of multi module hyperelastic material models. These are directions in which we plane to continue our work.

Acknowledgements

This study was supported by Sakarya University Research Fund (BAP) no.2014-01-00-001 to Assist. Prof. Dr. Mustafa Zahid Yıldız. The authors thank to Professors from Mechatronics Engineering Department of Technology Faculty for their motivations and suggestions in the initial design of the experiments, and for critical comments on the paper. The authors are grateful to Biomedical Instrumentation Lab. Students for their contributions.

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TAX INCENTIVES FOR INNOVATION IN THE LIGHT OF IT GOVERNANCE BEST PRACTICES (EVIDENCE FROM THE FINANCIAL SERVICES INDUSTRY AND IMPLICATIONS FOR EXECUTIVES)

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Abstract: IT governance frameworks and in particular COBIT, are today accepted internationally. Particularly in the emerging market of Turkey, there have been efforts to encourage the use of IT governance but practitioners have had varying perspectives. IT governance allows businesses, for example, those in the financial service markets, to align themselves with strategies in the information technology sector. Many companies adopt IT governance to increase efficiency, increase IT infrastructure control, reduce costs, make better decisions and motivate employees (Lahti and Peterson, 2007). Companies with integrated IT governance are in a stronger position to increase their organizational accountability, offering better returns on investment.

Innovation serves the same purpose as IT governance, (managing innovation is a part of COBIT) fostering competition, productivity and job creation – essential factors for sustainable growth. Innovation extends beyond mere technological advancement, encompassing new business models and organizational change. Innovation is frequently a product of R&D efforts, driven by vectors like IP and software, alongside organizational and human capital. R&D carries risks both in uncertainty of investment outcomes and spillover effects to third parties; this risk typically results in below-socially-optimal R&D investment. Governments frequently intervene to increase R&D investment, either through direct sponsorship of research or through policy measures, e.g. tax breaks to correct the market failure (OECD, 2013).

Keywords: Tax Incentives, Innovation, Research&Development, IT Governance, COBIT 5.

Introduction

The march of globalisation has affected a wide range of organisations in almost every aspect of their businesses (Peters and Savoie, 2000). Crucially, globalization links to new concepts such as innovation, recognised as the primary factor driving economic growth in both developed and developing countries, as well as governance and corporate governance, accepted as the primary philosophy of “legistative responsibilities”, “accountability” and “transparency” increasing and supporting ethical decision making within organisations (Good Governance Guide, 2015).

COBIT 5 IT governance incorporates innovation management, allowing businesses, for example those in financial service markets, to align themselves with strategies in the information technology sector. In this context tax incentives play a crucial role in supporting markets, a market intervention taking the form of various policies and regulations in order to achieve economic stability, enhance economic development and reach social and economic targets. To this end it is an undeniable fact that governments have an essential role to play.

Materials and Methods

The emphasis placed on the role of innovation management by COBIT 5 IT governance frameworks within Turkish businesses is not without costs. By promoting IT governance benefits, organizations hope to achieve the advantages propagated by IT governance frameworks. Studies have shown that while implementations of IT

governance frameworks are typically beneficial, their adoption can impose high costs (Calder, 2007). Many organizations in Turkey are willing to pay the costs associated with IT governance in the hope that returns on the investment will exceed the costs of implementation. There have been inconsistencies in IT governance - unrealistic benefits stated or published - that differ from the practical elements of the framework. IT governance frameworks have on some occasions demonstrated themselves to be more theoretical rather than practical.

The paper addresses the different theoretical aspects of innovation, research and development and IT governance in the context of COBIT 5, as well as tax incentives for innovation in the Turkish financial industry. In so doing it seeks to evaluate existing tax incentives promoting innovation in the Turkish financial industry and assess whether or not tax incentives for innovation constitute effective government intervention. It will also evaluate the need for harmonization among related governmental bodies which have imposed COBIT 5 on the industry, i.e. the Turkish Banking Regulation and Supervision Body and Republic of Turkey Prime Ministry Undersecretariat of Treasury, and which offer tax incentives, i.e. the Ministry of Finance.

I elected to use interviews to conduct a qualitative research study for this paper. This paper's first information collection, by means of interviews, was conducted with board members, IT Steering Committee members, both senior and line managers, and managerial staff of other IT domains from several Turkish financial companies in order to adopt a holistic approach covering all these managerial positions. In line with Benbasat et al., (1987, p.373) I chose multiple case studies to compare and contrast among different organisations. This selected group of people is in a position to provide the most articulate responses (Prasad et al., 2010), given their understanding of the IT system hierarchy.

In conducting these interviews, I preferred to use voice-recordings where possible, since they allow the interview content to be revisited later, preserving both accuracy and detail (Yin, 2006).

Results and Discussion

1. Innovation: "Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2005, p.46). "The concept of innovation used in the Frascati Manual is characterised by the following": (OECD, 2005, p-34-35).

a - Innovation is associated with uncertainty over the outcome of innovation activities.

b - Innovation involves investment.

c - Innovation is subject to spillovers.

d -Innovation involves the use of new knowledge or new use or combination of existing knowledge.

e - Innovation aims at improving a firm's performance by gaining a competitive advantage.

"Innovation is broader in scope than R&D activity, including improvements in logistical, support and sales/marketing efforts. Moreover, innovation extends to include the acquisition of external knowledge or capital goods, activities typically outside the scope of R&D. The innovation activities that a firm chooses to undertake will hinge upon its access to information, knowledge, technology and financial and human capital" (OECD, 2005, p.18-20). This broad definition encompasses a wide range of possible innovations; a narrower categorisation might be the implementation of one or more types of innovations, e.g. product or process innovations. "The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new to the firm (or a significant improvement) (OECD, 2005, p.46-47).

"Firms often invest heavily in market research and developing new marketing strategies, targeting new markets or sales strategies. These marketing practices are important for the success of new products, playing a crucial role in product and process development through demand-led innovation (OECD, 2005, p.12).

"Organisational innovations not only support product and process innovation; they can also have an important impact in their own right. Organisational innovations can improve work quality and efficiency, information exchange, and improve the adoption and uptake of new knowledge and technologies. Not all changes in organisational operations are to be considered innovations; creating a written strategy document to improve knowledge management within a firm is not in itself an innovation, while the first implementation of a new method in businesses practice, external relations or workplace organisation could be considered organisational innovation. (OECD, 2005, p.12).

Organisational innovations' role in engendering technological innovation may have been understated, as Lam comments (2005, cited by OECD, 2005, p.12), "economists assume that organisational change is a response to technical change, when in fact organisational innovation could be a necessary precondition for technical innovation".

"The inclusion of marketing and organisational innovation also allows for more extensive analysis of the interactions between different types of innovations, in particular the importance of implementing organisational changes in order to benefit from other types of innovations" (OECD, 2005, p.12).

2. R&D: "Research and experimental development (R&D) consists of creative and systematic work undertaken in order to increase the stock of knowledge and devise new applications for available knowledge. R&D activity must satisfy 5 core criteria: Novelty, creativity, uncertainty, systematic, transferability and / or reproducibility" (OECD, 2015, p.28). The term R&D covers three types of activity: basic research, applied research and experimental development. "Basic research is experimental or theoretical work seeking new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is original investigation undertaken in pursuit of a specific practical aim or objective. Experimental development is systematic work, drawing on knowledge gained from research and practical experience to produce new products or processes or to improve existing products or processes" (OECD, 2015, p.29). "There are many flows of information and knowledge in the R&D system. Experimental development can inform basic research, and there is no reason why basic research cannot lead directly to new products or processes" (OECD, 2015, p.45).

2.1. Fields of R&D Classification (OECD, 2015, p.59).

1-Natural sciences (computer & information sciences, mathematics, physical sciences etc)

2-Engineering and technology (electrical engineering, electronic, information engineering etc)

3-Medical and health sciences

4-Agricultural and veterinary sciences

5-Social sciences (economics and business- political sciences etc)

6-Humanities and the arts.

2.2. Examples of R&D in banking and insurance (OECD, 2015, p.69)

1-Mathematical research relating to financial risk analysis

2-The development of risk models for credit policy

3-The experimental development of new software for home banking

4-The development of techniques for investigating consumer behaviour for the purpose of creating new types of accounts and banking services

5-Research to identity new risks or new characteristic of risk that need to be taken into consideration in insurance contracts.

3. IT Governance: Many people are increasingly interested in using IT in this era of globalization (Ilharco (2002). Mehta (2011, p.19) defines IT as "computers, telecommunications and automation technologies" For the purpose of this paper, ISO's (International Standards Organization 38500, 2008, cited by Bin-Abbas and Bakry, 2014, p.261) definition is used: IT refers to "resources required to acquire, process, store and disseminate information".

The best way to understand the concept of IT governance is to analyse the different aspects of the term. Kooper et al. (2011, p.196) define IT governance as "the primary way that stakeholders can ensure that investments in IT create business value and contribute toward meeting business objectives." In addition, Phillips (2012, p.18) observes that "IT Governance is a subset of Corporate Governance". Here it is necessary to clarify two important terms, governance and corporate governance: according to Muller (2009, cited by Too and Weaver, 2014, p. 1383), "governance provides a framework for ethical decision-making and managerial action within an organization that is based on transparency, accountability, and defined roles". Concerning corporate governance, the OECD (2004, p.11) states that "corporate governance involves a set of relationships between a company's management, its board, its shareholders and other stakeholders. Corporate governance also provides the structure through which the objectives of the company, the means of attaining those objectives and monitoring performance are determined. Good corporate governance should provide proper incentives for the board and management to pursue objectives that are in the interests of the company and its shareholders and should be conducive to effective monitoring."

3.1. IT Governance Best Practices: COBIT is the official best practice for Turkish financial institutions, a legal requirement enforced in the banking industry by the Turkish Banking Regulation and Supervision Body, and the Republic of Turkey Prime Ministry Undersecretariat of Treasury in the Turkish insurance industry.

COBIT 5, the latest iteration of the COBIT framework, provides a comprehensive framework that assists enterprises in achieving their objectives for the governance and management of enterprise IT, helping enterprises derive optimal value from IT resources by achieving and maintaining a balance between potential payoffs, risk levels and resource use (ISACA, 2012a).

COBIT 5 identifies 37 governance and management processes for IT (Snedaker and Rogers, 2006), and in so doing facilitates IT governance and management across the entire enterprise, encompassing the end-to-end business and IT functional areas of responsibility and addressing the IT-related interests of internal and external stakeholders.

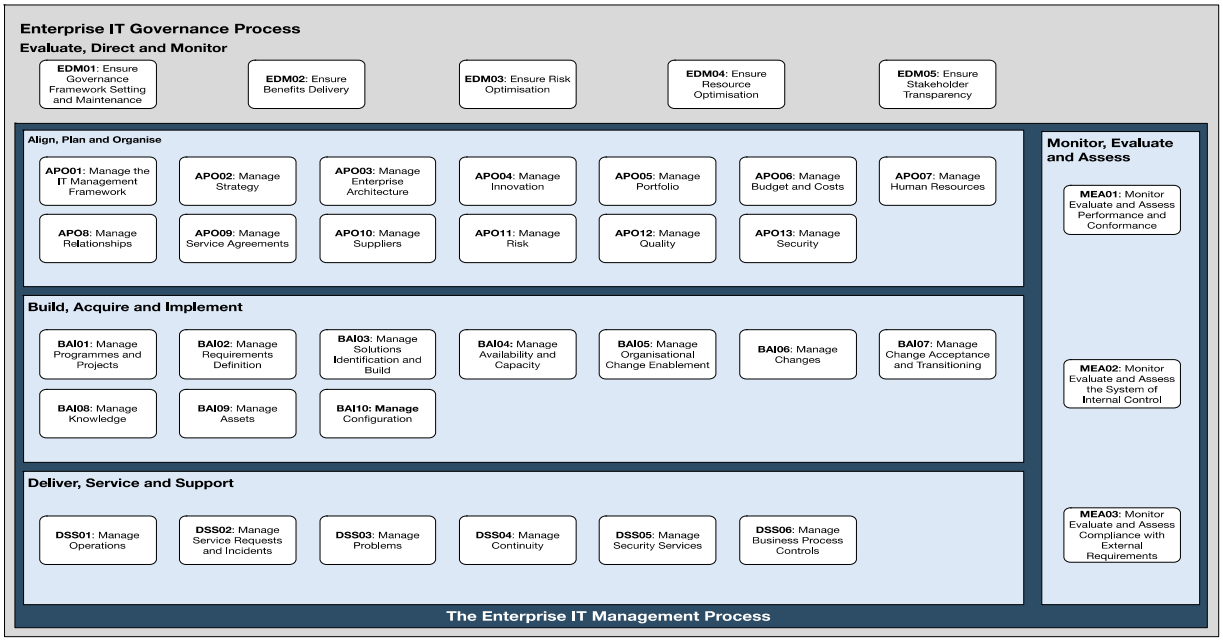

Figure 1: COBIT 5- 37 Process Reference Model (PRM). Source: Adapted from ISACA, 2012c, p.61.

The following table summarises how COBIT 5 supports adoption of the standard's principles and implementation approach. "The ISO / IEC 38500:2008 standard - Corporate Governance of Information Technology, is based on six key principles, the practical implications of which are explained here, together with how COBIT 5 guidance enables best practices. (ISACA 2012a, p.57) The OECD's categorizations of types of innovation can be combined with COBIT 5 to illustrate how COBIT 5 guidance enables good practices, as shown in Figure 2.

Responsibility, strategy, acquisition, performance, conformance and human behaviour are shown to be principal components of COBIT 5 guidance. Moreover COBIT 5's prescriptions for corporate IT can be considered supplementary components of OECD's definition of innovation.

TYPES OF INNOVATION	OECD Definitions	HOW COBIT 5 GUIDANCE ENABLES GOOD CORPORATE GOVERNANCE OF IT PRACTICES					
		PRINCIPLE 1 RESPONSIBILITY	PRINCIPLE 2 STRATEGY	PRINCIPLE 3 ACQUISITION	PRINCIPLE 4 PERFORMANCE	PRINCIPLE 5 CONFORMANCE	PRINCIPLE 6 HUMAN BEHAVIOUR
Product Innovation	"A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. The term "product" is used to cover both goods and services"						
Process Innovation	"A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products. Process innovations also cover new or significantly improved techniques, equipment and software in ancillary support activities, such as purchasing, accounting, computing and maintenance. The implementation of new or significantly improved information and communication technology (ICT) is a process innovation if it is intended to improve the efficiency and/or quality of an ancillary support activity"						
Marketing Innovation	"A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Marketing innovations include significant changes in product design that are part of a new marketing concept. Product design changes here refer to changes in product form and appearance that do not alter the product's functional or user characteristics"						
Organisational Innovation	"An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Organisational innovations can be intended to Organisational innovations in business practices involve the implementation of new methods for organising routines and procedures for the conduct of work. These include, for example, the implementation of new practices to improve learning and knowledge sharing within the firm. An example is the first implementation of practices for codifying knowledge, e.g. establishing databases of best practices, lessons and other knowledge, so that they are more easily accessible to others. Another example is the first implementation of practices for employee development and improving worker retention, such as education and training systems. Other examples are the first introduction of management systems for general production or supply operations, such as supply chain management systems, business re- engineering, lean production, and quality-management systems. Innovations in workplace organisation involve the implementation of new methods for distributing responsibilities and decision making among employees for the division of work within and between firm activities (and organisational units), as well as new concepts for the structuring of activities, such as the integration of different business activities.						

Figure 2: Combining the OECD's definition of innovation and how COBIT 5 guidance enables good corporate governance of IT practices. Source: Adapted from ISACA 2012a, p.57.

MAPPING COBIT 5-IT RELATED GOALS to PROCESSES -2-																	
			Alignement of IT and business strategy	IT compliance and support for business compliance with external laws and regulations	Commitment of executive management for making IT-related decisions	Managed IT-related business risk	Realised benefits from IT-enabled investments and services portfolio	Transparency of IT costs, benefits and risk	Delivery of IT services in line with business requirements	Adequate use of applications, information and technology solutions	IT agility	Security on information, processing infrastructure and applications	Optimisations of IT assets, resources and capabilities	Enablement and support of business processes by integrating applications and technology into business processes	Delivery of programmes delivering benefits, on time, on budget,and meeting requirements and quality standards	Availability of reliable and useful information for decision making	IT compliance with internal policies	Competent and motivated business and IT personnel	**Knowledge, expertise and initiatives for business innovation**
			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
COBIT 5 Process			**Financial**						**Customer**		**Internal**							**Learning and Growth**	
Align, Plan and Organise	APO01	Manage the IT Management Framework																	**Primary**
	APO02	Manage Strategy																	**Primary**
	APO03	Manage Enterprise Architecture																	Secondary
	APO04	**Manage Innovation**																	**Primary**
	APO05	Manage Portfolio																	Secondary
	APO06	Manage Budget and Costs																	
	APO07	Manage Human Resources																	**Primary**
	APO08	Manage Relationships																	**Primary**
	APO09	Manage Service Agreements																	
	APO10	Manage Suppliers																	Secondary
	APO11	Manage Quality																	Secondary
	APO12	Manage Risk																	Secondary
	APO13	Manage Security																	

Figure 3: Mapping COBIT 5-IT Related Goals to Processes-2- (Align, Plan and Organise). Source: ISACA 2012b, p.228.

Processes for Governance of Enterprise IT aims to achieve an organisation's predefined targets and strategies, by addressing the needs, conditions and activities of all IT-stakeholders, and coordinate different stakeholder groups within IT to achieve best possible parallel-performance. Processes for Management of Enterprise IT encompass the planning, development, management and monitoring of the activities carried out within the organization in accordance with these targets and strategies (Stroud, 2012).

In this context, innovation management is covered by the Align, Plan and Organise (APO) process. Innovation management is therein subdivided into 4 main goals: Financial, Customer, Internal and Learning and Growth. Each of the APO subcategories are defined as either primary or secondary in their importance to Learning and Growth through Knowledge, expertise and initiatives for business innovation (ISACA 2012b, p.228).

Related financial goals:
01-Alignment of IT and business strategy (Secondary / S),
04-Manage IT related business risk (S),
05-Realised benefits from IT-enabled investments and services portfolio (Primary /P)

Related customer goal:
08-Adequate use of applications, information and technology solutions (P)

Related internal goals:
09-IT agility (P),
11-Optimisations of IT assets, resources and capabilities (P),
12-Enablement and support of business processes by integrating applications and technology into business processes (S),
14-Availability of reliable and useful information for decision making (S)

Related learning and growth goal:
17- Knowledge, expertise and initiatives for business innovation (P)

APO04 Manage Innovation	
	Domain: Align, Plan and Organise
Process Description	
Maintain an awareness of information technology and related service trends, identify innovation opportunities, and plan how to from innovation in relation to business needs. Analyse what opportunities for business innovation or improvement can be created by emerging technologies, services or IT-enabled business innovation, as well as through existing established technologies and by business and IT process innovation. Influence strategic planning and enterprise architecture decisions.	
Process Purpose Statement	
Achieve competitive advantage, business innovation, and improved operational effectiveness and efficiency by exploiting information technology developments	
The Process Supports the Achievement of a Set of Primary IT-related Goals	
IT-related Goal	**Related Metrics**
05 Relaised benefits from IT-enabled investments and services portfolio	*Percent of IT-enabled investments where benefit realisation is monitored through the full economic life cycle
	*Percent of IT services where expected benefits are realised
	*Percent of IT -enabled investments where claimed benefits are met or exceeded
08 Adequate use of applications, information and technology solutions	*Percent of business process owners satisfied with supporting IT products and services
	*Level of business user understanding of how technology solutions support their processes
	*Satisfaction level of business users with training and user manuals
	*NPV showing business satisfaction level of the quality and usefulness of the technology solutions
09 IT Agility	*Level of satisfaction of business executives with IT's responsiveness to new requirements
	*Number of critical business processes supported by up-to-date infrastructure and applications
	*Average time to turn strategic IT objectives into an agreed-on and approved initiative
11 Optimisation of IT assets, resources and capabilities	*Frequency of capability maturity and cost optimisation assessments
	*Trend of assessment results
	*Satisfaction levels of business and IT executives with IT-related costs and capabilities
17 Knowledge, expertise and initiatives for business innovation	*Level of business executive awareness and understanding of IT innovation possibilities
	*Level of stakeholder satisfaction with levels of IT innovation expertise and ideas
	*Number of approved initiatives resulting from innovative IT ideas
Process Goals and Metrics	
Process Goal	**Related Metrics**
1-Enterprise value is created through the qualification and staging of the most appropriate advances and innovations in technology IT methods and solutions	*Increase in market share or competitiveness due to innovations
	*Enterprise stakeholder perceptions and feedback on IT innovation
2-Enterprise objectives are met with improved quality benefits and / or reduced cost as a result of the identification and implementation of innovative solutions	*Percent of implemented initivatives that realise the envisioned benefits
	*Percent of implemented initiatives with a clear linkage to an enterprise objective
3-Innovation is promotd and enabled and forms part of the enterprise culture	*Inclusion of innovation or emerging technology-related objectives in performance goals for relevant staff
	*Stakeholder feedback and surveys

Figure 4: APO04 Manage Innovation. Source: Bernard, 2012, p.6**.**

It can be interpreted from the figure that APO04 Manage Innovation covers diversified goal-types reflecting each of the definitions of innovation as described above: Product, process, marketing and organisational. It is therefore apparent that APO04 Manage Innovation indirectly addreses responsibility, strategy, acquisition, performance, conformance and human behaviour.

4. Tax Incentives

"Governments in several countries provide tax support for R&D with the aim of promoting R&D investment in the economy by offering preferential tax treatment for eligible R&D expenditures, especially to business enterprises. Tax expenditures are complex objects of measurement; not all statistical systems separately capture all types of tax relief measures" (OECD, 2015, p.343). Likewise, in Turkey, tax incentives have a crucial role to play in supporting markets in order to enhance Turkey's international competitive power through increased efficiency, cost reduction, job creation etc.

4.1. Tax Incentives for R&D Activities in Turkey

The Law on Supporting Research, Development and Design Activities dated 28.02.2008 and numbered 5746 and the Law on Technology Development Zones dated 26.06.2001 and numbered 4691 are the two main laws that regulate incentives aimed at Research and Development activities in the Turkish Finance Sector.

4.1.1 - The Law on Supporting Research, Development and Design Activities dated 28.02.2008 and numbered 5746

The Law on Supporting Research, Development and Design Activities dated 28.02.2008 and numbered 5746, defines R&D and Innovation as follows:

R&D: "Research and Development Activity (R&D): Research and development are original, experimental, scientific activities with technical content consisting of works conducted systematically to increase the accumulation of knowledge formed by the culture, humans and the knowledge of the society and to use it to design new processes, systems and applications, the activities of designing environment friendly products or software and activities that provide scientific an technologic development, focus on a scientific and technologic uncertainty" (Article 2, Clause A of Law 5746).

Innovation: "the processes that meet social and economic needs, created with the idea of a new product, service, application, method or business model which may be successfully launched to the markets or which may create new markets and the results of these processes" (Article 2, Clause B of Law 5746).

According to the Application and Supervision Regulation on Supporting Research, Development and Design Activities published at the Official Gazette dated 10.08.2016 and numbered 29797;
The activities that do not constitute R&D or innovation are indicated below. (Article 5, Clause 1of Law 5746)

a) Marketing activities, market screenings, market researches or sales promotion
b) Quality control
c) Researches in social sciences
d) Oil, natural gas, mineral reserves search and drilling activities
e) Clinical trials prior to medicine production license which do not have at least two of their phases performed abroad and clinical trials that are performed after production license
f) Use of processes that are invented without being in the scope a R&D project or the use of already developed processes
g) Formal changes that are not aimed at R&D and Innovation activities which include change of shape, color, decoration and similar esthetic and visual changes
h) Excluding programming languages and operating systems, software development activities made by using current software that assist in the development of web sites and similar
ı) Ordinary and repetitive activities related to software that do not include scientific or technologic progresses or a solution for technologic uncertainties
j) Research expenses related to establishment and organization
k) Investment activities aimed at production and production infrastructure, planning of commercial production and expenditures related to serial production
l) Production and distribution by obtaining copies from prototypes with the purpose of giving samples and consumer tests for advertisement purposes,

m) Without being in the scope of an R&D project, direct or embedded technology transfer that do not serve to produce a new process, system or product,
n) With the exclusion of acquiring intellectual property rights, activities aimed at the product or process developed through R&D or innovation activities.

The Law numbered 5746 on Supporting Research, Development and Design Activities entered into force in 2008 and the tax related supports and incentives provided in the framework of the Law are explained below.

4.1.1.1. R&D and Design Deduction

The total of the expenses related to R&D and innovation or design (100%) realized in the R&D/Design Centers in the scope of the law numbered 5746 on Supporting Research, Development and Design Activities may be subject to reduction until 31/12/2023 in determining the revenue of the corporation.

Furthermore, in R&D Design Centers that obtain an increase of at least twenty percent compared to the previous year in any of the indicators below, 50 percent of the amount of increase over the previous year in innovation and design expenses made during that year may be subject to a deduction in determining the business income.

- The share of R&D expenses in the total turnover or the share of design expenses in the total turnover,
- Number of registered national and international patents,
- Number of internationally supported projects,
- The ratio of researchers with postgraduate degrees to the total R&D personnel,
- The ratio of the total number of researchers to the total R&D personnel,
- The ratio of the turnover obtained from new products produced as a result of R&D to the total turnover.

The amount of R&D and design deduction which cannot be subject to a reduction due to the income being insufficient in the framework of the provisions of the Law numbered 5746 is transferred to the subsequent periods. The transferred amounts shall be taken to account without any restriction in time in the following years by increasing it in line with the revaluation rate determined each year according to the Tax Procedure Law 213.

4.1.1.2. Incentive on Income Tax Withholding

In the scope of Law 5746, with the exclusion of the civil servants, from the income tax calculated over the wages of the R&D and support staff working in the R&D centers obtained in return to such work;

- 95% for those who have a Doctorate or Masters degree in one of fields of the fundamental sciences,
- 90% for those who have a Masters degree or bachelor degree in one of fields of the fundamental sciences,
- 80 % for others shall be written off by deduction from the tax accrued over the withholding tax statement.

4.1.1.3. Support to the Employer's Contribution to the Insurance Premium

In the scope of the provisions of Law 5746 with the exclusion of the civil servants, half of the employer's share in the insurance premium calculate over the wages earned in return to their works related to R&D an innovation activities of the R&D and Support personnel working in the R&D Centers are met from the allowance made by the Treasury in the Ministry of Finance's budget.

4.1.1.4. Stamp Duty Exemption

Papers issued in relation to all R&D an innovation activities in the scope of the Law numbered 5746 are exempt from stamp duty.

4.1.1.5. Customs Tax Exemption
Goods imported to be used in R&D; innovation and design projects have been exempted from customs duty and all funds as well as stamp duty and fees in relation to papers issued and transactions made in this framework.

4.1.1.6. Additional Support Extended to Personnel Graduated from the Fundamental Sciences
To the R&D Centers employing R&D staff equipped with at least bachelor degree in the domain of Fundamental Sciences (mathematics, physics, chemistry, biology), the portion of the salaries of such personnel amounting to equal of the monthly gross amount of minimum wages applied during that year shall be met from the allowance made at the budget of the Ministry of Science Industry and Technology for a period of two years.

In this framework:
-The number of personnel to benefit from the support at each of the R&D centers may not exceed ten percent of the total number of personnel employed in the R&D center during the related month.

-It is essential that the personnel to be employed is hired after 1/3/2016 (included) and is employed in the related enterprise for the first time.

-The enterprise is under the obligation of notifying the Ministry in written or in electronic environment the matters related to the recruitment or leave of employment of the personnel it employs.

-Payments to be made in relation to the support is made by the Ministry in monthly periods by taking to account the number of insurance premium days concerning the personnel included in the scope of the support.

-In order to effect payments, it is necessary to present the report indicating that the above conditions have been fulfilled and the wages related to the period have been paid to the related personnel. The amount found appropriate by the Ministry is paid until the end of the month following the delivery date of the report at the account number indicated by the enterprise.

4.1.2 - The Law on Technology Development Zones dated 26.06.2001 and numbered 4691
In the Law on Technology Development Zones dated 26.06.2001 and numbered 4691, R&D, Innovation and Technology Development Zone have been defined as follows.

R&D: “Research and development activity (R&D): Research and Development are creative works conducted on a systematic basis to increase the knowledge accumulation consisting of culture, humans and society and to use it to design new processes, systems and applications including also software” (clause c of the article 3 of the Law numbered 4691).

Innovation: “means the processes created with the idea of a new product or goods, services, applications, method or business model that can meet social and economic needs, which can be successfully launched in the existing markets or which may create new markets as well as the results of these processes”(clause g of the article 3 of the law numbered 4691).

Technology Development Zone (Zone): “a site where academic, economic and social structure are integrated or a technology park which has such features within the same university, high technology institute or the area of a R&D center or Institute where companies that use high/advanced technologies or which aim new technologies benefit from their facilities and produce/develop technology or software, operate to transform a technologic invention into a commercial product and, method or service and in this way contribute to the development of the zone ”.

As the law numbered 4691 is focused on Technology Development Zones it is a more specific law:

“According to the regulation the revenues of taxpayers operating in the technology development zones obtained exclusively from their software and R&D activities in this zone are include in the scope of their software activities. Activities such as complementary training, consultancy, maintenance, additional equipment may be

performed in the technology development zone. However there is no tax incentive for the revenues obtained from those activities." (ruling dated 17.04.2014).
The supports and incentives extended to the Technology Development Zones are indicated below and to benefit from the mentioned support and incentives, it is necessary for companies to be located (by founding a new company /opening a branch of the existing company) within the Technology Development Zones indicated in Law 4691 regarding Technology Development Zones.

4.1.2.1. Corporate Tax Exemption
The revenues of taxpayers operating in the technology development zones obtained exclusively from their software and R&D activities carried out in this zone are exempt from income and corporate taxes until the date of 31.12.2023. The taxpayers' income obtained from activities performed outside the zone may not benefit from the exemption even if it is generated from software and R&D activities.

4.1.2.2. Income Tax Exemption (+Stamp duty exemption in salaries)
With the Law numbered 6170 Amending the Law on Technology Development Zones, it has been decreed that the wages related to their work in this zone of researchers, software developers, R&D and their support personnel working in the zone shall be exempt from all taxes until the date of 31.12.2023.

4.1.2.2. Insurance Premium Support
Although there is no support concerning insurance premiums in Law 4691 on the Technology Development Zones, there are arrangements aimed at supporting the employers' share in the insurance premium stated in the Law 5746 on Supporting Research and Development Activities concerning the wages of R&D and software personnel operating within the organization of the technology park. In this scope, in the framework of the Law 4691, half of the employer's share of the insurance premium calculated over the wages of the personnel who are exempt from income tax in the scope of this work is met by the Treasury.

4.1.2.3.VAT Exemption
In the scope of the provisional Article 20 of the Value Added Tax Law "According to the Law numbered 4691 on Technology Development Zones, during the period in which the entrepreneurs' revenues generated exclusively from those zones from services and deliveries such as system management, data management, business applications, sectoral, internet, mobile and military command and control applications software are exempt value added tax.

However, any arrangement has not been made in relation to the VAT exemption stated in the Law numbered 6170 and the Law numbered 4691 and the regulations that are currently stated in the Law shall be valid until 31.12.2023.

4.1.2.4. Customs Duty Exemption
Goods imported to be used in R&D, innovation and design projects have been exempted from customs duty and all funds as well as stamp duty and fees in relation to papers issued and transactions made in this framework.

Law 4691 on Technology Development Zones	**Law 5746 on Supporting Research, Development and Design Activities**
Corporate tax exemption	100% R&D and Design deduction
Income tax exemption (100%)	Incentive on Income tax withholding (80% -90%-95%)
Support to the Employer's Contribution to the Insurance Premium (50%)	
Customs duty exemption	
Support for Fundamentals Sciences	
Stump duty exemption (only on payrolls)	Stamp duty exemption
VAT exemption	

Figure 5: Components of Supports and Incentives of Laws 4691 and 5746.
Source: Pwc, 2015, p. 3.

Conclusion

Although research and development activities as well as innovation activities may be borderline activities, it would be wrong to expect that each innovation activity includes research and development activity or that each research and development activity would result in innovation.

The OECD has gathered innovation types under 4 main categories as product, process, marketing and organizational but has not limited the definition of R&D to software. Similarly, in the framework of COBIT 5, while the innovation management scope aims to realize different IT objectives such as Alignment of IT and business strategy, Management of IT related business risk, Optimization of IT assets, resources and capabilities, knowledge, expertise and initiatives for business innovation, it is clear that COBIT extends its focus beyond R&D.

The Frascati Manual gives examples of R&D in banking and insurance; in addition to software works such as the development of new software for home banking also gives examples that include works like surveys, the development of techniques for investigating consumer behavior for the purpose of creating new banking services and research to identify new risks or new risk characteristics that need to be taken into consideration in insurance contracts.

When incentives targeting innovation activities in the Turkish financial sector are considered, it is seen that the majority of these incentives are incentives aimed at R&D activities, activities which are treated as equivalent on a one-to-one basis with software development activities.

Suggestions

Finance companies may only obtain benefits of profitable return on investments, obtaining expected added value from innovation activities, increased competitive power in the international markets through corporate governance and through IT governance as part of corporate governance. In this context, innovation management ought be performed as a necessary part of IT governance for finance companies.

Turkish finance companies ought to carry out lobbying activities to bring together government authorities such as the Banking Regulation and Supervision Agency (BDDK), the Undersecretariat of the Treasury and the Ministry of Finance. Such lobbying activities, with international arrangements such as the OECD regulations, COBIT 5 criteria are important for establishment of a finance system that operates harmoniously with international regulations.

Transition to and integration of ERP systems, improvements in quality of service provided to existing clients and new target markets, changes which occur in business operations, restructuring, and training and motivating the company staff in this respect are needed. These activities each include the capacity for innovation but extend well beyond software development activity. Therefore this tax incentive system, aimed at fostering innovation, should be freed from its software R&D-focused perspective and should be further developed to strengthen development of corporate structures.

While harmonization with international arrangements such as COBIT 5 that guarantee IT governance competency is will eventually occur without intervention, the judicious use of tax incentives can be used to offset the potential financial costs and competitive imbalances that may arise from the adoption of such frameworks by businesses.

Acknowledgements

With thanks to the following for their insight and support;
Ufuk Batum (CEO Ventures & Mentors League), Prof.Dr.Turgay Berksoy (Board Member, Isbank), Hakan Aran (IT General Manager Assistant, Isbank), Ömer Gökçeli (Manager, Sales and Business Partnerships Management, SoftTech Co. Inc.)

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THE CHARACTERISATION OF BIMETAL DISKS USED FOR THERMOSTATIC CONTROL AND OVER-TEMPERATURE PROTECTION

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Abstract: In this study, the two-layer bimetal disks used for thermostatic control and over-temperature protection were investigated for the effects of the shaping procedure and heat treatments on the instantaneous specific deflection of the temperature range.

A parametric study was carried out in which several mechanical disc shaping procedure and several heat treatments on differences in accuracy of switching temperatures were considered. As a result of this study, a simple thermo-mechanical shaping procedure was discovered for the accuracy of specific working temperature range. Also digital switching action was obtained for transducer used for thermostatic control and over-temperature protection.

Keywords: Bimetal, Thermostatic Bimetal, Thermostatic Control, Instantaneous Specific Deflection, Thermo-Mechanical Shaping.

Introduction

Thermostatic Bimetal is a composite material, made up of two or more metallic layers having different coefficients of expansion. When permanently bonded together, these layers cause the material to change its curvature when subjected to a change in temperature (Khadkikar 1993). This change of curvature, or bending, in response to temperature change, (flexivity), is a fundamental property of all Thermostatic Bimetals (Freyang 1996)

Thermostatic bimetal components both simple and complex are at the heart of numerous measuring instruments, regulation systems and safety devices. In heating and sanitary equipment, in electrical engineering systems and domestic appliances, in motor protectors, automobile fan controls, and as temperature compensators in television sets, and wherever a device must react to changes in temperature (Kantal 2008).

The uses of thermostatic bimetal components fall into four general classifications as follows (Howard 1942):

- Temperature Indication
- Temperature Control
- Control of function with temperature change over a range of temperature
- Control of function by auxiliary heating of the bimetal

The shapes of bimetallic elements vary depending on the application and include beams, disks, spiral helices, and U-shaped elements. Straight strips are the commonest form of bimetals, being the simplest and cheapest. When the available space is limited, a U shape can be employed. Spiral and helical bimetals convert temperature changes into a rotational movement or torque when the displacement is impeded. A spiral shape enables a large length of bimetal to be incorporated into a small volume, producing high sensitivity, limited only by strength considerations beyond a certain length. Bimetallic discs (shallow shells) reverse suddenly at a critical temperature which depends on the grade of bimetal employed and the geometry. They are used in numerous regulation devices and protection systems (Ziga 2013).

Thin and shallow bimetallic shells with suitable material and geometric properties have the characteristic of snapping-through into a new equilibrium position at a certain temperature. The result of such a fast snap-through of a bimetallic shell, acting as a switching element in a thermal switch, is the instantaneous shutdown of electric power and the machine (Henry 1972) The snap-through of the bimetallic shell is a dynamic occurrence that lasts a very short time and as such prevents the damaging sparking and melting of electric contacts and extends the life time of the thermal switch (Jakomin 2011)

A thermostatic bimetal shallow shells are constructed from a laminated composite of metals with different thermal expansion coefficients. They deform with changes in temperature (Kosel 2007). At least one bimetallic shallow

shell is used in each device; however, there are some controls that use three of them. The bimetallic shallow shell performs a snap action at defined temperatures and produces enough force to open or close electrical contacts. The temperature at which a bimetallic shallow shell "snaps through" on heating is called the "break temperature" and the temperature at which it "snaps back" on cooling is called "remake temperature".

Bimetallic shallow shells have been developed by purely empirical means. A great deal of experimentation has been carried out over the past decade to improve performance, and the improvements have been remarkable (Batista 2007).

It has been said that "Bimetallic shallow shells lend themselves poorly to calculation. They are designed empirically, based largely on experience. More than any other form of bimetal, they require starting materials whose physical and mechanical properties are precise and uniform, with small thickness variations, and excellent surface quality and flatness" (Trostel 1996).

At low temperatures, bimetallic shallow shells have a concave shape which then snaps to a convex shape at high great enough to activate a switch or make an electrical contact mechanically. As is common in discontinuous phase changes, shallow shells show considerable hysteresis behaviour (Figure 1). With adequate materials and correct shaping, the lower and upper snap temperatures, TLS and TUS, respectively, can be adjusted within a wide range.

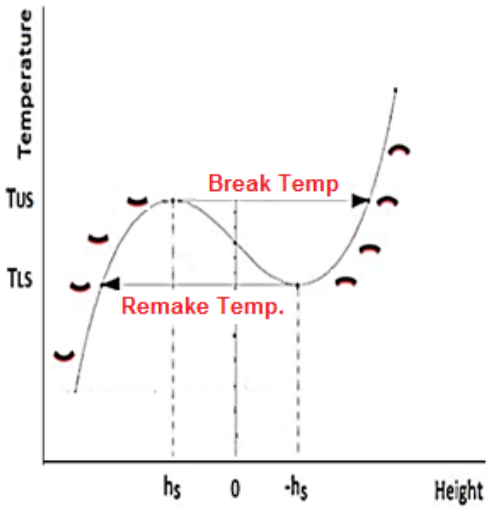


Figure 1. Qualitative characteristic of thermo-bimetal-snap disc.
The active steel layer is black and the passive invar layer is red (Ziga 2013)

The performance characteristics of the snap action disc are determined by a number of variables. These can be broadly classified into two groups: geometry and material variables. In order to optimise bimetallic shallow shell performance, it is necessary to define and understand these variables and identify the relative importance of each variable. Bimetallic shallow shell characteristics and variables are very specific, so the data about them cannot be easily found in literature. So, the effects of the shaping procedure and heat treatments of snap action disc on the instantaneous specific deflection of the temperature range will be investigated in this study.

Materials and Methods

In this study, manufacturing and calibration studies of the transducer using to control automotive engine temperature range to run on 86-94°C were performed. For this purpose, the test unit shown in Figure 2, was carried out design and production. The test unit is designed to simultaneously perform the control of 10 transducers and continuous stirring was applied to homogenize the oil temperature. At the same time the oil temperature is kept under control in the middle level of the oil in the tank by a precision thermometer.

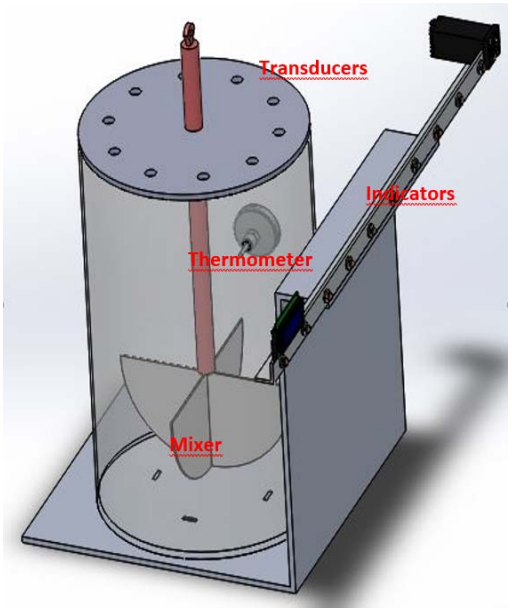


Figure 2. Test unit used in experimental studies.

A commercial bimetal strip was used for the manufacture of transducers. General properties of bimetal strip were given Table 1. The strip of bimetal material has a 0.2 mm thick and 25 mm wide was die cutted primarily in the form of a disk has a diameter 12.7 mm. Then, a hole has a diameter of 2 mm was die cutted to make it suitable for installation in disk from the centre as shown in Figure 3.

Table 1. The general properties of bimetal strip, used for manufacturing transducers

ASTM Type	TM2
High Expansion Alloy	Alloy P (72%Mn, 18%Cu, 10% Ni)
Low Expansion Alloy	Alloy 10 (36%Ni, Balance Fe)
Thickness	0,20 mm
Density	7.61 g/cm^3
Useful Deflection Temperature Range	-70 - 260 °C
Recommended Max. Temperature	430 °C
Specific Curvature (10-93°C)	39.1 x10^{-6} (mm/mm)/°C (Tolerance ±4%)
Specific Deflection	20.6 x10^{-6} (mm/mm)/°C

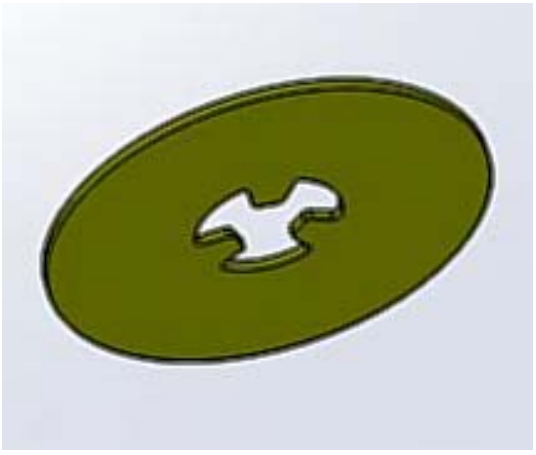
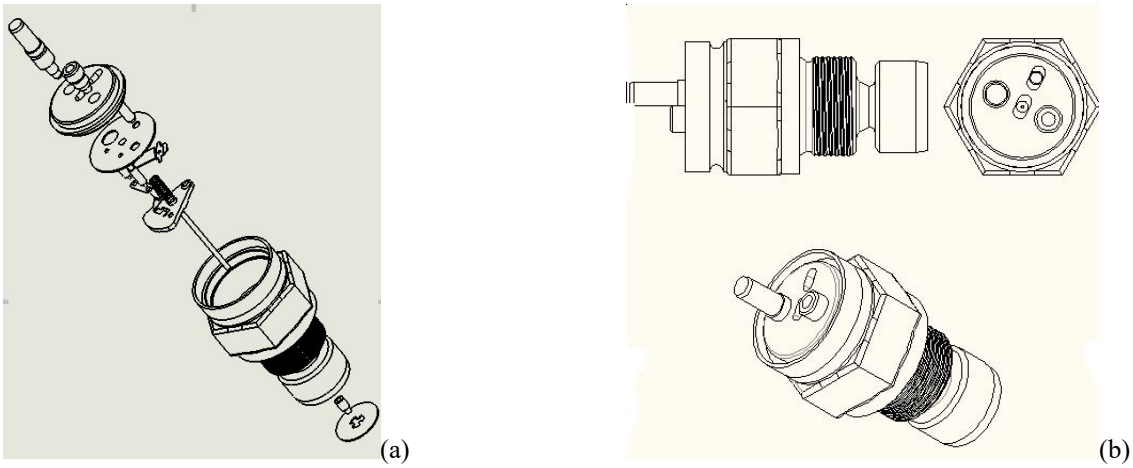


Figure 3. The schematic of the bimetal disc was die cutted for transducers

The parts of the engine temperature transducer (Figure 4a) and mounted transducers are shown in Figure 4b. The test unit was calibrated for the desired temperature range. The average values of every 10 measurements obtained from each transducer.



(a) (b)

Figure 4. The schematic of engine's temperature transducer used for experimental studies
a) The parts of transducer **b)** Mounted transducers

Results and Discussion

The performance of a particular bimetallic shallow shell can be summarized by the following process and material characteristics (Ziga 2013):

- Break temperature
- Remake temperature
- Force produced on snap through
- Shells life
- Temperature spread
- Specific thermal curvature of shell material

The break temperature (**The Upper Snap Temperature)** is the temperature at which a bimetallic shallow shell snaps from a concave to convex shape while being heated.

The remake temperature (**The Lower Snap Temperature)** is the temperature at which a bimetallic shallow shell snaps back from convex (broken shape) to concave shape while the blade is being cooled (Figure1). The difference between the break and the remake temperature is known as the "differential"

The test results of commercial bimetal strip used in transducers, the lower and upper snap temperatures, TLS and TUS, respectively, were given Table 2.

Table 2. Test results obtained from flat bimetal discs

Transducer	The Lower Snap Temperature (T_{LS}) (86±1°C)	The Upper Snap Temperature (T_{US}) (94±1°C)
S101	84.0	89.0
S102	83.0	88.9
S103	78.6	92.0
S104	84.0	90.0
S105	83.0	91.0
S106	87.0	98.5
S107	78.7	97.2
S108	92.8	95.4
S109	86.0	91.0
S110	86.0	98.0

Due to lack of the desired range of test results for the upper snap temperature and the most of the results are out of tolerance limit for the lower snap temperature, it was decided to form bimetal disc a shallow shell given in Figure 5. For this purpose, the bimetallic discs were loaded by a 3 MPa bending stress within 3 s to achieve desired shape has 0.50 mm height and 5° bending curvature.

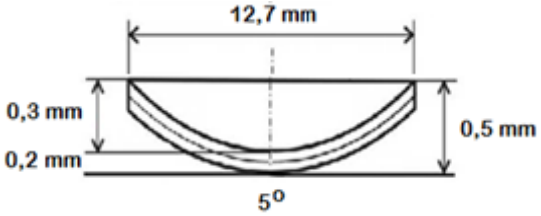


Figure 5. The schematic of the mechanically shaped bimetal shallow shell

After installation of transducers made of this shaped bimetal shallow shell were experimented in test unit. Obtained test result can be seen in Table 3.

Table 3. Test results obtained from pre-shaped bimetal shallow shell

Transducer	The Lower Snap Temperature (T_{LS}) (86±1°C)	The Upper Snap Temperature (T_{US}) (94±1°C)
S201	86.7	98.2
S202	87.6	91.5
S203	87.9	94.7
S204	87.5	91.0
S205	81.3	95.2
S206	82.0	95.4
S207	92.0	94.5
S208	89.5	89.6
S209	86.5	97.8
S210	85.6	93.5

Again because of the experimental results are not within the range to satisfy, it was decided to perform thermo-mechanical treatments to bimetal shallow shells. For this purpose, preformed discs heated to 350°C in a furnace then cooled in a stagnant air. After installation of transducers made of this shaped bimetal shallow shell were experimented in test unit. Obtained test result can be seen in Table 4.

Table 4. Test results obtained from preformed discs heated to 350°C in a furnace then cooled in a stagnant air.

Transducer	The Lower Snap Temperature (T_{LS}) (86±1°C)	The Upper Snap Temperature (T_{US}) (94±1°C)
S301	86.7	98.3
S302	88.0	92.0
S303	88.0	94.2
S304	87.3	91.5
S305	87.0	96.3
S306	82.4	96.3
S307	88.6	93.5
S308	86.7	90.0
S309	86.1	94.7
S310	86.2	94.9

Most of the experimental results are not within the tolerance limit, it was decided modify thermo-mechanical treatments. Firstly, preformed discs were heated to 350°C in a furnace then cooled immediately to -30°C. Then, discs were heated to 160°C in a furnace then cooled immediately to -30°C. This process was repeated 3 times. Obtained test result, after installation of transducers made of this shaped bimetal shallow shell were experimented in test unit, can be seen in Table 5.

Table 5. Test results obtained from the preformed discs were heated to 350°C in a furnace then cooled immediately to -30°C. Then, discs were heated to 160°C in a furnace then cooled immediately to -30°C. (Repeated 3 times)

Transducer	The Lower Snap Temperature (T_{LS}) (86±1°C)	The Upper Snap Temperature (T_{US}) (94±1°C)
S401	84.6	97.1
S402	88.7	95.0
S403	87.6	91.3
S404	86.9	92.7
S405	84.3	93.2
S406	87.6	90.3
S407	86.7	89.8
S408	87.4	97.2
S409	85.6	95.0
S410	86.5	92.8

Again these experimental results are not within the range to satisfy, it was concluded that the angle of curvature on the bimetal disc is insufficient. To increase bending curvature and achieve the shape has 0.60 mm height, the bimetallic discs were loaded by a 3 MPa bending stress within 3 s (Figure 6).

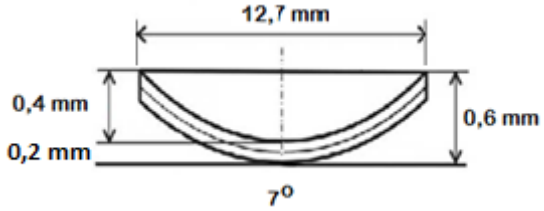


Figure 6. The schematic of the mechanically shaped bimetal shallow shell

After mechanical shaping, discs were heated to 350°C in a furnace then cooled immediately to -30°C. Then, discs were heated to 160°C in a furnace then cooled immediately to -30°C. This process was repeated 3 times. Obtained test result, after installation of transducers made of this shaped bimetal shallow shell were experimented in test unit, can be seen in Table 6.

Table 6. Test results obtained from the discs have 0.60 mm height and were heated to 350°C in a furnace then cooled immediately to -30°C. Then, discs were heated to 160°C in a furnace then cooled immediately to -30°C. (Repeated 3 times)

Transducer	The Lower Snap Temperature (T_{LS}) (86±1°C)		The Upper Snap Temperature (T_{US}) (94±1°C)	
	#10 repetitions	#50 repetitions	#10 repetitions	#50 repetitions
S501	86.0	85.1	94.0	93.5
S502	86.0	86.2	94.0	95.3
S503	86.0	86.7	94.0	94.0
S504	86.0	86.0	94.0	95.0
S505	86.0	87.1	94.0	93.6
S506	86.0	85.9	94.0	95.3
S507	86.0	87.1	94.0	93.6
S508	86.0	86.3	94.0	94.0
S509	86.0	86.0	94.0	94.5
S510	86.0	86.1	94.0	94.8

All transducers work at unique snap temperature. But as repetitions increase deflections from snap temperature increase. The life time of bimetallic shallow shells depends on repeatability and fatigue failure. The repeatability of bimetallic shallow shell performance characteristics under cyclic condition are of vital importance. If some significant deviation of any of these characteristics occur then appliances may not operate safely. After a sufficient number of cycles, bimetallic shallow shells will eventually fail due to fatigue. Premature failure of a bimetallic shallow shell could result in an unsafe appliance. Functional tests on controls and appliances are carried out as a matter of course to ensure the bimetallic shallow shells have sufficient fatigue life. These tests are also required to obtain necessary safety approvals for both controls and appliances.

In order to accurate exact snap temperature action for 100 recapitulate without any fatigue deflection, we decided to perform mechanical shaping process is repeated twice then the details of heat treatment mentioned above was applied. Obtained test result can be seen in Table 7.

Table 7. Test results obtained from the sample discs shaped twice by mechanically shaping process and heat treated by above procedure

Transducer	The Lower Snap Temperature (T_{LS}) (86±1°C)		The Upper Snap Temperature (T_{US}) (94±1°C)	
	#10 repetitions	#100 repetitions	#10 repetitions	#100 repetitions
S601	86.0	86.0	94.0	94.0
S602	86.0	86.0	94.0	94.0
S603	86.0	86.0	94.0	94.0
S604	86.0	86.0	94.0	94.0
S605	86.0	86.0	94.0	94.0
S606	86.0	86.0	94.0	94.0
S607	86.0	86.0	94.0	94.0
S608	86.0	86.0	94.0	94.0
S609	86.0	86.0	94.0	94.0
S610	86.0	86.0	94.0	94.0

Even after 100 repetitions no fatigue deflection was observed at any transducers. So we assured the digital behaviour for exact snap temperature and for all transducers.

Conclusion

The unique property of flexivity that characterizes thermostatic bimetals allows these materials not only to sense the temperature but also to control it by making or breaking an electrical circuit. Although the design of a thermostatic bimetal primarily depends upon the expansion characteristics of the components, resistivity is also critical in some applications. In addition, the strength and fatigue properties, interface integrity, and residual stresses play a major role in determining the behaviour of thermostatic bimetal elements.

The characteristic properties of transducers using thermostatic bimetal materials depend of mechanical shaping and heat treatments as well as materials properties. In this study, the digital switching action behaviour for exact snap temperature were assured by way of residual stress control with the application of unique mechanical shaping process and thermal treatment to stabilize the mechanical properties.

Acknowledgements

This study was supported by grants to the author from Sakarya University, Scientific Research Projects Coordination Unit project grant coded: 2016-21-10-001.

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THE EFFECTS OF WORKPLACE FRIENDSHIP ON JOB INVOLVEMENT

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Abstract: This study aims to investigate the assumed direct relationships between workplace friendship and job involvement. Data for the sample was collected from 63 employees working in Karabuk University School of Foreign Languages via survey method. Hierarchical regression analyses was conducted to test the hypotheses. The results show that friendship opportunity and friendship prevalence were positively related to job involvement and friendship prevalence has a bigger effect on job involvement than friendship opportunity. Theoretical and applied implications are discussed.
Keywords: Friendship Opportunity, Friendship Prevalence, Job Involvement

Introduction

This article discusses the effects of the workplace friendships on job involvement. What is more, we argue that workplace friendships have a significant role on the employees' job involvement through friendship opportunity and friendship prevalence.

Work and workplace provide opportunities to human beings to productively channelize energy and create something useful and meaningful and fulfill many of their needs. In this sense then both work and workplace are critical factors in creating purpose and focus in human life (Singh et al., 2012).

It's very common that working people spend much more time at their workplace than their homes. Working hours may vary but people usually work from 9:00 in the morning till 6:00 in the evening. Thus, working people meet other employees more than anyone else even their close friends, family members or neighbors in a week or month. So the relationships between employees at work become very important for the employers and for the company itself for reaching the organizational goals. As a result, close or distant friendships among employees can be a real advantage or disadvantage for the organizations.

Human beings have a social nature. They always try to be in contact with other people and to make relationships. Friendships develop in all kinds of settings. This happens all the time and in all parts of life, including work (Kiesel, 2011). If you've worked with the same company for several years, you've probably built many friendships. Some of your coworkers might be close friends, while others are individuals with whom you might share a weekend story on Monday morning. A friendship at work can become a powerful networking tool or a toxic relationship (Swales, 2015). Effective employment relations are vital to the workplace, whether at the time of recruitment, during an employees' tenure or at the time of separation. Employers, managers, employees and their representatives are all key players in this relationship. Where the employment relationship breaks down, conflict can occur (Wanrooy et al., 2011). To sum up, workplace friendships are often viewed as a positive aspect of organizational culture, but they can also be the cause of discomfort for employees and inefficiency in the organization (Morrison and Nolan, 2007).

THEORETICAL FRAMEWORK

Workplace Friendship

Many work settings are also social environments. Workers interact with their supervisors and co-workers about job-related matters, such as the job tasks that need to be done and the best way to accomplish these tasks. In addition, workers interact frequently about nonrelated job tasks, such as the weather, current events, and leisure pursuits. Because the workplace can often be a social environment, it has the potential to promote the formations of friendships (Chadsey and Rusch, 1988).

The workplace has become a uniquely important site for the building of cooperative and constructive social ties across lines of group identity and social division. Workplace cooperation, sociability, and solidarity all play a role

in promoting these ties, and all of those emerge out of basic features of human psychology and basic imperatives of human labor in a modern economy (Estlund, 2003). Relationships are important, as they are the mechanism through which we work. Organizations are built on people with skills and resources, and relationships are the links between those people. Good relationships are an investment, and a valuable tool which we use to help attain our work goals. In contrast, bad relationships are a liability. They can be emotionally draining and divert mental energy from work. Dealing with bad relationships can take up valuable time and lead to stress which in turn undermines work performance (Clydesdale, 2013).

Workplace friends share superordinate goals (to fulfil their interdependent work tasks), and workplace contacts have broad institutional support (the backing of managers, owners and the law). Moreover, given the time spent at workplaces, contacts are frequently personal and intimate. Functional and cognitive interdependencies and interpersonal contacts coincide in the prediction that diverse workplaces will generate diverse friendship networks (Kokkonen et al., 2015). In addition, friends at work also form a strong social support network for each other, both personally and professionally. Whether rooting for each other on promotions, consoling each other about mistakes, giving advice, or providing support for personal situations, comradeship at work can boost an employee's spirit and provide needed assistance (Rioardan, 2013). On the other hand, traditionalists argue that pals have no place at the office for a number of reasons. Friendship between colleagues can blur decision making, they say, making difficult decisions more complicated and leading to distractions or inappropriate behavior (Clark, 2013).

Workplace friendship is related not only to employee perception of people, but probably to perception of jobs, and thus affects employees' work motivation (Mao et al., 2012). In fact, it is sometimes hard to overcome the challenges of managing workplace friendships. Workplace friendships represent potential threats to the self-concept of friends if they obtain differential organizational outcomes; they involve the exchange of resources which are incompatible; and they represent contrasting norms of reciprocity. The emotional bond between colleagues may not overwhelm the competition they face over who will get promoted. Indeed, business challenges may be exacerbated by the friendship with rival or debtor. Workplace friendships bring benefits but may also intensify some relational costs (Ingram and Zhou, 2008).

Friendship opportunity, friendship prevalence are the two main subtitles of workplace friendship. Workplaces are the habitat for making friends. When people get a new job they normally meet new people and begin to know each other as they are together nearly more than 6 hours a day. Although workplace friendship depends on voluntary actions, workplaces offer lots of opportunities to socialize and to make friends. Since friendship is a close, mutual and voluntary dyadic relationship workplace is naturally related to opportunities for friendships in the workplace (Bornstein and Lamb, 2011). Song (2006) concluded that friendship opportunity and quality of friendship have a positive impact on work attitudes and not only do workplace friendships create alternatives to the negative effects often seen in working relationships, but workplace friendships can contribute to the positive aspects of a working relationship.

In organizations, patterns of friendship may vary by status, shared experiences, and interests (Kiopa, 2013). The prevalence of friendship(s) is expected to increase when the co-workers trust each other and spend time as much as after work. However, workplace friendships can lead to an increase in job satisfaction, job involvement, positive organizational commitment, longevity on the job, social support, communication and coordination, can enable shared values, and experiences and for the organization, workplace friendship increases institutional participation, motivates employees to better serve the organizational purpose, establishes supportive and innovative climates, and increases organizational productivity (Song, 2006).

After all, workplace friendship involves more than people merely acting in friendly ways or being mutual acquaintances: There must be trust, liking, and shared interests or values, too. Workplace friendships are sometimes limited to certain spheres of work or work-related leisure (such as having a "lunch" friend). Workplace friends usually are able to articulate what they like about another person or what they enjoy doing together ("What I like most about [working with] you is that …"), even though the relationship includes instrumental considerations as well ("I like you, and I need you, too") (Berman et al., 2002).

Job Involvement

Workplace friendships directly impact both job satisfaction and job involvement and friendship opportunities are associated with increases in job satisfaction, job involvement, and organizational commitment (Riordan and Griffeth, 1995). Job involvement plays a significant role basically on role segmentation and time and attention devoted to the job role at workplaces. There is an important link between the workplace friendships and job involvement at workplaces -the better the quality of workplace friendships, the better the job involvement and performance will be at the organizational level.

According to the Business Dictionary the definition of the job involvement is "The degree to which an employee is engaged in and enthusiastic about performing their work. Business managers are typically well aware that efforts to promote job involvement among staff tend to pay off substantially since employees will be more likely to assist in furthering their company's objectives" (Business Dictionary: 2015). Job involvement is the degree to which a person is identified psychologically with his work, or the importance of work in his total self-image (Lodahl and Kejner, 1965). Liao and Lee (2009) defined job involvement, "the extent to which a person's self-esteem depends on his or her work efficiency" (p.24).

The job involvement concerns the degree to which employees identify themselves with their job. It may be influenced by the level of satisfaction of one's needs- intrinsic or extrinsic (Gilkar and Darzi, 2013). Disengaged employees are an unfortunate reality in the workplace, and poor leadership is often to blame (Kim and Mauborgne, 2014). On the other hand, affectively job involved employees tend to do their jobs more eagerly and they generate behaviors that facilitate good human relationships for their organization (Ueda, 2012).

As noted by Jayawardanaa et al., (2013), job involvement represents a key factor influencing employees' levels of perceived organizational support and job satisfaction. Job involvement represents a cognitive and emotional identification by individual employees with their job. For highly involved employees, their jobs are connected with their identities, interests and life goals. Highly job-involved employees are more likely to be prepared to reciprocate the organizational benefits and supports provided to them, to exert extra efforts to ensure that organizational goals are achieved. They may also experience high levels of task identity, task significance and job autonomy. On the other hand, low job-involved employees are more likely to leave the organization, withhold work effort or 'engage in various undesirable on-the-job activities'.

Involved employees can use their insights to improve their jobs directly and jobs with a high degree of employee involvement might increase satisfaction. In conclusion, satisfied workers are more likely to increase participation in high-involvement practices and establishments with satisfied workers may be more likely to adopt new programs (Mohr and Zoghi, 2008).

The Effects of Workplace Friendship on Job Involvement

The importance of the link between workplace friendship and job involvement has been recognized recently in previous studies. The feelings of friendship affect the performance of the workplace. The personal relations in the workplace are associated with the higher level of job involvement. Workplace friendship increases institutional participation, motivates employees to better serve the organizational purpose, establishes supportive and innovative climates, and increases organizational productivity, job satisfaction and job involvement (Song, 2006). Workplace friends give each other more real job information/viewpoints and accept each other's information/viewpoints more than workplace acquaintances do, i.e., others with only a work relationship and workplace friendship has a positive relationship with perceived job significance and job involvement (Mao et al., 2012).

A friendly atmosphere within an organization, making the entire workforce enthusiastically work together in order to achieve individual employees' as well as organizational goals and it directly affects the level of the job involvement of the employees positively. Thus, employees with high job involvement are more focused towards their jobs, likely to have less turnover and leaving intensions and are more motivated to stay with the organization. They grow in expertise and thus become even more valuable to their employer and the organization. Employees with high levels of job involvement make the job a central part of their personal character and focus most of their attention on their jobs (Mohsan et. al., 2011). More involved persons also feel more competent and successful at work, believe that their personal and organizational goals are compatible, and tend to attribute positive work outcomes to their internal and personally controllable factors (Liao and Lee, 2009).

We expect that workplace friendship has effects on the job involvement and we examine the friendship opportunity and friendship prevalence greater detail in the following sections.

H1: Workplace friendship will be positively related to job involvement.
H1a: Friendship opportunity will be positively related to job involvement.
H1b: Friendship prevalence will be positively related to job involvement.

MATERIALS AND METHOD

Sample and Procedure

Data were collected from the employees' working in Karabuk University School of Foreign Languages via face to face survey. Surveys were distributed to 78 employees and all employees were invited to participate. From 78 employees 63 participants choose to participate and completed the questionnaire. Participants represented staff roles like teaching staff, manager and administrative staff. The questionnaire assessed demographic variables, dimensions of workplace friendship and job involvement. Participants were %51 male and %49 female. %73 working as teaching staff, %6 working as manager and %21 working as administrative staff. %9.5 high school or vocational school graduate, %65 college or university graduate and %25.5 master or doctorate graduate. %5 working in the university 1 year or less, %31.5 working in the university between 2 to 3 years and %63.5 working in the university more than 3 years.

Measures

Questionnaire was prepared in Turkish. Participants responded to all items using 5-point Likert scales (1 = strongly disagree to 5 = strongly agree) with items coded such that a higher score indicated a greater amount of the focal construct.

Items to measure *Workplace Friendship* were derived from Nielsen et al.'s (2000) study. Workplace friendship was measured along two dimensions: friendship opportunity and friendship prevalence. Six items were used to measure friendship opportunity and six items were used to measure friendship prevalence. A sample item for friendship opportunity is 'I have the opportunity to get to know my coworkers' and a sample item for friendship prevalence is 'I have formed strong friendships at work'. The Cronbach's alpha obtained for friendship opportunity was 0.94 and for friendship prevalence was 0.95. A Cronbach's alpha obtained for the workplace friendship scale was 0.93.

Job Involvement was measured by Kanungo's (1982) ten-item scale. A sample item for this scale is 'Most of my interests are centered around my job'. The Cronbach's alpha obtained for this measure was 0.93.

RESULTS

Prior to testing the hypotheses, separate confirmatory factor analyses were performed to examine the construct validity of the studied constructs (Tabachnick and Fidell, 2007). Several fit indices were used to assess model adequacy (Hair et al, 1998; Brown, 2006; Byrne, 2010; Kline, 2011), namely chi-square ($\chi 2$), the Root-Mean-Square Error of Approximation (RMSEA), the Goodness of Fit Index (GFI), the Normed Fit Index (NFI), the Tucker-Lewis index (TLI) and the Comparative Fit Index (CFI). RMSEA scores below 0.08 and GFI, NFI, TLI and CFI values above 0.90 represent a good fitting model.

In the analysis concerning workplace friendship, results suggest that the two-factor model had an acceptable fit with the observed data, $\chi 2(51)= 56.713$, RMSEA= 0.04, GFI= 0.88, NFI= 0.93, TLI= 0.99, CFI= 0.99. In the analysis involving job involvement, the model fit statistics were acceptable, $\chi 2(26)= 31.483$, RMSEA= 0.05, GFI= .91, NFI= 0.92, TLI= 0.98, CFI= .99.

Additionally, the convergent and discriminant validity was assessed of the scales by the method outlined in Fornell and Larcker (1981). For convergent validity, the composite reliability (CR) and the average variance extracted (AVE) were calculated in order to determine whether the measurement variable was representative of the related construct. All AVEs in Table 1 were 0.61 or higher, and exceeded the cutoff value of 0.50 (Fornell and Larcker, 1981; Hair et al., 1998), and all CRs were 0.93 or higher and exceeded the cutoff value of 0.70 (Fornell and Larcker, 1981; Hair et al., 1998). These results provided evidence for convergent validity of each of the constructs involved in the research model of this study.

The evidence of discriminant validity can be demonstrated when measures of conceptually different constructs are not strongly correlated among themselves as compared to similar constructs. In order to evaluate the discriminant validity, the square root of the AVE in each construct is compared with the correlation coefficients between two constructs (Fornell and Larcker, 1981; Hair et al., 1998). The square root AVE in each construct that appear on the diagonal in parentheses in Table 1 was larger than any correlation between the associated construct and any other construct. These results provided evidence for discriminant validity.

The means, standard deviations, zero-order correlations, and reliability estimates (α) for the measures used in the study are reported also in Table 1. As seen in this table, zero-order correlations were all in the expected direction and the internal consistency for each measure was above the 0.70 as recommended by Nunnally and Bernstein

(1994). In addition to this, correlations between measures never exceeded 0.85, suggesting that no bivariate multicollinearity exists between scales (Kline, 2011).

Table 1. Descriptive Statistics

	Mean	SD	α	CR	AVE	Correlations						
						1	2	3	4	5	6	7
1.Gender	1.50	0.50	-	-	-	-						
2.Staff Role	1.47	0.82	-	-	-	0.03	-					
3.Education	3.12	0.65	-	-	-	0.19	-0.41**	-				
4.Tenure	2.58	0.58	-	-	-	0.39**	-0.05	0.18	-			
5.Friendship Opportunity	3.62	0.84	0.94	0,94	0,72	-0.01	-0.11	0.25*	0.24	**(0.86)**		
6.Friendship Prevalence	3.38	1.03	0.95	0,94	0,73	0.01	-0.27*	0.29*	0.04	0.50**	**(0.85)**	
7.Job Involvement	3.38	0.89	0.93	0,93	0,61	0.05	-0.16	0.17	0.08	0.53**	0.71**	**(0.78)**

*p<0.05; **p<0.01; N=63, The square root of the constructs' AVE appear on the diagonal in parentheses

Hierarchical regression analyses were conducted to test the hypotheses (Table 2). Because they may affect the variables and relationships of interest, gender, staff role, education and tenure were included as control variables.

Table 2. Hierarchical regression analysis examining the effects of workplace friendship on job involvement

	Job Involvement	
	Step 1	Step 2
	β	β
Control Variables		
Gender	0,02	0,08
Staff Role	-0,12	-0,01
Education	0,11	-0,09
Tenure	0,05	-0,02
Independent Variables		
Friendship Opportunity		**0,25***
Friendship Prevalence		**0,61****
F Value	0.67	11.65**
R^2	0.04	0.55
Adjusted R^2	-0.02	0.50
ΔR^2		0.51**

*p<0.05; **p<0.01; N=63

Hypotheses 1a predicted that friendship opportunity would be related to job involvement. As shown in Table 2, friendship opportunity was significantly and positively associated with job involvement (β=0.25, p<0.05). Thus, Hypotheses 1a was supported.

Hypotheses 1b predicted that friendship prevalence would be related to job involvement. As shown in Table 2, friendship prevalence was significantly and positively associated with job involvement (β=0.61, p<0.01). Thus, Hypotheses 1b was supported.

DISCUSSION

This study was conducted to determine the relationship between workplace friendship and job involvement. For this purpose, data for the sample was collected from 63 employees working in Karabuk University School of Foreign Languages via survey method and the hypotheses were tested by hierarchical regression analyses.

The results of this study confirm and extend prior findings that workplace friendships influence individual and organizational outcomes (Nielsen et al., 2000; Kiesel, 2011; Mao et al., 2012; Asgharian et al., 2013). First, prediction relating to the direct effect of friendship opportunity on job involvement was confirmed. These findings suggests that when a job allows employees to talk with one another on the job and to establish informal relationships with other employees at work, employees are more likely to be committed to their organization identify themselves with their jobs. Second, study findings confirm the direct effect of friendship prevalence on job involvement. That is, when co-workers trust each other and spend time as much as after work, they are more likely to be committed to their organization identify themselves with their jobs. These results were similar to that of prior studies (Riordan and Griffeth, 1995; Nielsen et al., 2000; Morrison, 2004).

The findings of this study also showed that the effect of friendship prevalence on job involvement is greater than the effect of friendship opportunity. This finding shows that while the friendship opportunity is an important predictor of job involvement, spending more time and building trust between employees play a greater role for employees to identify themselves with their job.

This study was conducted on full-time employees labored in a university setting. Thus, the present findings have important implications for university organizations. Universities should be aware that by improving the friendship in working environment, employees will be more committed to their jobs and their organization. Friendship within the work environment may be severely underrated and underutilized as a condition for individual and organizational effectiveness (Riordan and Griffeth, 1995). But, as mentioned by Song (2006), workplace friendship motivates employees to better serve the organizational purpose and increases organizational productivity, job satisfaction and job involvement.

There were a number of limitations to the current study. First, the sample used for the analysis consists of just 63 people. So it limits the generalizability of the findings. Second, data were collected at a single point in time. Thus, the use of cross-sectional research design limits the ability to make causal relationships among the study variables. Future research can rely on experimental or longitudinal designs and provide more convincing evidence on causation.

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THE INTERACTIVE LEARNING OF INTEGRATING ANIMATION GAME WITH KINECT SYSTEM FOR SENIOR WITH MILD ALZHEIMER

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Abstract：Alzheimer's disease is one of the common problems for the elders. Some mild symptoms of the Alzheimer's might be misinterpreted as normal circumstances because of aging, leading to the procrastination of treatment process. Affected people would have a hard time managing activities of daily living and forget roads back home, which may jeopardize their live safety. Because the patients barely leave their homes, it may place significant burdens for patients themselves and caregivers.

This interactive game of this projects focuses on Flash, with the help of Kinect motion sensor of Microsoft, making a combination of software and hardware. The skeletal tracking feature of Kinect enables users to control the mouse and other objects through human body, which allows the elders to play some simple games at home. The researcher also used easy questions to observe whether the elders have problems of Alzheimer's, and further to facilitate their brain functions.

The interactive memory learning game for the elders – with the application of Kinect, was developed in this research. The motion sensor camera of Kinect makes human body become a game controller, which provides interactions for the memory match game. With the availability of Kinect, television, and computers, seniors with mild Alzheimer's can facilitate their hand control and limb movements through simple commands. The memory game could enhance brain stimulation for seniors with mild Alzheimer's and decelerate aging process, bringing about effects of sport and entertainment.

Keywords: Alzheimer's disease, Kinect, Kinesthetic system, Flash, Interactive learning

Introduction

1.1 Research Background

Alzheimer's disease is one of the most common types of dementia and the typical beginning symptom is dysmnesia. The patient will forget events which happened just now (short-term memory is poor), and early memory (long-term memory) is relatively not affected in the early period of the disease. When a relatively mild dementia occurs, the recent memory often forgets daily things, when it becomes severer, he forgets a friend's name, phone number, direction, etc., and often forgets to return to do the outstanding work due to other distractions.

Microsoft's Kinect can rely on the change of human's body skeleton to judge the extent of human motion and detect gestures according to the finger's posture so as to achieve more subtle judgment, the corresponding response is made in accordance with the judgment of the change of the depth value, the provided virtual images are like personal experience, and what is used is the inseparable relationship between human's body movement and hands, for example, touch, pressing buttons and induction are all technologies of the development of hand movements.

1.2 Research Motives

With the coming of aging society, the problem of life caring for dementia patients constantly appears in communities and families. In the early period of dementia, it is difficult for family members to distinguish whether the forgetfulness of parents is normal aging or disease, and they may fail to know the disease even it becomes moderate degree, as the appearance of the patients are the same as ordinary persons. The elderly with dementia often forget how to go home, leading to family members often looking for them everywhere, many families are afraid of the elderly with dementia going out alone once again, because of which the elderly with dementia often sit for a whole day in the home. As family members are busy with housework, the elderly with dementia have no object to speak to, which causes the memory of dementia patients to decline gradually.

With the popularization of TV video game system, almost every family member can play TV video game system in today's society, the age of the game also rises gradually along with the popularization of TV video game system, and the game types also gradually increase; so animation game is combined with Kinect to produce the game of "Memory Test in Interactive Learning among Dementia Patients", matched with Kinect device of TV video game system, and the game is operated with the body without the need to carry on any manipulation, which can not only use the brain to think about the topics in the game, but make the body move around.

1.3 Research Purposes

This research uses Flash animation to produce interactive learning game of "Memory Game of Dementia Patient", the purpose is to produce the interaction with memory game with Kinect dynamic camera released by Microsoft with the concept of body controller to use simple Kinect operation to make the elderly patients with mild dementia:

1. Use body to control to promote physical movement
2. Use memory games to improve brain agitation
3. Help the elderly with mild dementia to slow down the speed of decline in memory
4. Achieve movement in body and achieve the effect of entertainment.

Literature Review

2.1 What is Dementia?

Dementia is not a single disease, but a combination of a group of symptoms (Syndrome), mild symptoms not only include the loss of memory, but affect other cognitive functions, including language ability, space perception, computing power, judgment ability, abstract thinking ability, concentration and other various aspects of functional degradation, and meanwhile interference behavior, personality change, delusion or hallucination and other symptoms may appear, the severe degree of which is enough to affect the interpersonal relationship and the ability to work and so on. Usually, the first symptom found in patients is the frequent forgetting what has happened recently, and then they have difficulty dealing with daily life, work and rest, and the work they are familiar with in the past. The patients themselves may have personality change, behavior change, loss of judgment, finding no proper words to express themselves, thinking obstacle or inability to follow some instructions.

The main symptom of dementia is the loss of memory, we are often forgetful, but the forgetfulness of dementia is different from that of ordinary people; their memory loss is continuous and progressive but not occurs once in a while. These can affect the function of their work or family, sometimes they can not find the way home, and what is more severe is that they will forget how to wear clothes, eat or take a bath and other human's basic life ability.

Introduction in Relation to Kinect

2.2.1 Hardware

Kinect has three lens, and the lens in the middle is RGB color camera, which is used for recording color images. The lens on the left side and the right side are 3D structure optical depth sensor composed of infrared transmitter and infrared CMOS camera, which is used to extract in-depth data (the distance between the object in the scene and the camera). The highest resolution of color camera is 1280*960, and the highest resolution of infrared camera is 640*480. Kinect is also matched with focus tracking technology, the motor in the base will rotate as the focused object moves, and the maximum elevation upwards and downwards is positive and negative 27 degrees. Microphone Array is built in Kinect, which collects sound simultaneously through four microphones, the noise is eliminated after comparing, and the sound collection, speech recognition and sound source localization are made through it.

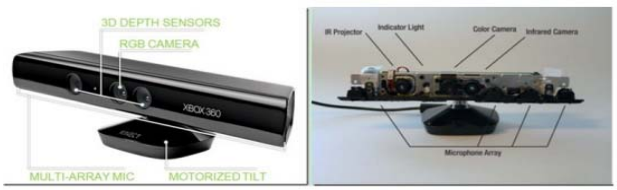


Figure 1, Kinect Sensor

2.2.2 Software

Kinect for SDK v1.7

Kinect integrates the continuous field depth snapshot of Windows sensor from Kinect to establish complete 3D model. SDK 1.7 also includes new Kinect interactive functions, including natural man-machine interface control

for the support of pushing and pressing (push to the button) (clip pan) and grasping and transferring, multiple people interaction and reorganization of gesture folding and unfolding: turn on and turn off hand recognition.

2.3 Interactive Learning

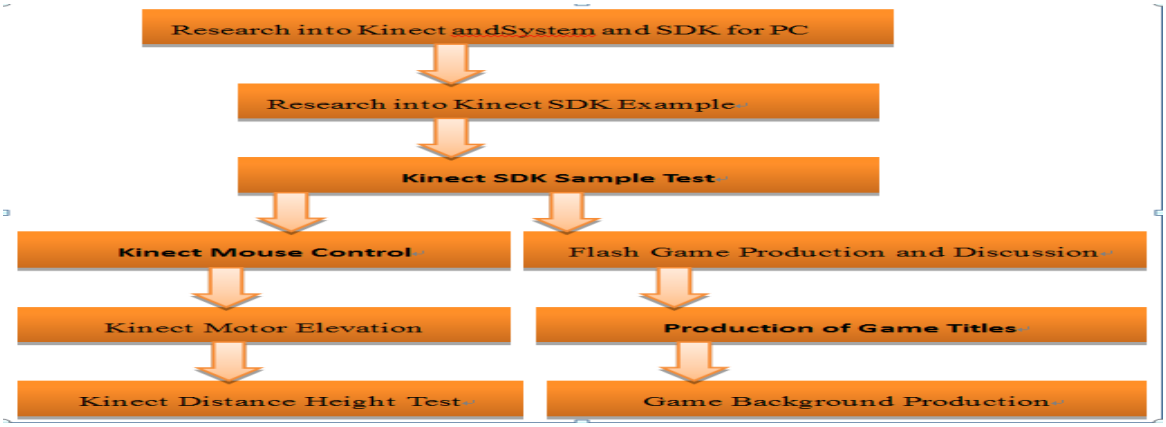
The application of Kinect is very extensive, which can be used in the operation and interaction of computer games, through body movement learning and game type learning, the operation of general carriers also have demand for interaction in order to avoid the touch of control system, housewives avoid using their hands with food residue to turn over electronic recipes while cooking, and simulation training, cognitive ability detection inspection, remote diagnosis and treatment, etc. in medical treatment.

In the learning application, such simple interesting physical interaction activities and games can be used and such method can also be used to achieve actual practice for dynamic learning topics such as dance, martial arts, sports and physical coordination, etc., and movement information relating to the learners can be collected as analytical skills and the data analysis on the coordination and fitness ability, thus further providing advanced personal body interaction learning tutoring.

Research Method

3.1 Research Process

3.2 Software and Hardware Demand and Development Environment Establishment



The demand for software and hardware in the development of Kinect application program is as follows, the operating system must use Microsoft Windows 7 operating system due to the need of software operating environment, and both 32 bit and 64 bit are available; hardware part needs CPU of dual core 2.66GHz and over 2GB RAM, supports display card of DirectX 9.0c or above and at least one Kinect sensor; software part uses Visual Studio 2010 or Visual C# 2010 Express to write program code, NET Framwork 4.0 environment and install Kinect SDK for Windows. It is suggested to install Microsoft DirectX9 as the skeleton detection part may be used.

3.2.1 Installation of Kinect for Windows SDK v1.7

For the installation of Kinect for Windows SDK, please do not connect Kinect with computer, and meanwhile Visual Studio 2010 is closed up to avoid the failure of installation. Load according to 32 or 64 operating system and install the corresponding Kinect SDK. Restart once again after the completion of installation so as to correctly

identify environment variables needed by Kinect SDK.

3.2.2 Installation and Testing of Kinect Sensor Drive Program

Before the installation of Kinect sensor drive program, network connection shall be confirmed to be normal. After connecting Kinect sensor with external power supply, then connect it with USB plug of the computer, and the system will automatically download and install necessary drive program after the steps mentioned above are completed.

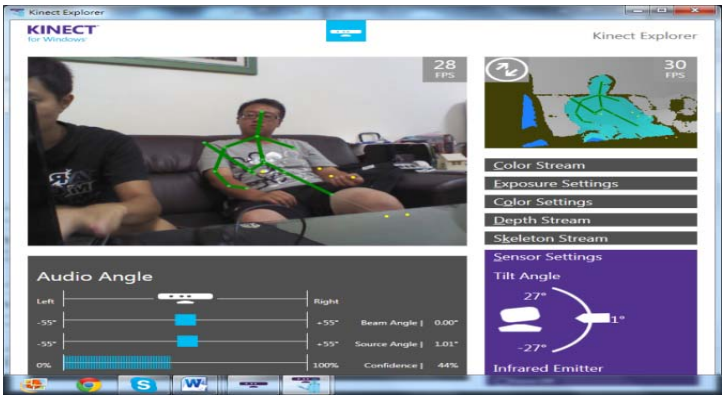


Figure 2. Start Kinect Explorer-WPF Program for Test

3.3 Adjustment of Motor Elevation

Use instruction
Right hand: move, change the position of mouse
Left hand: rise high, press down left button

Figure 3. Use and Instruction Interface of Mouse Control

3.4 System Structure

System mainly contains Kinect, Kinect for windows v1.7, Flash and C#; Kinect is responsible for sensing surrounding environment information and sending it to the computer, Kinect for windows v1.7 receives the environment information sensed by Kinect and executes actual mouse operation indication, computer integrates all the data to make decision on Flash game operation, and the whole system structure is shown in Figure.

3.5.2 Design Idea

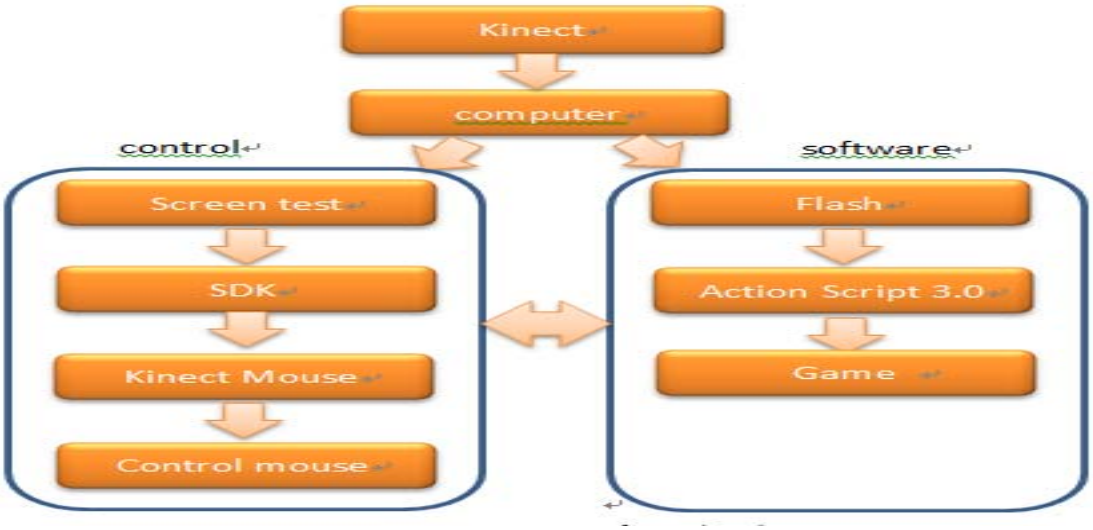


Figure 4 System Structure

Alzheimer's disease is the problem concerned by the whole world at present and its early symptoms occur mostly in people of more than 65 ages, but people of about 20-30 may have such symptoms due to the current way of life and pressure. The symptoms of Alzheimer's disease include irritability, aggressiveness, emotional ups and downs and loss of long-term memory, and our concept is mainly to use the mode of interactive games to help dementia patients train brain to strengthen the memory.

3.5.3 Improvement of Life

As the cases of dementia of elderly people increase year by year in our society, which causes troubles for a lot of families, besides, dementia leads to the memory of patients decline gradually, interactive learning game of "Dementia Kinect Interaction Game" is designed for patients with mild dementia, as the family members dare not make patients with dementia go out alone, they can only stay at home for a long time, or they must wait for their family members to accompany them to go out when they have spare time; while we produce interaction learning games to make patients with mild dementia think about the topics in the game and move bodies to operate TV video game to realize the activation of brain cells of patients and the movement of patient's body to slow down the decline of memory, this can make family members not afraid that patients have no speech objects at home when they are busy.

3.6 Internal Program

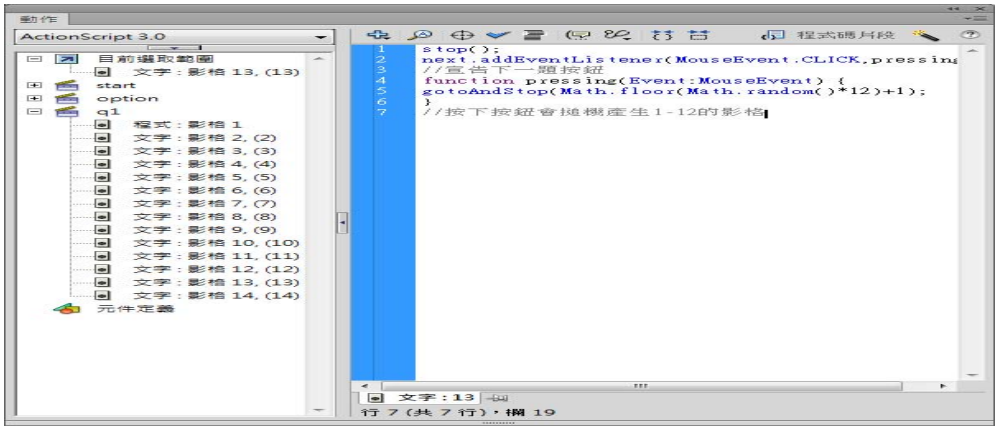


Figure 5. Adobe flash Program

3.7 Game Operation

Currently we make a measurement on the distance between Kinect device and operators, device angle and height so as to realize the best effect when operators are controlling mouse, but not make the mouse flap, nobody should stand behind the operators, Kinect mouse control is to capture hand movements of persons, so in case of two or more persons, the hand movements of the other person will also be caught, which will cause disorder of mouse.

Kinect layout height: about 64cm

Kinect elevation angle: 7 degrees

Distance between Kinect and operator: about 3.27 meter

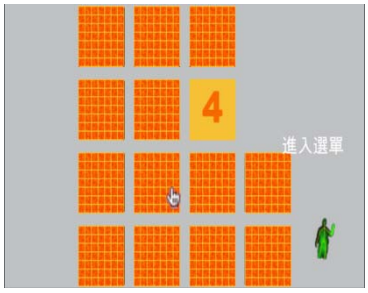


Figure 6. Game Menu

Conclusion and Future Studies

Kinect device is to combine computer to develop interactive learning system, this research uses flash software as the interactive operation mode of main game Kinect for the game. The main programming language of Kinect is C# program, Kinect is used to control the mouse and operate flash game, Kinect is connected to flash through continuous attempts, lastly the mouse control program is first started in the computer, the Kinect is used to operate flash game, the interaction learning in this plan which makes dementia patients test animation games in combination with Kinect has achieved initial effect, this research plans to present the game in future with 3D form, 3d max modeling software and Unity game engine platform are used to produce and develop works to make the pictures presented more delicate, this program has successfully completed interaction game learning system, which

has preliminary growth space for the health of dementia patients.

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THE RELATIONSHIP BETWEEN CHILD AND URBAN SAFETY: CHILD-FRIENDLY SAFE CITIES

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Abstract: The main concern of this study is urban areas open to risks despite the child's need for a safe and healthy environment in the childhood, lack of urban safety in the streets which are the socialization area and playground of the child and failure to develop child-friendly urban policies that can solve this safety problem. The aim of the study, on the other hand, is to identify the lack of safety for children using urban areas full of dangers during their developmental period, their needs of protection, failure of urban areas to provide safe environment for children and the shortcomings of child welfare system in this regard. This study handles current academic publications, current news and data from the international non-governmental organizations through children's rights and child-friendly perspective within the scope of literature review.

Anahtar Kelimeler: Child-Friendly Cities, Urban Safety, Child Welfare,

Introduction

In the scope of the Convention on the Rights of the Child and the Child Protection Law, it is an obligation to protect each child within the borders of Turkey against all risks, support their developmental processes, ensure child welfare under the modern childhood paradigm beyond the basic needs and provide safe living environment on the basis of rights-based approach and social justice approach. Despite these obligations in the legal legislation, policy processes and on paper, it is known that the situation is not quite like this in practice and on the contrary, the majority of children are facing serious problems such as poverty, abuse, drug addiction and violence, and that urban areas trigger these problems.

Literature Review

1. About Childhood

1.1. Childhood Concept and Modern Childhood Paradigm

In accordance with Article 1 of the Convention on the Rights of the Child, a child is described as; "For the purposes of the present Convention, a child means every human being below the age of eighteen years unless under the law applicable to the child, majority is attained earlier." Although the age of majority varies depending on the country, each person under the age of 18 is generally considered a child. Children are individuals; they have equal status with adults as a part of humankind. They are not the property of parents and the government. Healthy development and active participation of children are quite important for the future of all cities or communities. Children start the life as fully dependent individuals; however, they grow and develop with the assistance of adults to gain independence. They do not have only physical needs but also cognitive, emotional, social, psychological and physiological needs. Their dependence and developmental situations make them more sensitive, and therefore; they are affected more by the environmental conditions, poverty, insufficient sheltering, environmental pollution and other negative conditions compared to adults (UNICEF Innocenti Research Centre, 2004, p. 5).

According to Uçar (2013), prevailing child paradigm of the 20th century is based on three basic assumptions:

a. Children are different from adults; or children constitute a special biological category.
b. Children need to be prepared -raised- for adulthood or adulthood is an acquisition.
c. Child raising responsibility belongs to adults or the government (Uçar, 2013,p. 36).

1.2. Children's Rights

Turkey put the UN Convention on the Rights of the Child (CRC), which grants rights to "each child" without distinction of any kind, such as race, colour, sex, language, political, national, ethnic or social origin, property, disability, birth or other status, into effect in 1994. Protection of children against discrimination, ensuring their participation and looking after high benefit of children are under the responsibility of the Government. There as 4 fundamental rights including "*living, participation, protection and development*" that should be granted to children.

The UN Convention on the Rights of the Child ensured quite significant developments such as

- setting the ground for the preparation of Child Protection Law,
- meeting the needs of children, supporting their socialization, ensuring the improvement of their skills, recognizing and valuing their rights, preventing violation of their rights, strengthening their capacities, protecting children against dangers/risks and supporting their bio-psycho-social development.

1.3. Children's Needs

Being aware of children's rights is important in terms of designing and identifying the features of a child-friendly urban space.

Each child needs feeding, sleeping, moving and to be protected in order to develop as of the moment they were born. In addition, children have basic spiritual needs such as loving, to be loved, to be looked after, feeling successful and sufficient and gaining freedom like other individuals (Uçar, 2013, p.15). During their development, children have certain needs such as dependency, socialization and obtaining information regarding their environment (1st Istanbul Child Congress, Istanbul Child Report, 2000, p. 65).

Researchers such as Piaget, Montessori and Werner emphasize in their studies that interaction of children with the environment constitutes the basis of development, and the environment includes measurable physical components on cognitive-perceptual development. Considering that children use observation, exploration, trial and error methods while learning, it is a widely accepted truth that they need a physical environment with various resources (Kirazoğlu, 2012, p. 16).

Furthermore, while reviewing the literature to analyse the needs of children, it is observed that Maslow's (1954) hierarchy of needs model, Max-Neff's (1991) human scale development, Peet and Bossel's (2000) ethics-based system model regarding basic needs as well as conceptualizations for gender needs are of crucial importance.

2. Child-Friendly Urban Design

2.1. Relation between the Child and Space

Child-friendly environment concept does not only refer to the natural environment or constructed environment but also to the physical, psychological, economic, political and cultural environment. These environmental criteria determine the outline of children's lives based on physical, psychosocial, cultural, economic and even political existence. On the other hand, they are based on human rights and democracy to a certain extent (Horelli, 2007, quoted by Tandoğan, 2011).

Spaces hosting daily life and particularly housing areas do not only serve as shelters but they also determine the life quality in terms of differences between spaces people live in and accessibility or inaccessibility to public services. Repetition of opportunities and lack of opportunities in the spaces and their results bear important consequences for children living there (Erder, 2002:26-30; Ümit,2007:103). Physical environment and urban

spaces (particularly open areas) that children interact with play an important role in child development and growing to be healthy individuals (Zomervrucht, 2005). Experiences, emotions, hopes and concerns of children are shaped through spaces (Philo, 2000). Relation of children with the spaces refers to their socialization area beyond a physical space where they establish social relationships and gain social experiences (Moss and Petrie,2002).

2.2. Child-Friendly City

All people, social interactions, economic, political and social structures determining the wellbeing of children are experienced in certain spaces. Well-being of children is limited with the spaces they are interacting with. Children's living areas and neighbourhoods represent a space where they establish social relationship networks and experience cultural interaction beyond just a physical environment they reside in. Therefore, physical and social features of the residence have a determining role in the wellbeing of children (Semerci et al., 2012).

Children need areas where they can gain and reflect their unique experiences in the urban spaces. Existence of children in urban spaces is an inevitable element in creating healthy, lively and happy urban spaces as well as it is a requirement for their physical and mental development (Aitken, 2001). In other words, child-friendly urban area is a space supporting physical and social development of children so that they would become adults looking after their urban spaces in the future. In physical terms; children should like and feel safe in the urban spaces and in symbolic terms; urban design, planning and behaviours of adults should convey the message that children are an equal part of the society along with other individuals (Churchman, 2003, quoted by Kirazoğlu, 2012, p. 59).

Kytta (2003) developed a model with two fundamental criteria to identify whether a space is child-friendly. These criteria are free movement of children and meeting their desires, needs and expectations. Nordström (2010) identified that children rather conceptualize child-friendly city concept in these 3 aspects: “safety and security”, “urban and environmental qualities” and “basic services such as health and education”. (quoted by Severcan, 2015, p. 146,149).

Haikkola and Horelli (2002) determined 10 aspects of child-friendly urban spaces in their study through the eyes of children:

1) Housing and sheltering
2) Basic services such as health, education and transportation
3) Participation
4) Safety and security
5) Family, relative, friend and neighbour circle
6) Urban and environmental qualities
7) Existence and distribution of resources
8) Ecology
9) Sense of belonging and continuity
10) Good governance (quoted by Severcan, 2015, p. 145-146

Child friendly city foresees a good administrative system looking after children's rights and is obliged to realize organizations and activities required to ensure active participation of children in the city management and decision-making mechanism through all service units in the province, to evaluate all relevant decisions through the perspective of children's rights and to grant the right of equal access to all basic services (Çocuk Dostu Şehir Projesi Uygulama Yönergesi, 2006:2). Child-friendly city refers to a city where voices, needs, priorities and rights of children become an indispensable part of public policies and implementations. Actually, it is possible to consider such a city also as a human-friendly city. (Korkmaz, 2006, quoted by Topsümer, 2009, p. 9).

Furthermore, the most important issue in the relation between child and city is games. Urban outdoor areas such as playgrounds play a crucial role in the physical, perceptive and mental development of children. When there are even common parking lots of buildings, there should certainly be common playgrounds and recreation areas allocated for children. Children's desires should be listened and their opinions should be taken into consideration while making decisions affecting them. If children would not be aware of the results and impacts of their opinions, then their participation in urban design would not be realistic and meaningful.

However, urban spaces pose dangers for children as a result of decrease in open areas and increase in traffic density and safety problems due to disordered housing caused by rapid and unplanned urbanization. Due to these dangers, children are deprived of open areas and streets where they freely move and develop. This spatial deprivation

negatively impacts the development process, personality formation, behaviours, attitudes and reactions of children.

2.3. Child-Friendly Street

Child-friendly cities should include child-friendly streets. Streets are one of the public spaces used by children the most. Therefore, child-friendly streets should be organized to be able to think about a child-friendly city. Streets are the social centres of towns and cities, meeting points for protests, stages of oppression and places where children acquire their very first knowledge about the world and neighbours meet each other (Appleyard, 1981, p. 1). Streets are common living spaces. Social behaviours are formed in outdoor spaces more than indoor spaces. In outdoor spaces, individuals have the opportunity to feel that they belong to a certain community; streets, squares and arranged spaces serve also as communication areas (Bal, 2005, p. 3).

3. Child, Safety and Urban Safety

"Safety" criterion formed using (Kiss 2.0) is handled in two parts as social safety and traffic safety. *Social Safety:* Social safety can be ensured with the existence of people on the streets or with the direct view of streets from houses. In this way, children would feel safe. Jacobs (1993) underlined the relation between the number of people using streets and social safety as follows: A properly used street is a safe street. An empty street is generally unsafe." (Jacobs, 1993, p. 54).

Regarding “urban safety”, there are two different aspects to be taken into consideration. First of all, urban safety concept recalls safety need arisen during the urbanization process and the relevant strategies developed. Looking through this perspective, urban safety, first of all, includes an urban safety perception different from the rural one and relevant services (Kosiak 2003: 7). "Safe city" concept has always been considered as an indicator of civilization, and "urban rights" were born with the improvement of human rights in modern times. Safe cities can be seen as spaces where crimes are actively fought, offenders cannot take shelter, opportunities for committing crime are not provided, unplanned housing does not exist, people show determination and will to reach to the level of contemporary civilizations and feel happy, meet their needs and have high living standards (Derdiman, 2014: 273).

Regarding these points, safety engineering should focus on the issues related to ensuring the highest possible protection of each space, either open or closed, against crimes, implementing procedures and measures to minimize the possibility of committing crime in line with safe architectural designs and then, warranting a structure or habitation approval/license (Derdiman, 2013: 47, 48). On the condition that it is safe, allowing children to go to the grocery store or spend time on the streets increases their self-esteem and sense of belonging while ensuring socialization with their peers and inhabitants of the neighbourhood.

In addition, trust rather than safety concept should be placed in the centre in cities, and trust-building policies should be aimed rather than safety policies.

Conclusion and Discussion

As a result of the literature review conducted, it was identified that safety level of urban areas is insufficient, they pose many risks and children suffer from urban safety deprivation the most in the society.

For children feeling the challenges of living in urban spaces the most, it is quite important to build child-oriented structures and conduct policies, implementations and designs in urban planning in line with children's needs. Therefore, child-friendly city concept is frequently emphasized and relevant activities are conducted with the aim of making urban spaces more habitable for children. Realizing required arrangements and practices to make children's living environment more "*child-friendly*"; in other words " *informative, guiding and advocate* " is important in terms of creating spaces that can answer the needs and desires of children.

A child-friendly city refers to an urban area or local government system endeavouring to reflect children's rights in urban daily life. Urban areas where children's voices, needs, priorities and rights become an indispensable part of public policies and implementations are child-friendly. Therefore, such an urban area is also a human-friendly space.

It also refers to a space with qualities contributing to the physical, psychological and social development of children so that they would become self-valuing individuals in the future. In physical terms, urban spaces should arouse positive feelings among children, provide opportunities for game activities, make them feel safe and an equal part of the society along with other individuals through the behaviours of adults (Churchman, 2003). Their aim is to ensure that children participate in family, society and social life; meet their basic needs such as health and sheltering; benefit from healthy water and health services at the maximum level; are protected against abuse, exploitation and violence; walk on the streets safely; meet and play with their friends; have green areas with animals and plants; live in a clean environment; participate in cultural and social activities; and have access to all services regardless of their race, religion, income, gender and disabilities. (Unicef, 2004, p. 1; Sivri Gökmen, 2013, p. 822).

Urban areas should provide spaces supporting social interaction, equal opportunities, accessibility, self-esteem and cultural identity where children can meet their basic needs such as social justice, equality, sheltering, education, health and playing in accordance with the UN Convention on the Rights of the Child; and they should ensure that safe environments meeting the needs, expectations and desires of children are available.

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